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Q&A

Sustainability in Laboratory Medicine

Moderator: Raeshun T. Glover,[a,*]; Experts: James Connelly,[b] Alistair Gammie,[c] Jane Kilcoyne,[d] Tomris Ozben,[e,f,g] Alicja Santos,[h] and Joesph R. Wiencek[i]

Introduction

Sustainability in laboratory medicine is not a novel concept. However, the topic is gaining significant global traction as recent guidelines and other publications are released. Unfortunately, before a laboratory result is generated, large amounts of resources are utilized. For example, in the research, development, and design phases of a clinical laboratory assay, laboratories and in vitro diagnostic (IVD) companies will consume considerable resources and produce significant waste. Similarly, clinical laboratories must go through numerous test verifications and validations that require multiple shipments of instrumentation, equipment, reagents, and other consumables. Additionally, the daily operation of clinical laboratory instrumentation requires large amounts of water, energy, chemicals, and other products that lead to recyclable and nonrecyclable waste.

Patient specimens are another major contributor of waste in laboratory medicine. Specimens are commonly collected by single-use plastics, placed in plastic tubes, and shipped in plastic biohazardous bags. Point-of-care testing (POCT) may eliminate some of this usage; however, many of these POCT devices are also single-use and contain dense plastic or other nonrecyclable materials (such as circuits, magnets, and heating elements) in their design. Fortunately, as sustainability efforts are highlighted, clinical and research laboratories as well as IVD and pharmaceutical companies are exploring ways to eliminate unnecessary waste production, increase efficiencies, and reduce their overall carbon footprints.

While an increasing number of groups around the world are investigating how to implement these practices, the implementation of appropriate strategies and the reporting of progress in sustainability efforts present many challenges in both academic and commercial settings. In this Q&A article, we invited key stakeholders from various areas of diagnostic medicine to offer their perspective on challenges, solutions, and outcomes in the implementation of sustainability within their respective domains.

Briefly describe your role and experiences with sustainability initiatives in lab medicine.

Tomris Ozben: I am the current President of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) and Chair of the EFLM Task Force-Green and Sustainable Laboratories (TF-GSL) founded in 2021. The goal of TF-GSL is to promote sustainable practices in clinical laboratories, focusing on carbon footprint reduction, guidance, and greater sustainability. TF-GSL includes the chair and members, representatives of the EFLM national societies, IVD industry, and MedTech Europe.

TF-GSL's mission is to drive carbon neutrality in clinical labs, aligning with the European Green Deal (EGD) Investment Plan. It offers guidelines and recommendations to decrease energy, water, waste, and chemical use. The TF-GSL prepares guidelines, checklists, and other materials for sustainable lab practices as well as a lab certification process. Currently, translations of guidelines, engagements with EFLM national societies, and assessment of applications of laboratories for EFLM Green Lab certificates are ongoing.

[a]Clinical Pathology Resident, Department of Pathology, Microbiology, and Immunology, Vanderbilt University School of Medicine, Nashville, TN, United States; [b]Chief Executive Officer, My Green Lab, Spokane, WA, United States; [c]Independent Principal Consultant, QuidelOrtho, San Diego, CA, United States; [d]Research Chemist, Marine Institute, Rinville, Oranmore, Galway, Ireland; [e]President-Elect, International Federation of Clinical Chemistry and Laboratory Medicine, Milan, Italy; [f]Chair, EFLM Task Force-Green and Sustainable Laboratories, Milan, Italy; [g]Professor, Department of Medical Biochemistry, Medical Faculty, Akdeniz University, Antalya, Turkey; [h]President and Chief Executive Officer, Polonium Foundation, Warsaw, Poland; [i]Associate Professor, Department of Pathology, Microbiology, and Immunology, Vanderbilt University School of Medicine, Nashville, TN, United States.
*Address correspondence to this author at: Department of Pathology, Microbiology and Immunology, Vanderbilt University Medical Center, TVC 4605, 1211 Medical Center Dr., Nashville, TN 37232, United States. Tel 615-343-9166; e-mail Raeshun.Glover@vumc.org.
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Alicja "Ala" Santos: My perspective on sustainability within lab medicine is from nearly 2 decades of work in scientific research and new technology development. This journey commenced with laboratory assignments in my native Poland, where I learned how to do meaningful research with sparse resources. At present, I am immersed in sustainability consultancy, focusing particularly on healthcare products. This role involves reducing the environmental impact of existing products and spearheading the creation of sustainable alternatives for the future. In addition, I am delving into the multifaceted realm of sustainable hospital operations, aiming to develop a comprehensive framework for sustainability.

