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# Estimation of Clinical Chemistry laboratory workloads and laboratory workplace survey, a laboratory workflow analysis at King Chulalongkorn Memorial Hospital

Viroj Wiwanitkit\*

Wiwanitkit V. Estimation of Clinical Chemistry laboratory workloads and laboratory workplace survey, a laboratory workflow analysis at King Chulalongkorn Memorial Hospital. Chula Med J 2000 Jul; 44(7): 515 - 23

- Objective** : *To analyze the workload of the laboratory and to survey data about workplace of Clinical Chemistry laboratory in King Chulalongkorn Memorial Hospital.*
- Setting** : *Clinical Chemistry laboratory, Division of Laboratory Medicine, King Chulalongkorn Memorial Hospital.*
- Design** : *Descriptive study.*
- Subjects** : *Routine clinical chemistry laboratory tests stated in laboratory request forms of the hospital during April 1999.*
- Method** : *Data about sample splitting and workstations for laboratory tests was collected. Surveying the workplace of the laboratory in aspects about site and floor space was performed. All received data were collected the analyzed in topics relating to the specimen processing process.*
- Results** : *The studied laboratory was a three-exited room with 14 staffs in the laboratory. It revealed that entry of specimens and exit of results was at the same place. Waste disposal made use of separating principle. It revealed that there were 5 machines, 2 workstations, 2 cupboards, 2 tables, 2 refrigerators and 1 sink in use in the laboratory. The rate of workplace to medical personal*

*was about 3 square meter/personal. The ratio of area for laboratory items to total area was 1:3.6. There were 2,777 samples with requests for 16,294 clinical chemistry tests passing the laboratory process with average of almost 6 tests per sample was notified. There were 3 major workstation for sample splitting and it appeared that a large majority of samples (70 %) had to be split before further processing.*

**Conclusions** : *Workload analysis is important in planning of laboratory reorganization. In this study, some problems were identified concerning workloads due to many workstations and high sample splitting rates. A suggestion to use more consolidation of laboratory services is made.*

**Key words** : *Workload, Workplace, Workflow analysis.*

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วิโรจน์ ไชวานิชกิจ. การวิเคราะห์ผลวัดของการส่งตรวจทางห้องปฏิบัติการในประเด็นเกี่ยวกับ  
ภาระงานในกระบวนการส่งตรวจทางห้องปฏิบัติการและการสำรวจสภาพปัจจัยของห้องปฏิบัติการ  
การศึกษา ณ ห้องปฏิบัติการเคมีคลินิกโรงพยาบาลจุฬาลงกรณ์. จุฬาลงกรณ์เวชสาร 2544 ก.ค;  
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- วัตถุประสงค์** : เพื่อวิเคราะห์ภาระงานที่เกี่ยวข้องกับกระบวนการส่งตรวจทางห้องปฏิบัติ  
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- รูปแบบการศึกษา** : การศึกษาเชิงพรรณนา
- ตัวอย่างที่ทำการศึกษา** : การส่งตรวจทางห้องปฏิบัติการเคมีคลินิกที่ระบุในใบร้องขอการส่งตรวจ  
ของโรงพยาบาล ในช่วงเดือนเมษายน ปีพุทธศักราช 2542
- วิธีการศึกษา** : ได้รวบรวมข้อมูลเกี่ยวกับการแจกจ่ายสิ่งส่งตรวจและหน่วยปฏิบัติการ ที่  
เกี่ยวข้องกับกระบวนการส่งตรวจทางห้องปฏิบัติการแต่ละชนิด และได้ทำ  
การสำรวจสภาพปัจจัยของห้องปฏิบัติการในประเด็นเกี่ยวกับที่ตั้งและการ  
จัดสถานที่ รวบรวมและวิเคราะห์ข้อมูลที่ได้ทั้งหมดในส่วนที่เกี่ยวข้องกับ  
กระบวนการส่งตรวจทางห้องปฏิบัติการ
- ผลการศึกษา** : ห้องปฏิบัติการที่ทำการศึกษเป็นห้องปฏิบัติการที่มีทางเข้าออก 3 ทางแต่  
พบว่าการรับสิ่งส่งตรวจและการจ่ายผลกระทำ ณ จุดเดียวกัน การกำจัด  
ปฏิภูมให้หลักการแยกประเภท มีเครื่องตรวจวิเคราะห์จำนวน 5 เครื่อง  
หน่วยปฏิบัติการจำนวน 2 หน่วย ตู้เก็บของจำนวน 2 ตู้ โต๊ะจำนวน 2 ตัว  
ตู้เย็นจำนวน 2 ตู้ และอ่างซักล้างจำนวน 1 อ่างในห้องปฏิบัติการ โดย  
เฉลี่ยสัดส่วนพื้นที่ในการปฏิบัติการต่อจำนวนเจ้าหน้าที่เท่ากับ 3 ตาราง  
เมตรต่อคน พื้นที่ใช้สอยตั้งเครื่องมือต่อพื้นที่ทั้งหมดเท่ากับ 1:3.6 มีจำนวน  
สิ่งส่งตรวจทั้งหมด 2,777 สิ่งส่งตรวจเพื่อการตรวจวิเคราะห์ทั้งสิ้น 16,294  
การทดสอบ โดยเฉลี่ยสัดส่วนจำนวนการทดสอบต่อสิ่งส่งตรวจเท่ากับ 6  
การทดสอบต่อสิ่งส่งตรวจ พบว่ามีหน่วยปฏิบัติการหลักอยู่ 3 หน่วย ทั้งนี้  
พบว่าโดยมากของสิ่งส่งตรวจคิดเป็นร้อยละ 70 จะผ่านกระบวนการแจก  
จ่ายสิ่งส่งตรวจก่อนการตรวจวิเคราะห์

