The application of TQM in a hospital's casualty and pathology departments

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Introduction

To be successful in the long term, an organization must produce quality goods or services. Quality is the value of goods or service as perceived by the customer. In recognition of these realities, good managers will establish a set of quality management principles that focuses on customer satisfaction and continuous improvement in the organization's processes. This set of principles is known as total quality management (TQM)[1].

Although the details may vary, the same TQM principles and concepts can be, and have been, successfully applied across enterprise types[2]. Generally, manufacturing enterprises have been leaders in TQM applications, and service firms have rapidly followed this lead. An exception has been the health-care organization[3].

In health care, quality monitoring has focused on individual performance and decision making. Historically, quality assurance methodologies embellished the theory of the "bad apple" or of finding the individual with a pattern of less than optimal care outcomes. In recent years, the cost of health care has become a major concern, and competition surfaced as a significant factor for health-care providers. These providers began to realize that customer (patient, family, physician, insurer and employee) satisfaction would be a major determinant for survival in the newly competitive marketplace. The health-care industry began to examine TQM and the success stories of the manufacturing and service industries.

Although TQM may be in various stages of implementation throughout health care, the entire industry has embraced the concept. In addition, the Joint

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Commission on Accreditation of Healthcare Organizations (JCAHO) has been progressively incorporating TQM into the accreditation process. Because of the market and accreditation pressures, hospitals are attempting to implement TQM philosophies and concepts. An American Hospital Association (AHA) study, for example, showed that 44 per cent of the surveyed hospitals use TQM to improve performance[4].

As Table I illustrates, all hospital TQM applications seek ways to lower costs and improve care. Some focus on improving administrative practices. Others concentrate on enhancing hospital operations. Additional applications demonstrate the use of TQM in ameliorating direct patient care processes (see[1,5-11]).

One area in which TQM has not been applied extensively is in the co-ordination of accident and emergency room (AE), i.e. casualty and pathology

Focus	Application	Benefits	Reference
Administrative practices	Human relations	Improved team productivity	Wakefield and Wakefield[5]
	Use of data for patient population risk, physician performance and reimbursement	Planning for future services, establishing "good practices"	Goldfield[6]
	Patient care redesign	Improved appropriateness-of-care indicators	Ventura *et al.*[7]
Hospital operations	Billing	Reduced inaccuracy of bills from 1,700 to 100 per month	Buterbaugh[8]
	Scheduling of facilities	Improved occupancy of operation room	Buterbaugh[8]
	Linking two hospitals' facilities	Improved patient satisfaction, reduced pathological tests	Hudson[9]
Patient care	Critical care unit	Improved patient outcomes, improved staff and patient satisfaction	Buccini[1]
	Accident and emergency through-put	Reduced patient elopement, increased patient volumes	Aldrich[10]
	Post-operative tests	Reduction in missing ECG results, lab tests, improved OR scheduling	Buterbaugh[8]
	Chest pain team	Reduction in the number of admission with chest pain	McEarchern *et al.*[11]

Table I.
TQM applications in health care

operations. This co-ordination is important for several reasons. Pathology turnaround time significantly affects AE care, attending staff satisfaction, and the patient's perception of quality. Improving this turnaround time can provide the hospital with an advantage over the competition. Since the accident and emergency room accounts for a sizeable portion of hospital admissions, such an advantage can have a substantial impact on financial performance.

Several studies have been conducted to review the quality of pathology laboratory performance through increased turn around time (TAT) in hospitals[12-14]. The College of American Pathology (CAP) publication *CAP Today* observes that a laboratory should be able to provide 90 per cent of tests ordered by AE within 45 minutes of the order. However, only 30 per cent of the hospitals participating in the studies were able to meet this goal. Ringel[15] indicates that doctors expect the TAT to be below 30 minutes which can be achieved by optimizing every possible method and pathway.

This article explains how TQM can be used to facilitate the co-ordination and optimization of hospital's AE department and pathology laboratory operations to improve TAT, and thus patient service. A case study involving these operations at a medium-sized, regional hospital is used to illustrate and validate the concepts. The article first overviews the case and the objective of the study. It then describes the flow of the AE laboratory process. Next, it describes how TQM was used to improve the co-ordination of the hospital's AE and pathology operations. The article then presents the benefits and lessons learned from the TQM application and the implications for hospital management.

Overview of the case

The TQM study was conducted at a 460-bed multi-specialty facility in a metropolitan suburban area. The hospital's AE accounts for approximately 40 per cent of the annual 20,000 in-patient admissions. Therefore, the efficient functioning of the AE is critical to the hospital's performance. For a number of years, the casualty department had been requesting faster turnaround time from the supporting pathology laboratory.

Goal of the TQM study

The goal of the TQM study was to reduce the TAT of the Stat lab tests, currently 60 minutes from the time they are ordered. Specifically, the goal was to reduce the TAT to 30 minutes. Administrators believed that the improved TAT would place the casualty department in a competitive position with other area casualty departments. As part of the TQM effort, the team was required to document the patient and specimen flows and collect data of the time it took at various points in the process.

