Chapter-05

AUTOMATION IN CLINICAL LABORATORY

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ABSTRACT

The clinical laboratory workflow has gone through various changes towards advancement in past few years, which specially includes the progression and improvement of technologies in automation. This chapter on automation in clinical laboratories is all about various information related to automation in clinical laboratories, the automation which has proved itself helpful in improving the efficacy, error free accuracy and quality of diagnostic test results. Automation in clinical hospital laboratories has proven itself as a boon to healthcare system. This chapter begins with the introductory knowledge in regards with what is automation and how useful the automation is for healthcare professionals. This chapter provides necessary information about how the clinical laboratories have adapted automation and nowadays laboratories are mostly dependent on this automation technology to value time and money. There is a comparison on semi and fully automated analyzers landscape and how the workflow of a laboratory from sample collection to report delivery and data management has been positively affected by the use of automated technologies for betterment of laboratory professionals and healthcare system. Furthermore, the information given in this chapter is all about various challenges related to automation adoption by laboratory professionals and clinical settings in healthcare system.

Keywords: *Clinical Laboratory, Automation, Efficacy, Diagnostic, Semi-Automated, Fully Automated.*

5.1 INTRODUCTION

The word automation is inspired by word automatic. Automatic means exercising control without interference or least human interference. So, automation means getting work completed by machines which can run themselves without any continuous monitoring by humans. Automation refers to machines with intelligence and adaptability which reduces labor interference, workload and need for nonstop supervision. With the use of automation, the probability of errors and variability in the results has decreased if collate with the manual methods (Vijay, Kiran 2018). Furthermore, if the historical background of automation is observed, it is clearly depicted that evolution of automated technologies in field of clinical laboratories is evidence to creativity and intelligence of humans if compared with the old manual methods. This automated technology in the area of hospital laboratories has replaced the old manual methods with labor intensive approach and are time consuming and almost vanished the chances of error in specimen analysis. Utilization of automation with integration of computerization is a paradigm of evolution of clinical laboratories.

5.2 OBJECTIVES

The main objective of the chapter is to provide information and practical guidance about automation and types of automation which will provides you knowledge about following points-

- To define automation
- To list the uses, positive aspects and enhancement of automation in clinical laboratory
- To discuss automation at each step of analysis
- To describe different types of auto analyzers used in the clinical laboratory & their functioning
- To enlist the positive aspects and drawbacks of automation (fully & semi-automated)

5.3 STEPS OF AUTOMATION IN CLINICAL LABORATORY

There are various individual steps in the analysis process as a whole in a laboratory. TLA represents a paradigm shift in clinical laboratory workflow management, modifying the way diagnostic tests are conducted and sample procession is done. TLA is an extensive approach which includes both analytic and non-analytic aspects of clinical laboratory. (Wittwer CT et al 2017) Following points describe the process of automation stepwise-

1. Identifying the patient
2. Getting the correct sample collected
3. Identifying and proper labeling of the sample with patients name, age, sex and tests to be performed.
4. Delivery of sample in proper storage condition and within time to the specific laboratory (pathology, biochemistry, microbiology).
5. Preparation of sample for test
6. Sample loading/aspirating
7. Analysis
8. Reporting
9. Entering in register/keeping record

If a technician is asked to run more than hundred tests repeatedly within a stipulated period of time, report the result and deliver the report one by one. How would the technician feel? Can he/she promised to provide perfection in the results after spending his whole duty hours in repeating the same test process and even though that technician working for his whole shift on same analyzer will not be bored and report test results without any error in given time.? If we compare this whole scenario of a technician working repeatedly same sort of tasks with an automated analyzer, the analyzer will never feel bored or lethargic also the chances of error won't be there as often as you it is found in workflow of semi-automated analyzer processed and monitored by a technician. With this comparison it is clear that automation has many advantages in a clinical laboratory. Some of the benefits of automation are given below-

- Decreases the workload and values the time.
- Increases turnaround time (Saves time used per analysis)
- Increases total number of tests done in less time
- Removes repetition and tediousness from human life so decreases human error, improves accuracy
- Improves reproducibility (repeatability)
- Minimize the amount of sample and reagent utilization

In a clinical laboratory set up automation is useful in routine chemistry, hematology, immunological assay, and daily processing of large number of samples etc. If mapping of workflow and mapping of timings of sample procession is observed in both manual and automated systems, it is clearly being noted that automation is better in all terms like, temperature handling, logistics of sample, cost justification etc. (ARUP scientific resource) Usefulness of automation in advanced and well-equipped clinical laboratory can be also extended to

1. Transport of specimen (logistics)
2. Sample processing
3. Sample loading in an automated analyzer
4. Results verification & cross checking of performed tasks

However, laboratory automation can solve this problem and can be utilized in la boratories as long as they do not introduce new vials into the experimental work. It is in disputable that full laboratory automation allows minimal operator intervention, thereb

y increasing productivity, ensuring in laboratory traceability of samples, reducing turnaround times, improving the overall quality of samples, increasing laboratory safety and decreasing the risk of errors (Bakan Ebubekir et al, 2016).

But if automation of the above steps is not possible due to lack of funds and infr astructure, then any central laboratory will run at leastfew of the screening steps. Operat ions and processes performed manually by experts are being changed by an electronic a nalyzer called autoanalyzer.

Let us see the possibility of utilization of automation in some of these steps.

1. Sampling

The use of glucometer is a perfect example for sample collection, just press the button at the tip of finger, a slight pain will be felt in the finger and on-site observation of the blood glucose can be made.

