Automation in Biochemistry Lab

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Abstract: Automation; To automate is to introduce or use mechanized equipment in a facility. The use is to take function in effort, decision making and observation in the case of many samples, with minimal human intervention. Lab automation gained spread in the 1990s. mechanized instruments enable effective work in the biochemistry lab without need for rapid increase in staff [7]. It is a process by which instruments perform various tests with minimal involvement of an analyst. In laboratory diagnostic, automation has been considered as one of the most important breakthroughs in its recent history. There are many analyzers that perform different types of tests on different sample matrices. These are integrated as physically connected by assembly lines or modular systems and give the opportunity to integrate multiple diagnostic specialties to one single track with effectiveness to improve efficiency, quality, standardization, organization, and safety of laboratory testing. It also provides a significant return of investment on the long-term and enabling staff requalification [5]. However, automation may also present some potential problems, mainly represented by higher initial costs, enhanced expenditure for supplies and so on. Therefore, in this review we will properly indicate the PROs and CONs of Automation.

Key Words: Automation, Biochemistry, Lab, analyzers.

1. INTRODUCTION:

Automation;- To automate is to introduce or use mechanized equipment in a facility, so as to take function in decision making and observation in the case of a large number of samples with minimal human intervention . Lab automation gained spread in the 1990s. mechanized instruments enable effective work in the biochemistry lab without need for rapid increase in staff. It is a process by which instruments perform various tests with minimal involvement of an analyst. There are many analyzers that perform different types of tests on different sample matrices. These are integrated as physically connected by assembly lines or modular systems and give the opportunity to integrate multiple diagnostic specialties to one single track with effectiveness to improve efficiency, quality, standardization, organization, and safety of laboratory testing.

2. BIOCHEMISTRY TESTS:

These tests are one of the many traditional methods used in the identification of microorganisms and phenotype identification is usually used to perform them. They are tests done on a different bacteria, identifying them by their different activities on compounds of biochemical nature.

TESTS:-

Some tests performed are as follows;

1. **KFT** - Kidney function tests are tests performed to help with the evaluation of the functioning if the kidneys enable early diagnosis and prevention of condition worsening [8]. The KFT parameters are as follows;
   - Urine analysis;
   - Physical examination includes- colour, volume, specific gravity, ph, odor.
   - Chemical examination includes- glucose, sodium,urine creatinine, protein, ketones, etc.
2. Blood examination
   - GFT
3. **LFT -** Liver function tests are tests performed to evaluated the correct functioning of the liver. The tests are;

   - AST - Aspartate Amino Transferase which was known as Serum Glutamate Oxaloacetate Transaminase.

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- ALT - Alanine Transaminase which was known as Serum Glutamate Pyruvate Transaminase.
- ALP - Alkaline phosphate
- GGT - y-Glutamyl transpeptide.
a. IgE for allergies
b. Procalcitonin Serum for sepsis
c. IL6 - Interleukin 6
d. TCL - Tacrolimus
e. TSH and other immunoassays
f. NT Pro BNP for cardiac stroke
g. Troponin and other cardiac tests
h. HBA1C - Glycosylated hemoglobin[8].

3. TYPES OF AUTOMATED LABS:
Pre-analytical automation:
Pre-analytical means any of the steps from sample storage until preparation. There has been error of up to 70% reported from factors such as mislabeling, poor storage etc. Inevitably, automating repetitive tasks offers a huge impact on the accuracy and reliability of results. Systems are now available to perform many tasks using a combination of robotics, sensors and software, from storing and labeling down to the analytical stage.

Analytical automation:
The early forms of lab automation were involved in the analytical stages of experimental processes. The first automated analyzer called the Auto Analyzer was produced in 1957, this deals with continuous flow of analysis and has improved the number of samples to test to potentially 150 per hour.
The software controls and integrates automated sample analysis instrumentation, as well as electronically collects and stores laboratory data measurements, which can then go under analyses.

Post-analytical automation:
This is the final parts of the experimental process which involve data analysis and interpretation, sample management, and reporting. These machines are built with the ability to be able to rerun a test if need be.

4. TYPES OF MACHINES :
Cobas e 411 is a biochemistry semi auto analyzer, used mostly to run biochemistry assays like PCT, TCL, IgE and so on. It is a fully automated analyzer that makes it's immunoassay analysis using a patented ElectroChemiLuminescence (ECL), designed in-vitro assay determinations for a broad range of applications including bone markers, cardiac markers and tumor markers, critical care, anemia, hormones, and infectious disease using both qualitative and quantitative analysis.

Figure 1: cobas e411

Vitros 5600

The VITROS 5600 can be considered as your lab workhorse because it combines an immunonoassay menu of more than 160 assays and comprehensive clinical chemistry all on a single integrated platform. This delivers high quality, productivity and value to your lab. It is designed to help you to consolidate critical testing efficiently, so as to deliver quality and precise results to the physicians and patients who depend on you on time. Used to run KFT, LFT, cardiac tests and all other tests [3].