Patient and specimen flows

Figure 1 illustrates the progress of the patient flow within the AE of the hospital. As the figure illustrates, when a patient reports to casualty, the Triage nurse

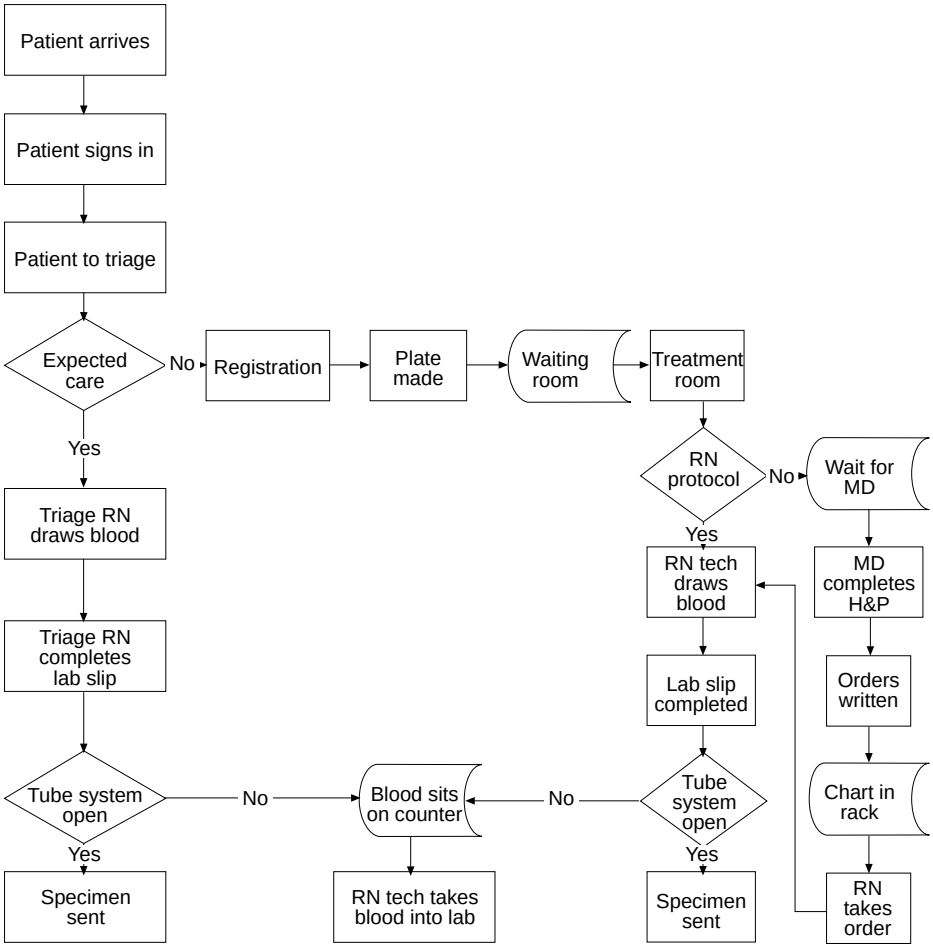

Figure 1.
Depicts flow of process from time patent arrives in hospital to time lab specimen is sent

assesses the patient's condition. If immediate care is needed, the patient is taken in for treatment; otherwise, the patient is diverted to registration.

Diagnosis and treatment for almost all AE patients require pathological tests. After receiving the patient, the AE sends specimen (blood, urine and other) samples to pathological laboratories (a regular lab and often a Stat lab for urgent cases). The flow of specimens within the laboratory is shown in Figures 2-4.

Figures 2-4 document the sequence of tasks for management study and policy improvement. They also identify the activities that must be co-ordinated with AE operations. The patient flow described in this article is typical of most hospitals.

Activity co-ordination

Diagnosis and treatment cannot be initiated until laboratory test results are received. To reduce TAT, then, administrators must improve the flow of

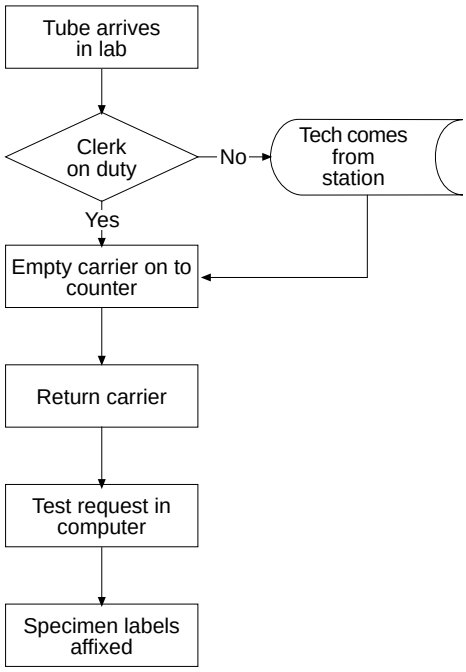

Figure 2.
Depicts flow of process from time lab receives specimen to the time just prior to specimen testing

specimen samples and information between the casualty and pathology departments. It is apparent from Figures 1-4 that such improvement will require the effective co-ordination of a number of activities. A delay at any step will hamper the entire process.

Some staff members made informal suggestions to improve the flow of specimen samples between the AE and pathology departments. These suggestions, however, were non-comprehensive in nature, and they had a minor impact on the turnaround time.