**บทสรุป** : การวิเคราะห์ภาระงานตลอดจนการวิเคราะห์สถาปัตยกรรมของห้องปฏิบัติการมีส่วนสำคัญในการวางแผนการจั้ดรูปองค์กรใหม่สำหรับงานทางด้านห้องปฏิบัติการ การจัดตั้งห้องปฏิบัติการควรได้รับการวางแผนเป็นอย่างดี และควรคำนึงถึงประโยชน์การใช้สอยด้านการยศาสตร์ และข้อคำนึงด้านความปลอดภัยเป็นหลัก จากการศึกษาที่พบปัญหาบางประการเกี่ยวกับจำนวนหน่วยปฏิบัติการที่กระจัดกระจายและอัตราการแจกจ่ายสิ่งส่งตรวจที่ค่อนข้างสูงทั้งนี้ได้อภิปรายข้อเสนอแนะแนวคิดเกี่ยวกับองค์รวมในกระบวนการจัดการสิ่งส่งตรวจสำหรับห้องปฏิบัติการทางการแพทย์

**คำสำคัญ** : ภาระงาน, สถาปัตยกรรมของห้องปฏิบัติการ, วิเคราะห์พลวัต

During the past few years there has been a persistent increase of laboratory use. There is a great variety tests used these days.<sup>(1)</sup> Laboratory unit plays important role in medicine. Therefore, every hospital setting must have its own laboratory unit. Several items about laboratory process should be considered and insight in to this matter can be obtained by laboratory workflow analysis concerning all phases of laboratory investigations - pre - analytical, analytical and post - analytical.<sup>(2)</sup> Workload and workplace of laboratory setting is one point that should be considered. There are many functional, ergonomic and safety aspects that should be considered. These aspects should be considered in laboratory setting designing and management.

King Chulalongkorn Memorial Hospital is the largest Red Cross Society hospital in Thailand. There are many laboratory tests provided for the physicians there. The Laboratory Medicine Division is the major division in that deals with laboratory processing. The work of the division starts with specimen collection and reception of specimens and continuing with the analytical process and ending with results reporting. In this study, a workflow analysis about the workload of the laboratory and laboratory workplace survey in clinical chemistry laboratory was performed. The results of this study can be useful information for reorganization of laboratory processes.

### Materials and Methods

Laboratory tests available in clinical chemistry laboratory request forms of the hospital in April 1999 were identified. As the work of the laboratory is the same in each month of the year, only a one month period was selected for study. The workload of the

laboratory was monitored by counting the total number of samples passing through the laboratory process and determining the degree of sample splitting for analyses at different workstations.