Alistair Gammie: My interest in sustainability dates back to 1997 when I investigated the incidence of hepatitis A in surfers and windsurfers. I had approached this from a purely scientific angle and was surprised when Surfers Against Sewage invited me to speak on their behalf. This opened my eyes to the overall topic of waste management and the effect this has on healthcare and the environment. I started to look more broadly at sustainability and fully believe that sustainability in the laboratory is not just about reduce, reuse, and recycle. Rather the focus should be about total sustainability, which focuses on the social goal of ensuring laboratory medicine continues to survive and thrive into the future. Therefore, we must continue to reduce carbon emissions and plastic usage, recycle packaging, and reuse consumables where appropriate. We also need to ensure we have the appropriate training and workforce planning.

James Connelly: I am the CEO of My Green Lab (MGL), a nonprofit dedicated to building a global culture of sustainability in science. Founded in 2013, MGL has worked with labs and scientists to improve the sustainability of laboratory research. Our initial focus was on academic research laboratories, but we have expanded to other areas including clinical labs.

Jane Kilcoyne: I am an analytical chemist at the Marine Institute in Galway, Ireland. Our laboratory runs Ireland's national chemical monitoring program for marine biotoxins in shellfish. Starting back in 2018, we took actions to reduce our environmental impacts.

We were producing about 4000 kilograms of waste each year, all of which was incinerated. We reduced that amount by more than 95% (to 130 kilograms). Much of the reduction was achieved easily by composting (shellfish waste), recycling (polystyrene), and replacing single-use plastics with glass and compostable cardboard alternatives. We additionally reduced our paper consumption by >95% by switching to digital document control.

We reduced our consumption of hazardous chemicals by 23%, simply by extending expiry dates and only preparing what was required. Also, for some methods we switched from using acetonitrile as a solvent to methanol, which is more environmentally friendly, cheaper, and less toxic.

A 30% reduction in energy consumption was achieved by installing standalone portable filtration systems to the chemical presses under the fume hoods and by taking multiple cold-storage units out of use by applying better management practices. Other more sustainable behavioral changes include pulling down fume hood sashes and powering down laboratory equipment after use.

Joe Wiencek: I am an associate professor of pathology, microbiology, and immunology at Vanderbilt School of Medicine. I also serve as the Service Line Medical Director over an academic Core and Emergency Department Laboratory at Vanderbilt University Medical Center.

My clinical research focuses on preanalytical variation with a distinct emphasis towards elucidating the environment's influence on the quality of laboratory testing and the ecological impact of laboratory medicine. The former route of research originated while I was a

clinical chemistry fellow, and more recently expanded to incorporate sustainability aspects. More specifically, as a second-year fellow, I was asked if we could possibly analyze specimens that were left to swelter in an outside courier lockbox over a hot summer weekend, subsequently discovered on a Monday morning. Unbeknownst to me then, this inquiry would propel me towards researching the effects of extreme weather on laboratory testing and the identification and mitigation of consumable waste streams, as well as ongoing quantification of water and energy consumption in the clinical laboratory.

What key parts of the environment are impacted by laboratory operations?

