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Improvement in laboratory test turnaround times for inpatients following move to hub and spoke model of delivery

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ABSTRACT

Objectives: The relative merits of hub and spoke models of service delivery are often debated, but accessing data on how they may benefit service delivery can be difficult, and may hinder the adoption of a model which can benefit the health community. Our aim was to provide objective data that would either support or refute one potential benefit of service redesign, namely the effect on turnaround times within the acute hospital.

Design and methods: Data on turnaround times for sequential requests containing creatinine as a request item received from inpatient locations at two acute hospitals were extracted from the laboratory computer system. Monthly data was collected for a period of 5 months prior to and the same 5 month period following the service redesign. Data was subjected to statistical process control (SPC) analysis.

Results: There was a statistically significant reduction ($P < 0.05$) in the average turnaround time of at least 29% for routine requests and 22% for urgent requests, accompanied by a statistically significant reduction ($P < 0.05$) in upper control limits of least 46% – improving the predictability of result availability and reducing the 95% confidence interval for turnaround times.

Conclusions: Adoption of a "hub and spoke" model has the potential to support laboratories in improving both urgent and non-urgent turnaround times in a cost-efficient manner within acute hospitals, and reduce the variability in turnaround time.

1. Introduction

A review of pathology services in the UK was completed in 2008, making a number of recommendations, the most recognised of which was the consolidation of laboratory services into fewer hub laboratories whilst maintaining acute laboratory services within hospitals [1]. Such a model is not uncommon in other parts of the world, but would be a significant change within the UK National Health Service (NHS). Whilst it may be assumed that the chief benefit of such consolidation would be in potential financial savings to the overall health economy, estimated to be between £250 m and £500 m p.a. in England, we believed from the outset that there were significant benefits to patients and their care within the acute care setting which would result from such a change, and also contribute to the more numerous recommendations around quality made in the review.

Following the formation of a Joint Venture with an independent sector partner (iPP) [2], we were able to transform service delivery within Somerset, from a model providing both acute hospital services and services for primary care physicians from laboratories within the acute hospitals to a hub and spoke model. An off-site Hub laboratory was created, and the laboratories within both acute hospitals were refurbished to enable co-location of all acute laboratory services within a single essential services laboratory (ESL) in each hospital operating 24/7.

An expected benefit of this transformation, removing non-inpatient work from the acute sites, was a decrease in turnaround times within the acute hospitals, without the need for an increase in staffing within the pathology service to provide the "hub and spoke" model.

This report highlights our findings in relation to turnaround times within the hospitals.

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2. Methods

Southwest Pathology Services provides laboratory services to Musgrove Park Hospital (MPH), Taunton (700 beds) and Yeovil District Hospital (YDH), Yeovil (345 beds). Both are acute admitting district general hospitals.

Data on turnaround times for sequential requests containing creatinine as a request item received from inpatient locations at both hospitals were extracted from the laboratory computer system, CliniSys Labcentre 1.9, using Clinisys PathManager 2.2 (CliniSys Solutions Ltd, Chertsey, UK). Turnaround times were calculated as the difference between time of sample entry into the laboratory computer and time of result availability to clinical users. Data was extracted for each month over a 5 month period prior to the commissioning of the hub laboratory and the same time period in the year following its commissioning.

The main chemistry platforms available prior to the opening of the Hub laboratory were: MPH – AU640+AU5800; YDH – two AU400 [Beckman Coulter, High Wycombe, UK]. Equipment was unchanged at YDH following hub commissioning, but analytical capacity was reduced at MPH with another AU640 analyser replacing the AU5800. Whilst staffing levels remained constant during the period of the study, training was commenced to increase the number of laboratory staff with multi-disciplinary competencies which gave greater flexibility to delivery of the service.

The implementation of the hub and spoke model resulted in a 60% reduction of workload at MPH and 50% at YDH laboratories compared to pre-hub levels. Test repertoires at both ESLs are largely comparable and are dictated by clinical requirements for immediate patient management.

The turnaround time for serum creatinine measurements was used, as it is the most frequently requested test within our acute hospital profiles. Data was collected for non-urgent inpatient requests (as a measure of "routine inpatient" turnaround times), and emergency department requests, all of which are treated as urgent (as a measure of urgent request turnaround times).

Data was subjected to statistical process control (SPC) analysis (SPC chart generator, Ian Snelling [3]) and the mean turnaround time, upper control limit (UCL), lower control limit (LCL) and mean moving range (MMR) established for each month. Additionally, the percentage of samples reported within 120 min (non-urgent requests) and 60 min (urgent requests) was recorded.

The results of pre-hub commissioning were compared with post-commissioning results using Students *t*-test. *P* values <0.05 were considered statistically significant.

3. Results

The results for average turnaround times, UCL, LCL and MMR are summarised in Table 1.

There was no significant difference in the numbers of monthly requests in each dataset pre- and post-hub commissioning, apart from an increase in the number of urgent requests received post-transformation at MPH ($P=0.034$). Overall, SPC analysis demonstrated a significant reduction in post-hub commissioning average turnaround times, together with a reduction in variability. All LCL values ranged from 0.0 min (36/40 results) to a maximum of 3.9 min (0.2, 1.1, 1.4, and 3.9 min).

For all other parameters a statistically significant difference was observed with improvements in both average turnaround time and reduction in the variability of turnaround time.

This was also reflected in the proportion of requests reported within 120 min (non-urgent requests) or 60 min (urgent requests), which although improved with reduced variance, at MPH, did not reach statistical significance, but did at YDH (Table 2).

4. Discussion

These improvements were brought about by moving to a hub and spoke model, which did not involve increasing staff numbers. We expected to see a decrease in average turnaround times and a reduction in variability, allowing a more consistent, predictable delivery.