Although, not every laboratory tests can be analyzed on a blood glucose meter. Automation in sample collection is the most advance, improved and less complex, faster techniques of collection. Sample collection can be easier and fast with the use of automation. For Example- robotic system, vacutainers etc.

2. Sample identification by Labeling and bar coding

This is where testing information comes into notice. It starts by creating an ID or hospital number for each new patient. The information will be saved for patients record. All samples collected must be labeled with patient's name, details, and a unique identifier hospital number or code. The same method is used when entering number into the automatic analyzer, software and in addition to this the results are pasted with this code and other relevant data.

Many laboratories are also utilizing bar coding technology for labeling samples which is generated by computerization. This technique of computerized bar codes comes with an advantage that it can be scanned and read by bar code reader precisely with full accuracy to avoid any transcriptional error and this resolves the problem of error while writing this information manually.

As noticed in a particular example of a patient, his barcode is attached to his wrist which helps the nursing staff or technician to read the barcode, the barcode consists of all helpful information about patient, like blood group, medical history etc. In

terms of laboratory practice these barcodes comes with sample of patients which is again helpful in finding out the test which needs to be processed.

3. Sample delivery

Most of the laboratories depends on personage pick up system or system where conveyer belts are involved. They may be cheaper but they may result in human error, postpone sample delivery etc.

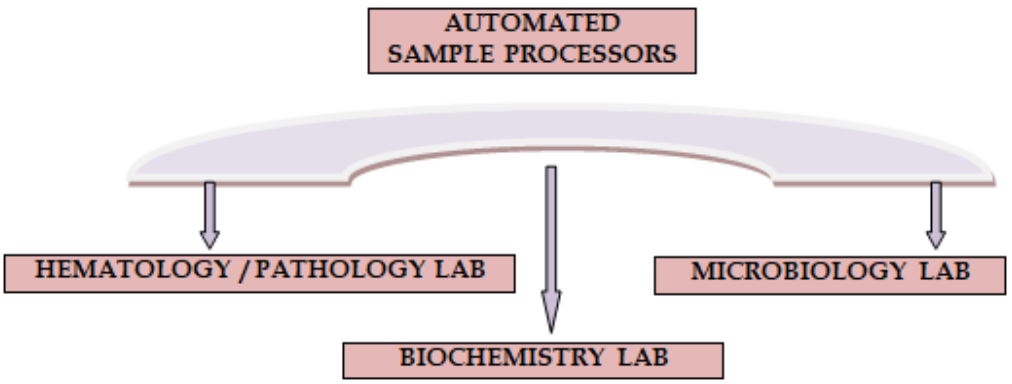
Pneumatic tube systems where pressurized gas is used to move the tubes which contains sample are used in some moder and advanced well equipped automated laboratories. However, this requires proper observance for acceleration and deceleration so that damage to any sample can be avoided.

4. Sample preparation

Many laboratories rely on technicians to immediately process samples (e.g., sepa rate blood) once they arrive. However, introducing automation can reduce the work of e xperts and save time and expertise for analysis. For this reason, many semi-automatic devices that can perform full blood analysis have now been developed. For Example, an automatic ion selection electrode, dry chemical use, etc.

The automated sample processors are of two types-Standalone automated sample processors and Independent automated sample processors.

These automated sample processors can perform various tasks such as differentiation of samples, separation of samples, bar coding etc. having an automated sample processor can helps in solving the workload of bar coding and sample delivery with the help of conveyer belt system.



The arrow mark represents pneumatic tube system or Conveyer belt

5. Sample Analysis

A brief study of every particular aspect of automation in the analysis protocol itself is the least essential aspect of automation for any laboratory. For automation in analysis process the invention of auto analyzer is done**.**

5.4 TYPES OF AUTO ANALYZERS

Clinical Laboratory automation of today's generation is a complex incorporation of robotics, computers, liquid handling, and various other techniques. The main role of automation in laboratory is to save time and improve performance through the minimization of human error (Olsen K, 2012). Auto-analyzers in clinical laboratory are of two types-

(i) Open system

(ii) Closed system

1. **Open system:** In an open system the laboratory operator can take an advantage of purchasing reagents from any company of his/her choice for cost cutting, by selecting reagents which are cheaper which makes the laboratory workflow cost effective. In a modular design all the parts of an auto analyzer are assembled together which is helpful in improving the flexibility of machine depending upon the customer's demand. An example of Ion selective electrode fits here perfectly where because of modular approach, the facility for analysis of sodium, potassium and chloride can be done into the system or there is an option of adding it later.

2. **Closed system:** The closed system bounds the operator to purchase reagents & chemicals specifically from a particular company, because the machine is not going to accept the chemicals from any other outsource, it only accepts the specific reagent which is meant for it. So in this type of system operator cannot manage cost cutting according to his profit. But the closed system is more reliable in terms of automation, it allows high degree of automation which increases the accuracy of test results.

5.5 CONCLUSION

In summary, the integration of automation into clinical laboratories represents a revolution in clinical practice and diagnosis. This chapter provides a comprehensive ove rview of all aspects of automation, from sampling and operations to data analysis and re porting. This chapter additionally explores a lot of benefits automation brings to

laboratories also which includes increased efficiency, accuracy, and production, and also reduced human error & labor costs. It discusses issues that come with automation, such as initial investment costs, training and maintenance needs, and issues to consider and good management. Laboratories must carefully plan and adjust their automation str ategies to meet their unique needs and operations. As technology continues to advance, automation in laboratories will become better and more powerful, achieving greater goals of improving patient care and testing. However, experts need to pay attention to the quality and integrity of the results produced by the technology. Abbreviations TLA-Total laboratory automation.

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