James Connelly: Laboratories have an outsized environmental footprint. Laboratory buildings can use up to 10 times the energy of a similar commercial building and 4 times the water, and they produce a massive amount of single-use plastic and other hazardous waste. A report from Healthcare Without Harm found that the healthcare industry is responsible for up to 4.6% of global carbon emissions. MGL released a study last year that found that biotech and pharma have a massive and growing climate footprint, producing up to 260 million tons of carbon dioxide equivalent (tCO2-e).

Purchased goods and services make up most of the environmental impact of laboratories (up to 90%), which anyone who works in a lab has experienced, particularly in clinical labs given the massive amount of single-use plastic waste. In addition, specialized ventilation and high energy-consuming equipment such as ultra low-temperature freezers have an important impact.

Alistair Gammie: Human activity, especially energy usage, significantly contributes to global warming. Among other things, this leads to atmospheric pollution, increased consumption of energy and water, and increased production of waste and the resultant contamination of soil and water through runoff. Laboratories contribute to these problems; it is estimated that labs use 10 times the amount of energy than a comparably sized office building. They are also significant users of chemicals and single-use plastics. Reduction in energy consumption and waste production can lead to cost savings as well as improving the environmental footprint. Even though initial clinical lab guidance was provided over 10 years ago, the number of laboratories making significant environmental changes has been limited. However, in the last 2 years, lab sustainability has become more publicized and discussed internationally, nationally, and locally.

Tomris Ozben: Clinical laboratories impact the environment in various ways. All organizations, including labs, must fulfill a societal obligation to reduce their harm to the environment and lessen environmental consequences. Labs need strategies to minimize harmful impacts, implement efficient actions and sustainable practices, and reduce energy, water, hazardous chemical use, and waste generation without compromising healthcare quality. By setting sustainable development goals and employing various means for reductions, hospitals and clinical labs can become greener and reduce their environmental impact.

Clinical labs are major water and energy consumers, producing waste and using substantial quantities of chemicals. They use more energy and water than offices and generate significant hazardous and nonhazardous waste. Recent years have seen increased waste, including hazardous waste, due to industrialization, urbanization, economic development, and rising populations. Medical waste has become a significant global pollutant, affecting soil, water, and air quality. In healthcare, improper waste disposal can contaminate water and air. Proper waste management is crucial, as landfills leach harmful chemicals into the environment, and incineration generates atmospheric pollutants.

Hazardous chemicals contribute to various health conditions and environmental problems, affecting ecosystems, air, and water quality. Their use, especially when disregarding guidelines, significantly contributes to climate change and biodiversity loss. To minimize chemical pollution, sustainable production processes and technologies are essential, promoting societal benefits while minimizing environmental damage.

Chemical production, a highly polluting and resource-intensive sector, requires sustainable practices. Novel and cleaner industrial processes and technologies can reduce environmental impact, costs, and create markets for sustainable chemicals. Chemicals should be produced and used to maximize societal benefits while minimizing harm to the environment and society.

Jane Kilcoyne: A study from the University of Exeter estimated that globally there are 20 500 institutions involved in medical, biological, or agricultural research alone. Laboratories are estimated to use, often unnecessarily, up to 15 times more plastic, 4 times more water, and 10 times more energy than office spaces. Furthermore, laboratories consume large amounts of hazardous chemicals and personal protective equipment (PPE), leading to a continual stream of waste that can often be difficult to dispose of. There is a growing realization that laboratories need to urgently make radical operational changes and adopt good environmental practices.

Every action towards sustainability, no matter how small, can make a difference, particularly within a resource-hungry laboratory environment.

Ala Santos: When discussing sustainability in healthcare, a noticeable aspect is the limited extent of dialogue and the scarcity of widespread, dynamic, and visible endeavors aimed at enhancing current laboratory practices. Unlike other sectors that are significantly advanced in adopting sustainable solutions and meticulously monitoring their progress, the healthcare industry has only recently embarked in this direction. This disparity could stem from a variety of factors, including a lack of stringent regulations, limited external/client influence (as seen in automotive, architectural, and fashion industries), or perhaps the critical life-and-death nature of healthcare, which necessitates a cautious approach to ensure uninterrupted operations rather than rapid experimentation. Therefore, apart from very field-specific key factors, the immediate sustainability initiatives within our field closely align with those identified by other industries, including waste management, supply chain, carbon footprint, sustainable workforce models, or new product development that highly prioritizes sustainable solutions.

