Leveraging technology and innovation to improve operational and environmental sustainability of clinical laboratory operations

DOI:- https://doi.org/10.62772/APFCB-News.2022.2.5

Corresponding Author: Douglas Chung,
Abbott Laboratories
E-mail: douglas.chung@abbott.com

Introduction

While environmental sustainability has become an area of growing global awareness and concern, the Covid-19 pandemic has caused great disruption to countries and societies around the world over the last few years. Recently, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) reported [1] that the Asia-Pacific region is falling behind on the 2030 sustainability targets. It now appears that these targets will not be reachable until 2065 [2] -- for us in laboratory medicine, there is an increasing need to re-energise our efforts, do more and move beyond "business as usual" to improve our environmental sustainability.

Before the pandemic, APFCB and experts in our region had already initiated some discourse in this area. An earlier publication by Lopez et al. [3] had earlier identified four main ways in which healthcare (and laboratory operations) impacts the environment. These are: (1) generation of large quantities of waste; (2) usage of hazardous or toxic substances that may cause harm to the environment; (3) consuming large amounts of energy and contributing to greenhouse gas emissions; and (4) consuming copious amounts of water. Some of the helpful recommendations included basic behavioural changes that do not impose financial burden on the laboratory's budget, such as an end-of-day walkthrough to ensure that unnecessary devices are switched off, consolidating tests and equipment, encouraging staff to carpool or commute via bicycle, etc.

While such peripheral behavioural changes can be easily implemented, the core function of the laboratory remains firmly rooted in well-defined, validated, and regulated analytical processes, which are pre-determined by the manufacturers of the analyzer systems. Therefore, it is important for laboratorians to understand the technological and performance characteristics of different analyzers in the selection stage. The decision on one particular analyser system over another can lead to significant downstream impact on laboratory operations and environmental sustainability, as demonstrated in publications [3].

This article focuses on the clinical chemistry and immunoassay core laboratory where the majority of the routine clinical workload is performed, introducing some of the specific technologies and innovations that can be leveraged to achieve more efficient and environmentally sustainable laboratory operations.

Waste Reduction

First, in the area of waste reduction we begin by looking at clinical chemistry analysers. Many systems utilise plastic cuvettes that require monthly replacement. By selecting a system that utilises permanent quartz cuvettes, there are both operational and environmental benefits: on one hand the laboratory can reduce its hidden costs of plastic consumables and waste disposal, while on the other hand reducing its plastic waste.

Also In clinical chemistry, samples often have analyte concentrations above the measuring range of the assay, thus requiring dilutions and reruns. This is particularly challenging for enzyme assays where the substrate can be exhausted rapidly before the rate measurement is completed. Some clinical chemistry analysers employ an extra Flex read window earlier in the reaction before the main measurement time, thereby achieving much higher upper measuring intervals even at very high enzyme levels with excellent precision [4]. This allows the laboratory to report reliable results in the first pass with less need for dilutions, less additional workload for analysers and staff, and less unexpected delays in the turnaround time, while reducing the materials and costs of such dilutions and reruns and lessening its environmental impact.

Next, let us examine the issue of sample-to-sample carryover. On sensitive immunoassays, carryover can potentially lead to sample contamination and incorrect results. To avoid this problem, most immunoassay systems require single-use plastic pipette tips for each test and recommend complex aliquoting workflows into additional tubes. For a typical laboratory that performs millions of tests per year, this translates to a significant environmental impact with millions of pipette tips and tubes being dumped into landfills and floating in the oceans. Fortunately, there are some systems which utilise a unique SmartWash technology which can prevent clinically significant sample-to-sample carryover (0.1 ppm or below) [5, 6], eliminating the need for plastic pipette tips and enabling more streamlined integrated workflows with both clinical chemistry and immunoassay tests aspirated from the same sample tube. This leads to reduced environmental impact, as well as lower hidden costs on plastic consumables, lower waste disposal costs as well as much more simplified workflow for the operators.

Beyond advanced analytical technologies, smart and efficient product design can also contribute towards waste reduction. For example, some systems have multiple reagent packing size configurations and powerful informatics capabilities that allow the same reagent cartridge to be shared and tracked between different modules. This allows laboratories to optimise inventory management, decrease the number of plastic reagent cartridges being used, reduce the amount of manual operation loading and unloading used cartridges, and lessen the carbon impact of the supply chain, while minimising waste and saving valuable refrigerator storage space.

Hazardous substances

Most diagnostics manufacturers are now moving towards compliance with the REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations under the European Chemicals Agency and removing Substances of Very High Concern SVHCs) from their products. This also contributes towards a safer working (environment for laboratory staff and reduce the impact to the environment, while offering new opportunities to enhance product ease-of-use to operators.An example of this change comes from Abbott's reformulation of the pre-trigger solution used across its chemiluminescence immunoassays. The formulation has now been updated to replace Triton X-100 with Tergitol 15-S-9 which is a readily biodegradable and more environmentally friendly compound. Furthermore, while the previous product required refrigerated storage (2 to 8°C) the new formulation can now be stored at room temperature (2 to 30°C) allowing the laboratory to free up valuable refrigerator or cold room space and simplify inventory storage.