TQM solution

The senior management recognized the need for a systematic analysis of the operational links between the casualty department and Stat lab. Taking action, the management authorized the vice-president on clinical information/risk management to constitute a TQM team that would develop ways to improve the co-ordination of AE and Stat lab operations using the principles of TQM and continuous quality improvement (CQI). The objective of the effort was to achieve an industry-competitive pathology TAT.

TQM team

The TQM group, called the Casualty Department/Laboratory Continuous Quality Improvement Team, was the first official TQM/CQI assembly within the hospital. It was led by the chief of medicine (an MD) who was familiar with

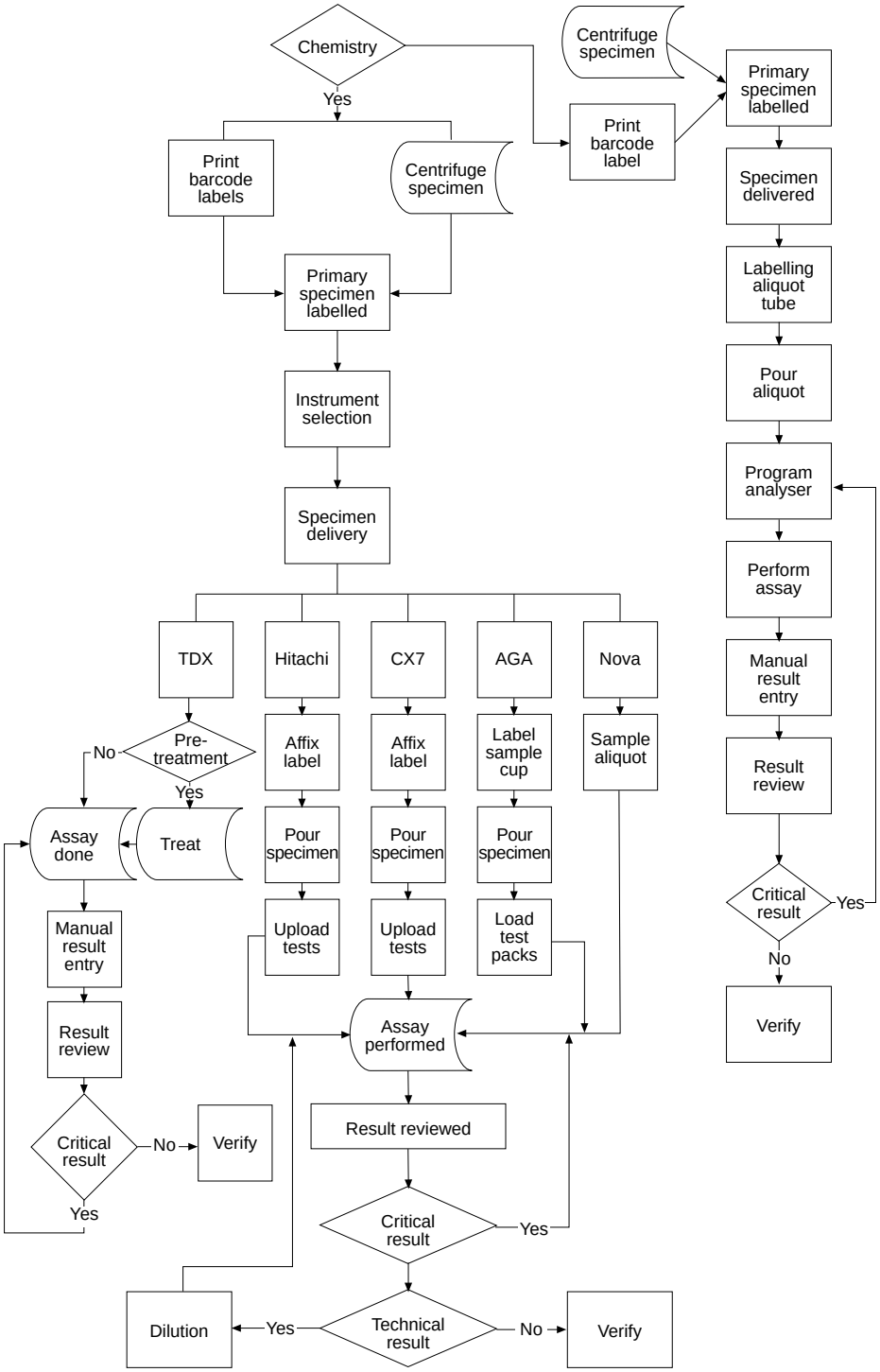

Figure 3.
Depicts flow of lab process which involves specimen testing related to coagulation