Joe Wiencek: Interestingly, I believe the COVID-19 pandemic underscored the preexisting issue that diagnostic testing has an enormous environmental footprint. Throughout the pandemic, the considerable number of resources required and waste generated during the rapid research, design, and implementation of diagnostic tests became strikingly apparent. I also sensed this period fostered heightened global awareness about the scope and vulnerability of the supply chain and the mass shipment of raw materials, mass production of chemicals, plastics, and other consumables necessary for patient testing.

Within the clinical laboratory, following a brief observation period, it becomes evident just how many resources are consumed and how much nonrecyclable wastes are produced. Unfortunately, assessments of clinical laboratory waste stream evaluations remain sparse in the literature, and discussions concerning sustainability with vendors, at least in the United States, are lacking during equipment acquisition or new test integration. For me, it is of paramount significance that these discussions around sustainability with vendors take center stage immediately, concurrent with aspects such as analyzer throughput, innovations, costs, and maintenance.

What are the challenges and opportunities in implementing sustainability in current healthcare practices and medical innovation?

Jane Kilcoyne: There's always going to be some pushback against any change, particularly when working in an accredited laboratory, but once you can demonstrate that it doesn't affect the results, then people are more open to it. For example, when we looked at switching to glass instead of single-use plastic centrifuge tubes for extracting our samples, there were concerns about toxin carryover and contamination. However, the verification results clearly demonstrated that carryover didn't happen, i.e., using glass had no impact on the results of our shellfish toxin tests. In fact, none of the changes we made had any impact on the integrity of our results.

The initial extra work involved in transitioning to greener procedures was well worth the effort as we found it led to greater efficiencies and reduced our overall workload.

Ala Santos: From my perspective, the most significant prospects for sustainability lie within the realm of new product development. Particularly, sectors characterized by rapid turnover, single-use applications, and the conceptual framework of personalized, equitable, and global medicine must prioritize the integration of sustainable practices. Moreover, newly designed technologies catering to high-volume, large-scale laboratory operations should transition toward a sustainable paradigm. The introduction of innovative solutions in new product development will inevitably shape the future trajectory of modern laboratory practices.

Alistair Gammie: Due to political and social pressures, many healthcare institutions have an active Environmental Management System (EMS), which covers the clinical laboratory. Whilst laboratories are resource intensive, there has not been a concerted approach towards sustainability. It is important to educate laboratories about environmental benefits and cost-effectiveness to effect a change in mindset. Persistence is the key. Once a system for sustainability is in place, people tend to follow and implement it. The top 3 reasons why EMS schemes fail are lack of knowledge, cost of time, and inability to motivate staff.

Tomris Ozben: Sustainability challenges stem from multiple uncertainties—technical, market, regulatory, political—impacting scaling, reliability, cost, and supply chain. Green chemistry addresses the lab's environmental issues, reducing pollution, hazardous chemicals, and accidents. The process of implementing sustainability includes evaluating the chemical's life cycle impacts, then seeking safer alternatives, increased efficiency, lower emissions, and improved safety while considering the socioeconomic aspects.

Sustainability measures are vital in rapidly changing healthcare to reduce negative impacts. Efficient resource use has long-term cost-saving potential. However, eco-friendly healthcare structures need campaigns and education. Auditing unnecessary tests can reduce reagent use, and costs. While sustainable healthcare methods are becoming more defined, clinical labs lack consensus on strategies and would benefit from official carbon footprint reduction guidelines.