Electricity and water consumption

It has been well documented that laboratory operations require very high consumption of water and electricity. Per unit surface area, the typical laboratory uses 3 to 6 times more than office space. Furthermore, research [7] has shown that equipment such as ultra-low temperature freezers and immunoassay analysers are amongst the most energy intensive devices in the laboratory. The utility consumption of different laboratory equipment should, therefore, be considered in the selection and procurement process, as it is related to the long-term operating expense and Total Cost of Ownership. Water and electricity requirements across different systems can be compared easily, since such information is usually published and readily found in promotional brochures and operator manuals. A recent case study from a laboratory in Vietnam [8] has shown that switching to a more efficient analyser enabled a reduction in electricity consumption rate by 51.1% and water consumption rate by 2.9%.

Conclusion

There are many technologies and innovations that can enable laboratory operations to be environmentally sustainable (via the reduction of wastes, hazardous substances, or utilities consumption) while at the same time delivering on operational and economic benefits (such as streamlined workflows, lower repeats and hidden costs, simplified sample and reagent management, decreased utilities and waste disposal expenses, etc.). While a few of these technologies are introduced in this article, there are certainly many more out there that can be considered and incorporated into procurement criteria to help laboratories to identify and select the right solution for their needs.

Organisations around the region are now beginning to incorporate sustainability implications into procurement and tender decisions [9]. Additionally, the environmental efforts of vendors and suppliers can also be assessed and endorsed by credible, independent third parties. For example, the Dow Jones Sustainability Index (DJSI) calculates an annual sustainability score for the top companies across 61 industry sectors. For the last nine years, Abbott has been ranked number one with the highest score in the health care equipment industry [10], and its corporate sustainability report [11] has shown that it has outperformed its 2020 goals of reducing normalised carbon emissions by 40% and water intake by 30% versus the 2010 baseline. Such industry awards and assessments are not only for publicity purposes, but also serves as powerful indicators of the company's investment and track record in environmental sustainability that can inform laboratorians and administrators in the vendor selection process.

Finally, implementing new technologies often involve significant transformation of laboratory processes and operations. It is, therefore, vital for laboratorians to understand the tangible and intangible benefits and the impact on overt and hidden costs. Demonstrating that environmental sustainability can also contribute towards operational and economic improvements will help to secure buy-in and support from senior leaders, employees, shareholders and other important stakeholders. Moreover, continuing education and training are important to drive deeper fundamental culture change across the organisation and instill a long-term sustainability mindset. Environmental sustainability is not only good for the environment, it can also help laboratories to succeed in gaining competitive advantage and drive long-term growth [3].

References

1. https://www.cnbc.com/2022/03/18/un-asia-pacific-is-falling-behind-on-its-sustainability-goals.html
2. https://www.eco-business.com/news/asia-pacific-may-take-till-2065-to-achieve-2030-sustainable-development-targets/
3. Lopez JB, Jackson D, Gammie A, Badrick T. Reducing the Environmental Impact of Clinical Laboratories. Clin Biochem Rev. 2017 Feb; 38(1):3-11. PMID: 28798502; PMCID: PMC5548370.
4. Berman M, Ruvuna L. Extended range of the Enzyme Panel assays on the Alinity c System using FLEX technology. Poster presented at 2019 IFCC EuroMedLab Congress, Barcelona.
5. Armbruster DA, Alexander DB. Sample to sample carryover: a source of analytical laboratory error and its relevance to integrated clinical chemistry/immunoassay systems. Clin Chim Acta. 2006 Nov; 373(1-2):37-43. doi: 10.1016/j.cca.2006.04.022. Epub 2006 Jun 14. PMID: 16777083.
6. Davidson C, Shultz J, Hynek R, Santiago J, Utts J. Alinity c and Alinity i Sample-to-Sample Carryover Performance. Abbott White Paper ADD-00062929
7. Christiansen, Nils, Martin Kaltschmitt, Frank Dzukowski and Friedrich Isensee. “Electricity consumption of medical plug loads in hospital laboratories: Identification, evaluation, prediction and verification.” Energy and Buildings 107 (2015): 392-406.
8. Case study: Medic-Lab, Achieving Sustainable Growth as a Result of the Abbott Total Solution. White Paper ADD-00073166. Core Diagnostics, Abbott.
9. Australian Government Procurement Guidelines. https://www.finance.gov.au/government/procurement/buying-australian-government/incorporating-sustainability
10. https://www.prnewswire.com/news-releases/abbott-achieves-highest-score-in-its-industry-for-the-ninth-consecutive-year-on-the-dow-jones-sustainability-index-djsi-301424215.html

    https://dam.abbott.com/en-us/docume