Table 1
Mean and standard deviation (SD) of monthly SPC parameters over 5 months.

MPH: Non-urgent						MPH: Urgent					
	Mean TAT (min)	UCL (min)	LCL (min)	MMR (min)	Number of requests		Mean TAT (min)	UCL (min)	LCL (min)	MMR (min)	Number of requests
Pre-	78.3	257.3	0.0	67.3	8577.4	Pre-	46.5	133.7	0.0	32.8	1455.2
SD	8.40	44.86	0.00	13.79	334.62	SD	4.13	22.09	0.00	6.84	91.30
Post-	55.4	124.0	0.0	25.8	8281.6	Post-	36.5	74.1	0.8	14.2	1580.0
SD	3.15	10.33	0.00	2.74	472.80	SD	1.67	6.57	1.54	1.88	100.62
P	0.012	0.006		0.005	0.064	*P*	0.010	0.005		0.004	0.034
YDH: Non-urgent						YDH: URGENT					
	Mean TAT (min)	UCL (min)	LCL (min)	MMR (min)	Number of requests		Mean TAT (min)	UCL (min)	LCL (min)	MMR (min)	Number of requests
Pre-	84.6	251.4	0.0	62.7	5358.4	Pre-	42.1	141.7	0.0	37.4	1391.6
SD	3.48	16.91	0.00	5.23	226.46	SD	4.73	27.98	0.00	8.75	63.18
Post-	50.1	101.8	0.5	19.4	5313.0	Post-	26.2	57.2	0.0	11.7	1412.8
SD	3.32	7.44	0.62	1.68	197.24	SD	1.35	4.33	0.00	1.13	47.48
P	<0.001	<0.001		<0.001	0.708	*P*	0.003	0.004		0.004	0.688

MPH: Musgrove Park Hospital, YDH: Yeovil District Hospital, TAT: turnaround time, UCL: upper control limit, LCL: lower control limit, MMR: mean moving range, Pre: pre-hub and spoke, Post: post-hub and spoke.

Table 2
Percentage of results available within 120 min (non-urgent requests) or 60 min (urgent requests) (mean monthly figures over 5 months).

		Pre-	Post-	*P*
MPH non-urgent TAT < 120 min	Mean	94.0	96.9	0.102
	SD	1.99	0.88	
MPH, urgent TAT < 60 min	Mean	87.8	91.1	0.142
	SD	2.76	1.53	
YDH non-urgent TAT < 120 min	Mean	86.5	96.8	< 0.001
	SD	0.69	1.29	
YDH, urgent TAT < 60 min	Mean	91.6	96.5	< 0.001
	SD	0.77	0.83	

MPH: Musgrove Park Hospital, YDH: Yeovil District Hospital, TAT: Turnaround time, Pre: Pre-hub and spoke, Post; Post-hub and spoke.

This has been seen in both hospitals, for both urgent and non-urgent requests, with an improvement of 29% and 22% in average turnaround time for non-urgent and urgent requests at MPH, and 41% and 38% for the same parameters at YDH. The difference in improvements seen at the two sites may be related to two factors. MPH has a significantly greater workload for non-urgent ($P < 0.001$) and urgent requests ($P < 0.04$), and YDH already had a single reception and laboratory space whereas the reception and laboratory areas at MPH were in several different rooms. At the time of writing this report, a new essential services laboratory (ESL) has been refurbished at MPH allowing co-location of all reception and laboratory functions into a common area, and we will be studying the impact of this brings on turnaround times.

Perhaps more significant is the improvement in the 95% confidence limits on turnaround times, as shown by the reduction in UCL, which fell by at least 46% and 56% at MPH and YDH respectively. To have achieved such an improvement without moving to a hub and spoke model would have required significant investment in estate to create a "cold" laboratory on each hospital site in addition to an ESL, and an increase in staff numbers to ensure that both were adequately resourced to ensure separation of workstreams – in effect to "lean" two separate processes. This move to a greater consistency of turnaround times has been most obvious during what were the peak periods of laboratory activity (afternoon/early evenings) when large volumes of primary care work also had to be processed. We now see a consistent average TAT across different parts of the day, together with a consistent UCL in both laboratories (data not shown).

Currently within the UK NHS there is a focus on delivering services within a constrained financial environment. Professionals are keen to play their part within this, but without compromising quality or affecting patient care or safety. Improving the timeliness of the availability of patient results in the acute setting will support more effective and safer patient care. Diagnostics are a key part in patient care and management within an acute setting, often quoted as being involved in 70–80% of health care decisions affecting diagnosis or treatment [4]. This appreciation of the importance of tests is reflected in the recent proposed key performance indicators (KPIs) from the Royal College of Pathologists [5] which proposes that 90% of key test results from Emergency departments should be available within 60 min of arrival in the laboratory by April 2014, and an aspiration that this time should in future be the target between the sample being taken and the results reported. There are many potential solutions to delivering these KPIs, but rather than adding additional resources (both equipment and staff), into acute hospital services (given the current financial constraints within the NHS), the data presented above shows improvements in turnaround times, whilst allowing for improved cost efficiencies to the health economy [1].

5. Conclusions

A move to a hub and spoke model of delivery for laboratory diagnostic testing alone can deliver benefits in significantly improving the timeliness and predictability of delivery of results to clinicians in an acute setting. Further changes and refinements within the acute hospital laboratories may further improve delivery of diagnostic tests.

Contributors

DT was responsible for extraction and manipulation of data, review and editing of manuscript, DJ was responsible for statistical analysis and drafting and review of manuscript.

Conflict of interest

None.

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