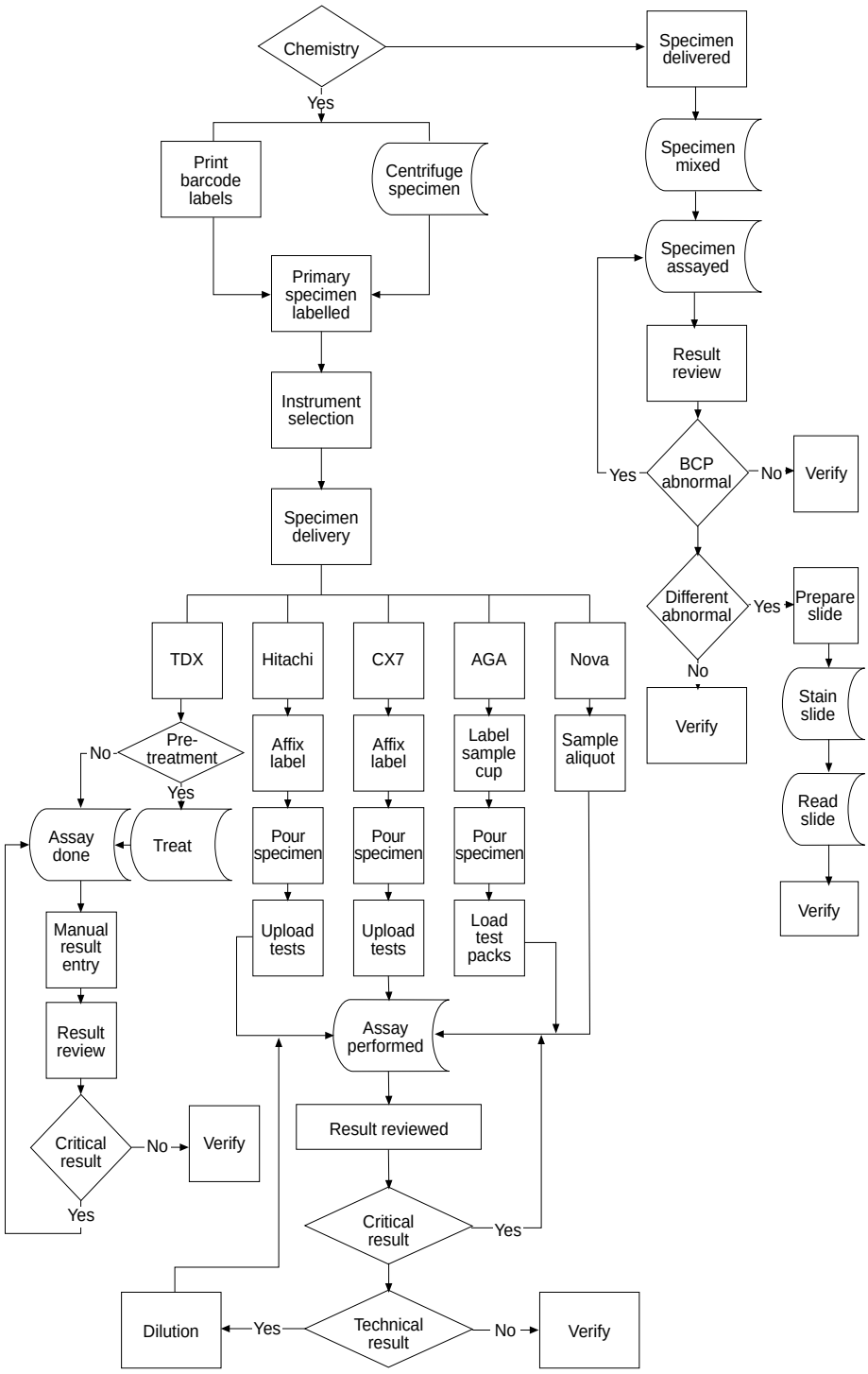

Figure 4.
Depicts flow of lab process involving haematology to time results are verified

the workings of the hospital, and it consisted of personnel from casualty, laboratory, quality assurance, and hospital information systems departments.

Casualty. Casualty personnel involved one doctor, two nurses, and one administrative staff. The doctor was the head of emergency medicine while the nurses were the head AE nurse and a staff nurse. Administrative staff was a representative from the registration department.

Laboratory. Laboratory personnel comprised two doctors, two administrators, and a technician. The doctors were the head of pathology and one additional pathologist, while the technician was a lab worker. The administrators were the director and the technical director of the medical laboratory.

Quality assurance and hospital information systems. Quality assurance personnel consisted of the manager of quality assurance, who was the facilitator of the TQM team, and an RN representative, who was the scribe for the team. The hospital information systems department's member was a systems analyst.

Team agenda

Initially, the team underwent a rapid orientation to TQM/CQI. The goals of the team were outlined, issues were identified, and actions were taken to resolve these issues.

Goals and issues. The team acknowledged that the customer was the AE patient. It also agreed on an objective of reducing turnaround time for Stat lab results. After studying the patient and specimen flows in detail, the team consensus was that data collection and staff resistance presented major barriers for the project.

Existing hospital information systems did not contain the data needed to implement TQM/CQI successfully. Since there was no way to collect the essential information from these systems, manual data collection was required. The team decided that sampling through observation was the best method to collect the necessary data.

Issue resolution. The casualty and laboratory team members identified the factors that can cause variations in AE and Stat lab work volumes. Virtually all were time-based (day of the week, hour of the day, shift, breaks and so on). A sample was designed to collect representative work condition data[16]. In the design, the team facilitator and a nurse observed patient and specimen flows over three whole (eight-hour) shifts on sampled hours of the day, including breaks, for three different days of the week. Collected data were recorded on worksheets such as the document shown in the Appendix.

The worksheet collected the data in a form that was suitable for statistical analysis. It also provided the supporting detail that would be useful to explain the analytical results. Moreover, the document served as a store of the collected data.