Joe Wiencek: Implementing sustainability in laboratory medicine presents numerous challenges and opportunities. As every clinical laboratory process could be reviewed for efficiencies to reduce the overall environmental impact, identifying a place to start may prove the most daunting. At Vanderbilt, one of our initial steps quantified yearly recyclable and nonrecyclable wastes produced by our clinical chemistry laboratory performing a comprehensive metabolic panel. This pilot helped fuel interest in our diagnostic laboratory to identify vested parties across all sections of the department. This in turn sparked dialogues with our current vendors regarding their organization and products' sustainability initiatives.

Additionally, Vanderbilt is presently engaged in a massive laboratory transformation to a 100 000 square foot facility and strategically renovating our main hospital laboratory with a lean approach. In these endeavors, there has been a key focus on curbing energy usage and waste through motion-activated lighting, paper consumption reduction, etc. However, a challenge we are navigating pertains to plastic recyclables. In particular, not all recyclable grades of plastic are accepted at our facility and many of these materials are contaminated with biological or toxic chemicals.

James Connelly: Often, there is a feeling that research and healthcare benefits are so crucial that sustainability should take a back seat. Further, we find pushback from lab workers and researchers on changing processes. There are concerns about modification impacting experiments and general resistance to changing things if they have always been done that way.

That is why MGL certification offers a flexible approach based on a list of best practices, where scientists and labs can pick and choose what is best for their workflow and research. Further, many of the suggestions include simple behavior changes like closing the fume hood sash when not in use. A single fume hood can use as much energy as 3 American homes, and closing the fume hood sash can reduce that energy consumption by a third!

What role does collaboration among key stakeholders (e.g., vendors, clinical labs, researchers, and patients) play in adoption of sustainability practices?

Joe Wiencek: Initiating open and collaborative dialogues with essential key stakeholders remains critical for the effective establishment and continued success of sustainability in lab medicine. Additionally, regulatory bodies and accreditation agencies, as well as national and international laboratory associations ought to institute task forces or committees aimed at assisting vendors, clinical laboratories, and researchers in formulating implementation strategies in these respective areas. It may also be prudent for scientific studies to begin commenting on waste and sustainability aspects in their investigations.

Alistair Gammie: In my opinion, vendors will continue to focus their efforts towards their own sustainability goals rather than working directly with clinical laboratories. It would be ideal if there was an agreement between vendors and regulatory authorities to allow vendors to review and create sustainable packaging without the associated cost and bureaucracy. This would be advantageous for everyone.

Tomris Ozben: Creation of a multidisciplinary, sustainable healthcare coalition involving IVD manufacturers, and health authorities is crucial in supporting sustainability. Implementing an EMS and a sustainability policy will also be key. Simple actions by staff and clear laboratory leadership as well as engaging patients, contractors, colleagues, and educating personnel can start the sustainable lab journey.

The European Commission takes climate-focused initiatives for hospitals. Guides like "Energy intelligent, energy Europe" help reduce carbon dioxide emissions. Hospitals and labs should lead on carbon neutrality by addressing climate change and pollution. Green and sustainable procurement with environmental criteria guidance is significant. Labs should use the 3R concept: reduce, reuse, recycle. Green purchasing policies and renewable energy use are recommended. Labs must reduce waste, pressurize the IVD industry, and support environmentally friendly practices.

James Connelly: Given that up to 90% of the environmental impact of a lab comes from your supply chain and the waste you generate, you can't have a green lab unless you also can find greener products and more environmentally friendly ways to dispose of those products. That is why MGL developed the Accountability, Consistency, and Transparency (ACT) label, the first third-party environmental certification for lab products. ACT is a tool for scientists, lab managers, and procurement to identify sustainable products, as well as for manufacturers to benchmark their performance and continuously improve their products. Labs are crucial in encouraging and rewarding suppliers to go green and preferentially buy products with reduced environmental impact.

Several companies now offer the ability to recycle waste into things like park benches and planters. Some new innovative companies can treat waste through mechanical shredding and chemical treatment, so you don't have to autoclave everything for sterilization, which has a considerable carbon benefit.

Jane Kilcoyne: The Irish government's climate and resource efficiency action plans, with implementation directed by all public sector bodies, were important in initiating action.