The advantages are:
- Consolidate critical testing
- Drive productivity
- Conduct intelligent sample management
- Improve reliability
- Flex your lab space

Vitros 7600
Some of the diseases tested in this machine are as follows ;
- Anemia, Bone Disease, Cardiac, Diabetes, Drugs of Abuse (Urine), General
- Chemistry, Hepatic, Immunosuppressant Drugs, Infectious Disease, Inflammatory,
- Lipids, Nutritional Assessment, Oncology, Pancreatic, Prenat al, Renal,
- Reproductive Endocrinology, Respiratory, Sepsis, Spinal, Therapeutic Drug Monitoring, Thyroid/Metabolic, Toxicology, Urine and so on.

Figure 2:. vitros 7600

Other automatic gadgets are:
1. **hemoglobinometer**
Also spelt as a **haemoglobinometer** is a medical device used to measure the concentratin of hemoglobin in blood. Operated by spectrophotometric measurements of hemoglobin concentration, they provide easy and convenient measurement of hematological variables.
A hemoglobinometer is a recommended method used for absorbance measurement of whole blood.

5. SIGNIFICANCE OF AUTOMATION:

There are many analyzers that perform different types of tests on different sample matrices. These are integrated as physically connected by assembly lines or modular systems and give the opportunity to integrate multiple diagnostic specialties to one single track with the effectiveness to improve efficiency, quality, standardization, organization, and

safety of laboratory testing. It also provides a significant return of investment on the long-term and enabling staff requalification [5].

- **PROVIDES VALUABLE TIME TO GET THINGS DONE**

There are many important tasks to get done in the lab, automating helps you save time and effectively get a lot of work done in a short period of time. For example, instead of spending a tedious amount of time recording patient information, the machine helps you generate bar codes. This would be less stressful and and less time consuming.

- **REDUCES REPETITIVE INJURIES**

Manual labeling of tubes can also lead to physical strain of the fingers and hands. People who have been hand labeling tubes for years are prone to experiencing frequent or regular tingling and numbness and in the hand,and face the risk decreased productivity. Constant labeling, filling, uncapping and capping of tubes in many cases lead to carpal tunnel syndrome.

- **ELIMINATES HUMAN ERROR**

Human error is when something that wasn't supposed to be done is done, for example mismatching samples, wrong patient information, mixed up results etc. Lab automation decreases human error involved with sample preparation and also increases efficiency in the lab by the ability to track the samples.

- **REDUCES COSTS IN THE LAB**

Laboratory automation in your lab will resulting in cost saving by decreasing the number of lab technicians needed to label tubes. You also might find an increase in revenue due to lab automation.

- **FLEXIBLE MACHINERY SAVES VALUABLE SPACE**

It is important to save space in the laboratory, it helps in avoiding accidents. Some machines are bench top, while others are flexible for movement.

- **CUSTOMIZIBLE LABORATORY AUTOMATION**

You can be able to customize your laboratory automation to suit your lab's requirements, by selecting modules to cover their needs and even change them for future purposes. This also helps in keeping the equipments up to date and avoiding running tests based on old methodology that may not be effective in the long run.
Automated systems help increasing your productivity and advancing your research

- **DECREASED COGESTION IN THE LABORATORY**

Decreasing personnel needed for performing identical volumes of tests would reduce staff congestion in the laboratory. Preventing technicians from moving back and forth multiple times is achieved by optimizing a layout of workstations which in turn minimizes the distance covered by the personnel for performing multiple analyses on different instruments.

- **IMPROVED QUALITY OF TESTING**

Enables you to use updated methodology for sample testing

- **ENHANCED STANDARD FOR ACCREDITATION**

Enables openings for international advantage, as it has become an international standard requirement

- **LOWER BIOLOGICAL RISK FOR TECHNICIANS**

As a workers safety is required, automation helps prevent hazardous accidents.

- **LOWER SAMPLE VOLUME**

You don't require much sample for collection as the machines can perform multiple tests using minimal sample [4].

6. ADVANTAGES AND DISADVANTAGES OF BIOCHEMISTRY AUTO ANALYZERS:

- Reduces repetitive tasks significantly
- Handles loading, cleans tubes, controls mechanics and processes data.
- Easy insertion of samples and automated programs.
- Speed up complex analysis
- Helps to streamlining daily laboratory activities To enable early detection as well as diagnosis of disease Comply with safety standards of the healthcare industry
- Provides a report on time.
- Samples are analyzed on time and accurately
- Improves the the medical industry level
- Optimization of time-consuming tests and analytical procedures
- Provision of reliable diagnostic information
- Brings about product innovation

- Wellness and patient care improvement
- Helps in the understanding of biological processes and other chemical reactions
- The efficiency of medical facilities, test centers and diagnostic centers is increased.
- Performs different tests at economical rates
- Enables the performance of fast and quality testing in labs.
- Optimize cell examinations
- Efficiently analyze multiple samples [2].