To minimize any potential "Hawthorne effect" (having the observation alter subject behaviour) and to alleviate employee fears, the sampling process was discussed thoroughly with staff from both the AE and Stat lab. The TQM team

explained that the focus of the project was on the patient and specimen flows and not on any employee's individual performance. AE and Stat lab staff were assured that the TQM implementation would not threaten their jobs or advancement prospects. These staff were requested to work at their normal pace during the observation period.

Data analyses

Raw data from the worksheets were accumulated and the composite was recorded in tabular form. Table II illustrates a portion of a composite table. The figure focuses on the supporting detail for justification and explanatory summary reports; and provides the data for the graphic representations included in the summary reports for management.

Data were compiled for three specific tests – SMA7, BCP and Differential – and depicted with histograms (bar charts) with written descriptions. The first series of charts showed the percentage of tests that were completed within 30 minutes by day, shift and test. Figure 5 gives an example of this first type of chart. A second series of charts displayed performance by department. Figure 6 gives an example of this second type of chart. Diagrams such as Figures 5 and 6 helped the team to understand the variable relationships better. They also suggested directions for further evaluations and analyses.

For example, the first and second series of charts induced the TQM team to develop a Pareto diagram that showed, by test, the turnaround time in excess of the 30-minute standard. Figure 7 illustrates the Pareto diagram. Based on the Pareto diagram findings, the team was led to investigate the Stat lab's average TAT by shift for selected tests. Figure 8 gives an example of this type of chart.

The TQM team also was interested in determining whether there could be factors other than TAT that might impact patient flow within the casualty department. Consequently, the team developed a final chart that compared times in the AE by shift in total and after laboratory results were available. Figure 9 illustrates this last type of chart.

Decision analysis

Using the results of the data analyses, the TQM team had a brainstorming session to develop alternative problem solutions. This session generated the following technically, organizationally, and economically-feasible alternatives:

- utilize heparinized whole blood instead of serum to decrease the pre-test prep time;
- dedicate a tube system to carry the specimen samples from the AE to the Stat lab;
- add clerk coverage in the Stat lab to cover lunch and other regular workbreaks;
- increase technical staff coverage in the Stat lab between 5 p.m. and 1 a.m. to accommodate additional physician coverage in the AE department;

Table II.
Sample turn around time (TAT) for casualty department Stat lab results

MR#	Date	Shift	Logged in	Time in registration	Time out registration	Time in triage	Time out triage	Triage draw	Triage sent	AE orders	AE draw	AE sent	Test type	Arrival lab	Comp login	Centrifuge	Instrument	Sample	Results available
33-85-70	12/14	11A-1P	10:55	10:55	NA	10:39	10:48			11:27	11:10	11:28	CHEM	11:31	11:32	11:37	11:44		SMA7 12:-06
	Mon												HEM	11:31	1:31:30		11:34		BCP 11:46
																			DIF 12:03 (MAN)
04-65-54	12/14	11A-1P	11:00	NA	NA	NA	11:55			11:31	11:28	11:32	CHEM	11:37	11:39	11:44	11:57		SMA7 12:01
	Mon												HEM	11:37	11:39		11:41		BCP 11:46
																			DIF 12:30 (MAN)
46-12-19	12/14	11A-1P	11:55	12:20	NA	NA	11:53			12:25	12:08(1)	12:45	CHEM	12:47	12:51	12:55	1:01		SMA7 1:31
	Mon										12:30(2)		HEM	12:47	12:51		12:56		BCP 12:56
											12.40(3)								DIF 1:25 (MAN)
50-39-93	12/14	11A-1P	11:45	11:45	NA	NA	11:33			12.28	12:10	12:48	CHEM	12:52	12:53	12:54	1:01:30		SMA7 1:18
	Mon												HEM	12:52	12:53		12:55		BCP 1:00
																			DIF 1:01
30-71-97	12/14	11A-1P	11:45	12:00	NA	11:42	11:55		12.26				HEM	12:29	12:30		12:33		BCP 12:34
	Mon																		DIF 12:34
50-35-33	12/4	5-7P	4:45	4:42	4:49	4:32	NA			6:02	5:23	6:05	CHEM	6:05	6:06	6:06	6:16	6:17	SMA7 6:23
	Fri												HEM	6:05	6:06		6:07	6:08	BCP 6:03
																			DIF 6:03
46-69-05	12/4	5-7P	4:12	4:05	4:15	3:54	NA			5:30	5:53	5:57	CHEM	5:59	6:01	6:03	6:09	6:10	SMA7 6:21
	Fri												HEM	5:59	6:01		6:02	6:06	BCP 6:06
																			DIF 6:07
29-97-93	12/4	5-7P	4:25	4:28	4:35	4:22	NA			5:45	5:50	5:51	CHEM	5:54	5:57	6:03	6:09	6:10	SMA7 6:21
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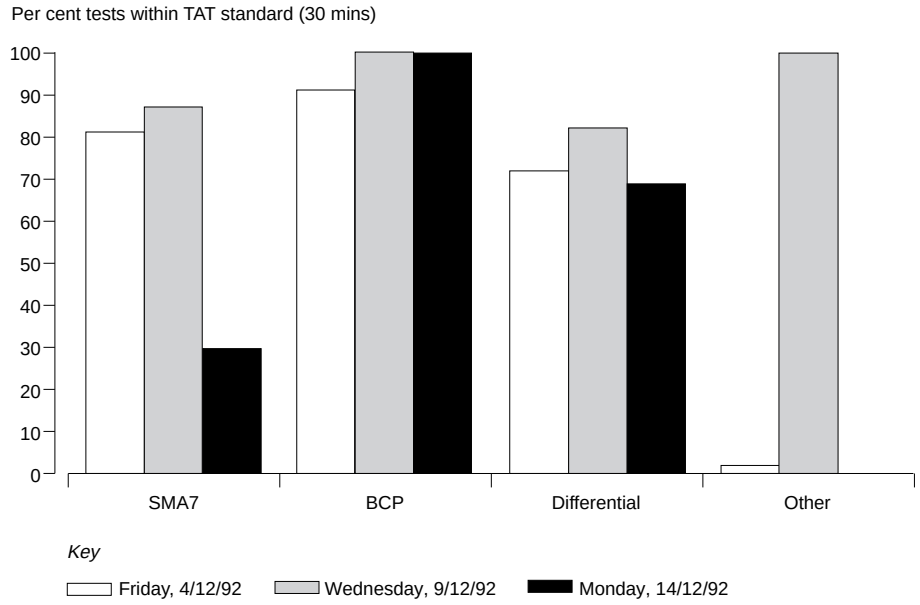