Surveying of the laboratory was also performed in order to collect information. Aspect focusing on site and floor space of the laboratory was performed. Descriptive statistical analysis was performed when appropriate.

### Results

Concerning to the site of the laboratory (Table 1), the studied laboratory was a three-exited room, connecting to supply room, hematology laboratory room and walk path. There were 14 staffs in the laboratory. The incoming specimens were delivered at reception counter sharing with hematology laboratory. It revealed that entry of specimens and exit of results was at the same place. Regarding to waste disposal, reusable materials were treated at supply room and non-reusable materials were collected in garbage bins then altogether with disposal from hematology laboratory, delivered out for destroying. It revealed that there were 5 machines, 2 workstations, 2 cupboards, 2 tables, 2 refrigerators and 1 sink in use in the laboratory. The rate of workplace to medical personal was about 3 square meter/personal. The ratio of area for laboratory items to total area was 1:3.6

There were 2,777 samples accompanying requests for 16,294 clinical chemistry tests. A total number of 22 different analyses were counted. Almost six tests per sample was average. Nineteen percent of the requested tests were stat-analysis or emergency tests. The majority of tests (87 %) originated from only 4 different analysis test groups (Table 2). There

were 3 major workstations for sample splitting (Table 3). And it appeared that a large majority of samples (70 %) had to be split before further processing (Table 4). Estimated workload for each

medical technologist was about 225 tests/day and for each assistant was about 90 tests/day. General workflow of the tests via the laboratory was present in Figure 1.

Table 1. Schedule of laboratory function description.

Equipment or items	Estimated dimension (m <sup>3</sup> )	Associated bench	Service		number
			Waste/ water	Gas/ Power	
Room	5 × 9 × 3				
Machine	1.5 × 1 × 1	Yes	+	+	4
Workstation	1.5 × 1 × 2	Yes	-	-	2
Cupboard	1 × 0.5 × 1.5	Yes	-	-	2
Table	1 × 1 × 1	No	-	-	2
refrigerator	0.5 × 0.5 × 2	No	-	+	2

Table 2. Survey of most frequent tests representing 87 % of total workload.

Laboratory groups	Percent
Liver function test	37.7
Electrolyte	31.7
BUN, creatinine	12.6
glucose	5

Table 3. Three workstations for routine analyses.

Workstations	Fractional of workload (%)
Batch analyser for analytes, enzymes, protein, etc.	44.6
Batch analyser for analytes, enzymes, glucose, etc.	23.7
Two electrolytes analysers	31.7

Table 4. Sample splitting rate from workload analysis.

Splitting rate	Sample splitting fraction (%)
0	30
1	48
2	22

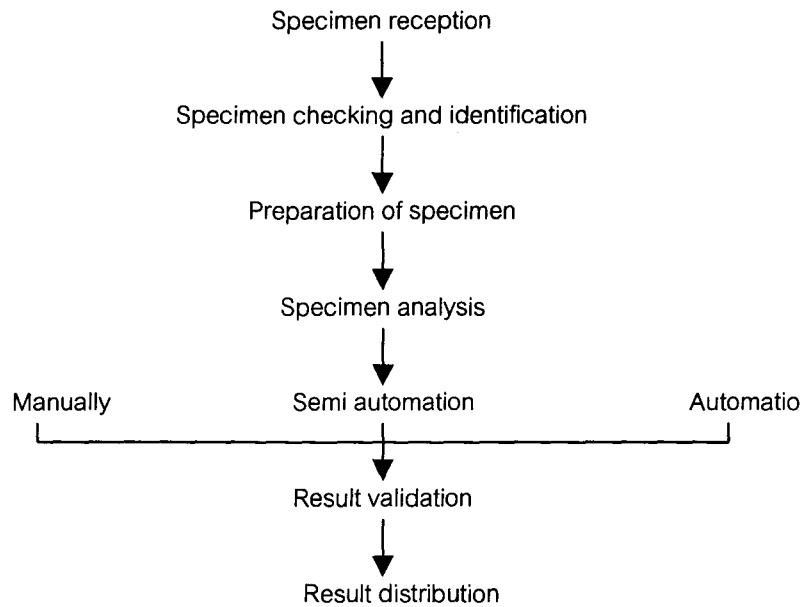


Figure 1. General workflow of tests via the laboratory.