Vitros 5600,
Has some effectiveness in the diagnosis of syphillis
Advantages
- Rapid easy to perform
- No expensive instrumentation required no expensive instrumentation required Higher sensitivity in primary and late syphilis
- Objective interpretation
- High-throughput of samples
- Connection to the laboratory information system[1].

Disadvantages
- False positive results caused by cross-reactions
- Lower sensitivity in primary and late syphilis
- Subjective interpretation
- Fluorescence microscope can be required
- Lower sensitivity in primary infections
- Labor-intensive
- Subjective interpretation
- Expensive on require [1].

VITROS 7600xt. Has Dry slide technology meaning it doesn't require water to run compared to the traditional wet systems.hence eliminating the risk of the impact of poor water quality. A postage-stamp-sized piece of film enables precise and accurate testing in a waterless environment. It also has digital imaging technology which enable better precision together withpoweful data intellegience. Increases productivity by processing multiple tests using less sample.

7. LIMITATIONS OF AUTOMATION:
1.Technology limits. Current technology is unable to automate all desired tasks. Some tasks cannot be easily automated. Therefore, technology cannot be able to automate all tasks, for example the production or assembly of products with inconsistent component sizes some work is best done by humans.
2. Economic limits. Automation is best suited to procedures that are repeatable, consistent and high volume because some tasks may cost more when preformed automatically than manually [4].
3. Unpredictable development costs. It is difficult to predict the precise research and development costs of automation before hand because the cost can have a great impact on profitability. You may be like to start or even finish the process and just end up discovering that there may be no economic advantage. However, with the continued growth of the various production lines, more accurate estimates can be made based on the previous projects [4].
4. Initial costs are relatively high. The automation of a new product requires a huge initial investment compared to the unit cost of the product. Hardware and labor are the other costs. The cost can be prohibitive for custom production lines where product handling and tooling must be developed [4].
5. Skilled maintenance. This department is often required to offer service and maintenance of the automation system in proper working order. Being unable to maintain the system would result in wrong results [4].

Other disadvantages are:
- Staff overcrowding; if the is no proper alignment of the machines there will be continuous movement of the staff going to and fro, causing congestion.

- Increased generation of noise and heat; there is a constant production of noise and heat at the machines continue running.
- Higher risk of downtime,
- Psychological dependence;
- Critical issues for bio specimen management,
- Disruption of staff trained in specific technologies,
- Risk of transition toward a manufacturer's-driven laboratory.

8. CONCLUSION:

Lab automation is focused on providing lower overall costs, a safer environment, higher throughput, reduced experimental error, more efficient testing and improved accuracy and reliability of the data.
However, automation still remains a costly process and should be planned efficiently separately to each lab, as well as depending on their experimental needs.

ABBREVEIATIONS:

- KFT = Kidney function tests
- LFT = Liver function tests
- PCT= Procalitonin serum
- TCL= Tacrolimus
- IgE= Immunoglobulin E
- GGT= y- Glutamyl transpeptide
- ALP= Alkaline phosphate
- AST= Apartate amino transaminase
- HBA1C= Glycosylated hemoglobin
- ECL= Electrochemiluminescence

REFERENCES:

1. Baradaran S, Benjamin J, Blasutig M. I, Chan M. K, Chen Y, Colantonio D, Khosrow A. Kulasingam, J. (23 May 2010). *Analytical evaluation of the VITROS® 5600 integrated system in a pediatric setting and determination of pediatric reference intervals.* Science direct.
2. Da Rin, G. and Lippi, G. (February 2, 2019). *Advantages and limitations of total laboratory automation: a personal overview.* De Gruyter.
3. Florence, E. Kenyon, C. Van Esbroeck, M. Van den Bossche, D. (November 2014). *Vitros 5600 Syphilis TPA assay: Evaluation of an automated chemiluminescence assay for detection of Treponema pallidum antibodies in a high prevalence Setting.* Pub med. Researchgate.
4. Frank. (February16,2014), *Advantages and Disadvantages of Automation.* Automation primer.
5. Narwat, P. S (May. 8, 2020). *Automation in biochemistry (autoanalyzers).*
6. September 4, 2019 (July 19, 2022) *Biochemistry Analyzer: Applications, Facts & Benefits.* Primedeq
7. Thomas-Moore, B. Reviewed by Henderson, E .(July21,2020). *What is Lab Automation?* Azo life sciences.
8. (December 24, 2021). *Biochemistry Test: Introduction, list of Tests, unit and normal range.* Medical lab notes
9. (January 5th, 2021). *5 Benefits of Laboratory Automation.* Hudsonrobotics.
10. Hudson Robotics, Inc. VITROS® 5600 Integrated System | Ortho Clinical Diagnostics