Figure 5. Lab performance related to four test types and comparing three days

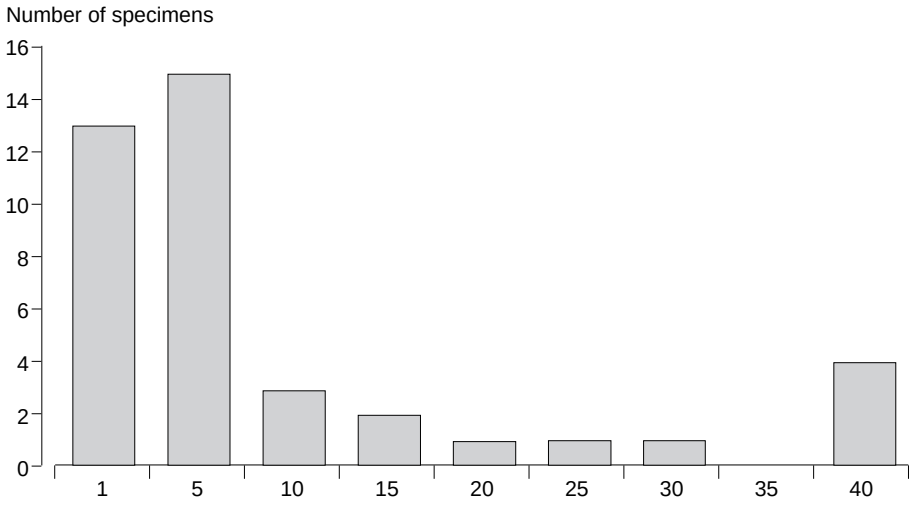

Figure 6. Time blocks and the number of specimens which fell under times

- add an additional centrifuge in the Stat lab to decrease pre-test prep time;
- install an online computer between the AE and Stat lab; and
- develop specific liver/cardiac profiles to improve efficiency.

Each alternative was compared against an established set of selection criteria using the concept selection matrix shown in Figure 10.

As Figure 10 illustrates, the multiple criteria were each measured qualitatively through the collective judgement of the TQM team. In the

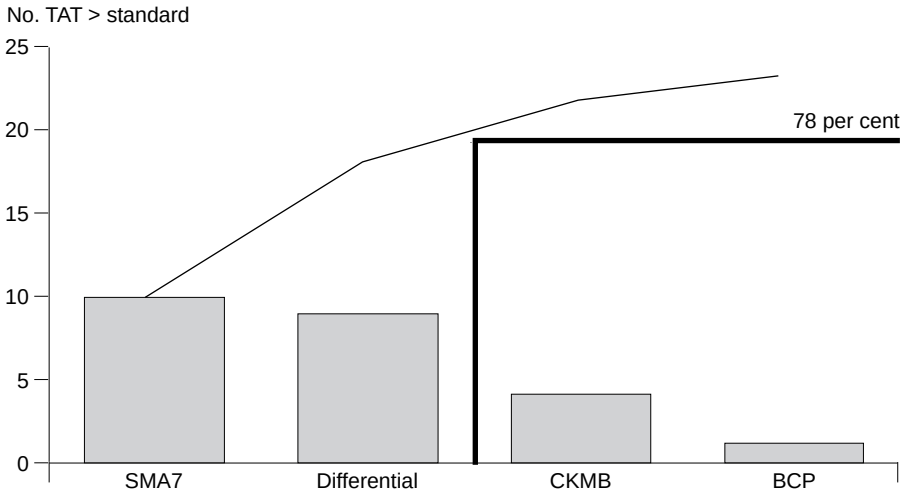

Figure 7.
Two test averages contributing to approximately 80 per cent of the deviation from the standard