Creating awareness and educational campaigns played a key role in instigating procedural and behavioral changes. Team members across multiple divisions were engaged in the process and it was a great team-building exercise. Being part of a network (e.g., Irish Green Labs, Sustainable European Laboratories, and the MGL Ambassador program) is also great for motivation, information, and spurring ideas. Engaging with funding bodies is also important in highlighting the need for them to stipulate that laboratories have green certification as a requirement for funding.

What are the certificates or standards laboratories and vendors should target to show commitment to sustainability?

Alistair Gammie: The current International Organization of Standards (ISO) 14001:2015 seeks to promote effective environmental management systems in organizations. The new version of ISO 14001 focuses on the improvement of environmental performance rather than the improvement of the management system itself. In Europe, there is the Eco Management and Audit System (EMAS) scheme available for any organization. Future laboratory accreditation is expected to acknowledge an organization's responsibility to improving environmental practice. The forthcoming changes to ISO 15189 are prime examples of this, demonstrating how service improvement will be expected to consider sustainable and climate conscious practices.

Tomris Ozben: Certification programs globally aid labs in sustainability goals, showcasing commitment. EFLM's Green Lab certification aligns with the European Commission, the EGD, United Nations Sustainability goals, and the Paris Climate Agreement. EFLM TF-GSL guides laboratories towards Green Lab certification, assessing hazardous chemicals, energy, waste, and water management. Applicants need 75% points in each section; unsuccessful applicants can reapply after improving per the guidelines. EFLM TF-GSL audits to verify lab compliance and certification are open to all clinical laboratory disciplines worldwide.

James Connelly: In 2021, the United Nations-backed Race to Zero Program selected MGL as a critical indicator of progress for the biotech and pharma sector and set a goal that 95% of labs in that sector are MGL certified at the highest level by 2030. To date, over 2000 labs from more than 300 organizations and 24 000 scientists have engaged with the program in 45 countries. It is a proven process to engage your scientists and your lab to drive down your environmental impact. Other certifications to consider include ISO 9001 and getting your building certification to Leadership in Energy and Environmental Design (LEED) or Building Research Establishment Environmental Assessment Methodology (BREAM) certification. For life science manufacturers, an Energy Star certification is available for freezers.

Jane Kilcoyne: Green certification, e.g., MGL, Laboratory Efficiency Assessment Framework, and ISO 14001, is an excellent way to formalize cultural change within an organization. Our laboratory recently gained the highest level of MGL certification and as part of that certification process, we won the Top Small Lab Award (Government Sector) for the 2023 International Freezer Challenge.

Besides the overall environmental impact, what potential benefits are associated with lab sustainability practices?

Ala Santos: The shift to sustainable approaches in healthcare promises substantial gains on 2 prominent fronts: the comprehensive enhancement of medical system efficiency and the strategic elevation of brand value and industry leadership.

Primarily, the transformation of how the medical field operates will be catalyzed by systemic initiatives spanning all facets of healthcare, encompassing academic research and commercial operations. Today, pioneering laboratories and companies are already reaping benefits from the adoption of sustainable solutions. These benefits span a spectrum, ranging from tangible cost savings and heightened innovation capacity (breaking away from traditional paths) to the desirability of being associated as employee, partner, or customer with entities that prioritize sustainability. This brings us to the second significant advantage: integrating sustainable practices is good for the brand. Whether it pertains to a product, a company, or a research institution, sustainability endeavors create a distinctive image that stands in stark contrast to the prevailing market norms and establishes a new way matched with the rapidly changing world we live in.

Tomris Ozben: Adopting sustainable and green lab practices yields numerous benefits beyond environmental impact. Laboratory medicine's contribution to sustainable healthcare optimizes resource use for quality healthcare. Healthcare systems gain long-term cost-saving potential. Reducing waste reduces disposal expenses and environmental impact. The economic toll of contamination is high—remediation and decontamination are expensive. Sustainable labs yield economic advantages.