### Discussion

The Workplace of the laboratory is one factor that should be analyzed in laboratory operations in order to make a plan for increasing laboratory efficacy.<sup>(2)</sup> The growing demand for rapid results from blood tests puts increasing pressure on both the clinical laboratory and the patients.<sup>(3)</sup> Proper laboratory workplace setting which provides the effective throughout flow of tests is the aim of reorganizations of each laboratory.

This study revealed that the site of laboratory is rather good - it was easily communicated with other laboratory session, supply room and walk path. But although there were three exits but it revealed that entry of medical specimens and reports of results occurred at the same place. There could lead the problem in flow of the tests and could be the weak point that errors in laboratory could occur.<sup>(4)</sup> Due to the principle of medical architecture<sup>(5)</sup>, flow of laboratory test should be a thorough straight line - no

cross section of work isle and repetition line flow should be found.

Considering the waste disposal of the laboratory, it revealed that the management of waste in the setting is rather good - separation of the waste could be found. Due to ergonomic aspect, environmental control of the laboratory workplace is very important. Sufficient service such as waste, water, gas and power should be provided. Crowded place could let many effects to the workers such as health problem due to volatile biological hazard and psychic problems<sup>(6)</sup> due to principle of architecture psychology. In this study, the rate of workplace to medical personal was about 3 square meter/personal, which is rather narrow. Therefore, proper distribution of work and cyclic return of medical personnel should be considered.

Considering to usage of workplace of the laboratory, it revealed that the ratio of area for laboratory instruments to the total area was 1:3.6, which mean



that there was more free-of-instrument area for flow of tests. Expiration of out of use or non-cost effective instrument should be considered.<sup>(7-8)</sup> To increase the efficacy of the laboratory in case that instrument cannot be expired, translocation of instrument in to parallel straight line is recommended.<sup>(5)</sup>

Workload of the laboratory test is another factor that should be analyzed in laboratory workflow analysis in order to make a plan for increasing laboratory efficacy.<sup>(2)</sup> The growing demand for availability of results from blood test represents an increasing pressure on both clinical laboratory and patient.<sup>(3)</sup> Reduction of the number of workstations and reducing of workload by decreasing sample splitting rate and concomitant activities are the aim of reorganization of each laboratory.

From the study, it revealed that the majority of workload in the laboratory was from small part of requested tests. Therefore, these groups of tests should be considered in depth for how to increase efficacy of analysis process for them. Although the number of tests requested for emergency analysis is not too much but this point can produce great pressure to report test results with the shortest possible delay. Furthermore, consideration the splitting of specimens, it revealed that most of the specimens sent to the laboratory required splitting process before further analysis, which could be the weak point that errors in laboratory could occur.<sup>(4)</sup>

Considering to the concept of modern laboratory, data obtained from the workflow analysis is very useful for reorganization. Investigating the number of tests per analysis is helpful in determining the pressure on the laboratory to report the results.

To reduce the problem about workload on the laboratory, concentration of workstations and decreasing of sample splitting rates are ideal. Selection of most effective equipment, which would speed up analytical procedure is necessary. Consolidation of workstations is the goal of reorganization. Therefore, multi-functional analyzer and effective medical personnel are the solution.

Each laboratory should perform workload analysis in order to search appropriate solution the pressure load. With the concept of standardization and consideration, reorganization of the laboratory by selection, evaluation and introduction of up-to-date process are all necessary.<sup>(2)</sup>

This study was limited only in one laboratory setting but can be a good example for other. Each laboratory should perform workplace analysis in order to search appropriate solution the pressure load. With the concept of standardization and consideration, reorganization of the laboratory by selection, evaluation and introduction of up-to-date process are all necessary.<sup>(2)</sup>

## Conclusions

Workload and workplace analysis is one important part of workflow analysis and is available as a tool in laboratory management. To design and manage the laboratory workplace, principle of functional, ergonomic and safety should be used. To minimize the workstations and sample splitting are necessary to increase efficiency of laboratories. Furthermore, fundamental information from analysis is useful for reorganization.

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