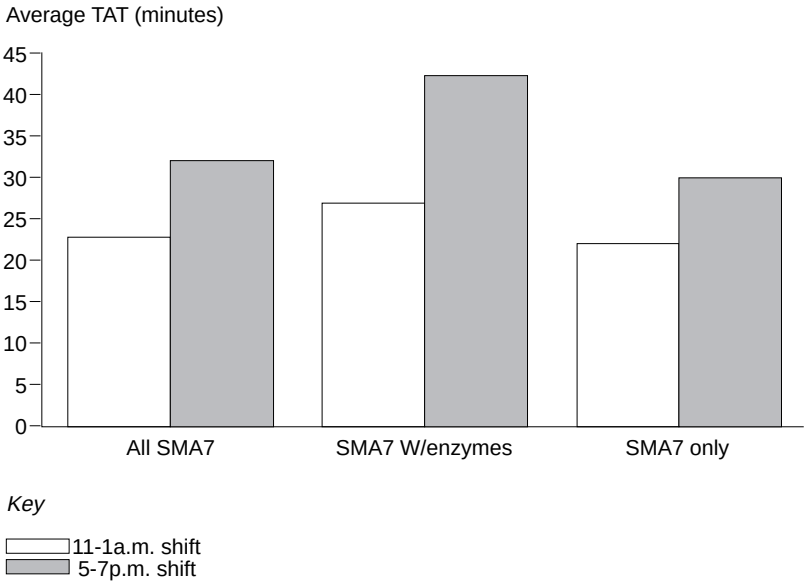

Figure 8.
Relationship between three test variations over two shifts

evaluation, the team sought the alternatives that generated better (+) or much better (+ +) than baseline performances across the multiple criteria. The decision analysis revealed that alternative (3) would have a significant impact on turnaround time and be the easiest and least costly to implement. Owing to the adverse consequences of failing to meet the 30-minute turnaround target, however, the TQM team recommended that all seven alternatives should be considered for implementation.

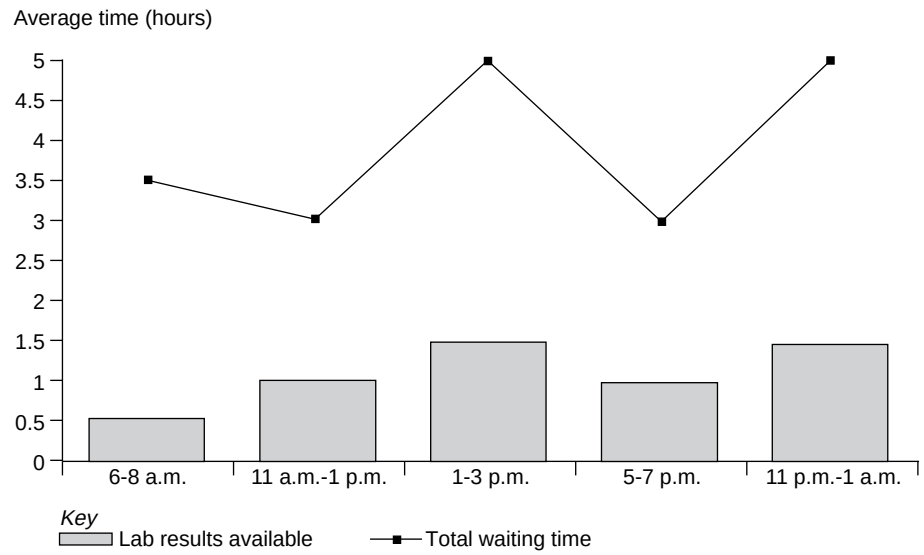

Figure 9. Combination of histogram and line chart illustrating relationship between the time results became available and the total waiting time of a patient

Implementation

A booklet and storyboard presentation was developed by the TQM team. The booklet summarized the team process, and the storyboard presentation closely followed the booklet. An executive summary, with supporting details, was first presented by the TQM team to senior leadership at the hospital. Later, the TQM team leader shared the results with the hospital's medical executive and medical affairs committees. Based on these presentations, the hospital's senior leadership approved all of the TQM team's recommendations.

Table III sets out the AE-pathology operations before and after the use of TQM. It also reports the pathology turnaround times corresponding to these operations. As the table shows, the use of TQM met the hospital's objective of reducing pathology TAT significantly.

Benefits

The policy recommendations ensure that Stat lab TAT will be reduced from the existing 45 minutes to under the targeted 30 minutes. This faster turnaround time is expected to improve patient and attending staff satisfaction, speed the patient flow, and provide a competitive ER performance advantage over neighbouring institutions.

The TQM team's AE-Stat lab study constituted the hospital's first formal CQI effort. This effort yielded important lessons for the hospital. These lessons involve organizational, educational and information system considerations. Table IV outlines the recommendations suggested by the lessons and the utility of these recommendations to hospital management.