Chemicals strategies for sustainability promote human health, innovation, and safe chemicals. Cleaner processes reduce the footprint, cut costs, and create markets. Safe waste management curbs health and environmental risks. Sustainable labs offer safe, efficient environments, align with goals, and may attract qualified personnel fostering green lab leaders.

Jane Kilcoyne: In addition to environmental protection and financial savings, these strategies enhance the reputation and influence of an organization, promote environmental awareness, innovation, and greater staff engagement. The changes we adopted in our procedures and behaviors are now embedded in the laboratory and such changes in mindset also have impacts outside of work.

Additionally, achieving green certification will aid funding applications—funding agencies are more likely to spend taxpayers' money on laboratories and organisations that have a good track record on efficiency and sustainability. Hopefully, in the near future, green certification won't be a "nice to have" but a "must have" in order for awards to be granted.

James Connelly: A sustainable lab is also a more efficient lab. The impact of MGL certification can vary depending on the type of lab and its sustainability baseline; however, recent case studies demonstrate a significant environmental and financial benefit. For example, AstraZeneca received a 4-fold return on investment from their energy savings alone, which equates to over 1.2 million kilowatt hours (kWh) of energy saved annually. They aim to certify all their labs globally at the highest level by 2025.

Another benefit is employee engagement. Notably, younger lab employees care about environmental protection, and it promotes a better workplace culture when employees can see how their actions align with their organization's priorities. This can further serve to benefit employee recruitment and retention positively.

Lastly, public recognition through an independent certification is a valuable way to enhance your lab's reputation with employees as well as customers and inspire your company and your peers to be part of becoming a proactive solution for addressing climate change and other critical environmental issues.

Alistair Gammie: Sustainable laboratories can be economically beneficial. It has been estimated that most of the existing laboratories can reduce their energy consumption by 30% to 50% using existing technology, which is significant given their annual energy costs in the United States alone amounting to approximately $1 to 2 billion. In 2019, published results from an ISO 14001 study in an Australian laboratory described how they were able to generate over $500 000 in savings through implementation of ISO 14001. Notable savings were made by moving to double-sided printing, introducing electronic reports, use of light-emitting diode (LED) and movement-sensors lights, turning off equipment when not in use, and directed air-conditioning in rooms that are in use. Besides the economic benefits, there are several other intangible benefits which can be identified. Going green enhances a laboratory's brand and image with its customers, suppliers, and other stakeholders. It sends out the message that the laboratory takes seriously its responsibilities to the society it serves.

The improvement of our environment has become an issue of increasing political importance. We should anticipate more legislation throughout regional and national government levels, and subsequent changes in local policy in response to this legislation. Going green voluntarily will preempt these changes in legislation and prepare the laboratory to be better placed when they are eventually enforced.

Joe Wiencek: There are many advantages to implementing sustainability practices. Two practical benefits our laboratory has experienced have been enhanced workflow efficiencies and collaborative sustainability dialogues with our vendors. For example, our chemistry team recently reviewed the analytical performance and consumable waste reduction strategies by implementing a tube-based quality control material. This seemingly modest, yet substantially impactful, evaluation allowed us to demonstrate a reduction in total plastic sample cups as well as technologist time savings. The significance of our findings was shared at a quality exchange summit as well as our town hall and faculty meetings. These platforms proved instrumental in showcasing the benefits to vested stakeholders, effectively highlighting the profound interconnection between the well-being of our planet, laboratory medicine, and patient care.

Nonstandard Abbreviations: IVD, In vitro diagnostics; EFLM, European Federation of Clinical Chemistry and Laboratory Medicine; TF-GSL, Task Force-Green and Sustainable Laboratories; MGL, My Green Labs; ISO, International Organization of Standards.

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Raeshun Glover (Conceptualization-Lead, Writing—original draft-Lead, Writing—review & editing-Lead), James Connelly (Writing—original draft-Supporting, Writing—review & editing-Supporting), Alistair Gammie (Writing—original draft-Supporting, Writing—review &

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