Organizational. During the AE-Stat lab study, the TQM team identified a number of other hospital operations that could benefit from CQI analyses. These operations included:

Selection criteria / Alternatives	Dedicated tube system	Clerk coverage in lab	11 p.m.-1 a.m. staff coverage	Second centrifuge	Heparinized whole blood	Online PCIS lab computer	Decision support system	Cardiac/liver profile
TAT impact	X	++	++	++		++	-	++
Cost	X	--	--	S		++	--	++
Capital investment	X	++	++	+		++	--	++
Simplicity	X	++	++	+	Must have baseline	S	--	++
Reliability	X	--	--	S		++	++	++
Versatility	X	++	++	S		S	++	S
Time constraints	X							
Availability	X	S	S	S		++	--	++
Totals:	++	4	4	1		5	2	6
	+			2				
	S	1	2	4		2		1
	-						1	
	--	2	2				4	

Key
++ Much better + Better S Same - Worse -- Much worse

Figure 10.
Concept selection matrix

TQM alternatives recommended	Step affected in the Lab-AE process	Time spent before TQM	Time spent after TQM
Dedicated tube system	Delivery of specimen from AE to lab	2 to 45 minutes	10-20 seconds
Clerk coverage in lab	Receipt of specimen from AE	5 to 30 minutes	0 minutes
11 p.m. to 1 a.m. staff coverage	Scheduling specimen testing on pathology equipment	10 to 15 minutes	< 5 minutes
Second centrifuge	Scheduling coagulation testing	Up to 30 minutes	Reduced probability of a 30-minute wait
Heparinized whole blood	Not implemented	–	–
Online patient care information system (PCIS): ongoing	a. Specimen labelling b. Results recording	3 minutes mislabelled specimen instances: 10	1 minute mislabelled specimen instances: 1
Decision support system: ongoing	Planning through modelling and simulation of AE-lab operations	Not directly applicable	Improved control of the overall AE-lab process
Cardiac liver profile	Identifying the sequence of tests	2 minutes	< 1 minute
Overall TAT	All of above	45 minutes	< 30 minutes

Table III.
Performance improvement before and after TQM

- accident and emergency registration;
- accident and emergency admissions;
- laboratory department floor sampling.

As part of the final report, the TQM team recommended that the hospital perform these additional CQI analyses in the future.

Educational. The AE/Stat lab TQM team educated themselves in TQM/CQI philosophies and concepts. While this self-education was personally beneficial to the individual team members, the process was inefficient from a time management perspective. Based on these experiences, the AE-Stat lab group recommended that, prior to implementation, the hospital provide education on TQM/CQI to upper level management and to the medical and support staffs. The AE-Stat lab group also suggested that any future TQM team receive a structured orientation to the CQI process.

Information systems. TQM/CQI is a data-driven process. Since none of the necessary information was available from the hospital's existing information

Area	Recommendation	Management value
Organizational	Re-engineer the AE department registration and admission processes	Speed patient flow: reduce AE costs; and improve staff and patient satisfaction
	Re-engineer laboratory floor sampling	Speed specimen flow: reduce lab costs; improve AE-lab co-ordination: and improve staff and patient satisfaction
Educational	Provide TQM/CQI education to hospital management and staff	Promote TQM philosophy throughout the hospital; facilitate the TQM process; and improve the hospital's competitiveness
	Provide structured CQI education for TQM team	Improve the efficiency and effectivenesss of the TQM process
Information systems	Implement a barcoding system system to collect TQM/CQI data automatically	Facilitate TQM data collection; reduce TQM costs; and improve staff satisfaction
	Integrate the barcoding system within the institution's hospital information and decision support systems	Facilitate TQM data analysis: improve information sharing throughout the hospital; reduce hospital costs

Table IV.
Recommendations

systems, the TQM team was forced to collect the facts manually. The manual collection was a time-consuming and error-prone process. To alleviate these data collection problems, the TQM team recommended that the hospital implement an automated bar coding system to collect TQM/CQI data automatically. The team also suggested that the bar coding system be integrated within the institution's hospital information and decision support systems.

Conclusions

The hospital's AE/Stat lab project is an application of classic TQM/CQI principles and concepts. The endeavour received a firm commitment from top management; there was an emphasis on the prevention of problems, improvement of processes, and total customer satisfaction; every affected party was involved in the effort; a quality team was created to identify problems and improve all relevant processes; the team utilized analytical tools, such as Pareto diagrams and control charts, to ascertain whether quality standards and customer specifications were being met; and the team focused on the process of producing a service in a systematic way that integrates all departments in the goal of maximizing quality[17,18]. Moreover, employees are being trained in quality techniques, with systems in place to ensure that high quality is achieved; managers are functioning more like facilitators whose main task is to guide and support empowered employees; and the enterprise is attempting to provide services as good as, or better than, those of the competition.

SJH also followed a classic prescription for success in TQM/CQI applications. They identified a small number of important, customer-focused areas and achieved (and built on) successes supported by measurable results. The quality management system yielded concrete results. Rewards came in the form of continuous improvements that, over time, would reduce variation in TAT, lower costs, improve productivity and create returns on their investments.

The same principles and concepts can be applied with equal success at other hospitals and health-care institutions. Building on these successes, however, will require improved information system support for the TQM/CQI processes within the hospital setting[19]. As this case demonstrates, TQM/CQI is highly dependent on information dissemination and feedback at and across all levels of the hospital, and analytical techniques are required to evaluate systematically quality management alternatives. Existing hospital information systems are ill-equipped to provide the necessary support, but intelligent decision support systems can be developed to close the support gaps[20]. Such technology will facilitate the hospital's ability to respond quickly to rapid, often unexpected, changes in patient needs.

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Appendix. Worksheet example to collect representative work condition data

		12/9/92 1-3 p.m. (red alert)			
Patient name/chart number	Time blood sent from triage	Time orders written	Time blood drawn	Time blood sent	Results received