Green gastroenterology adaptation, resilience and an industry perspective

Cassandra Thiel,[1] Emma Pak,[2] Rainer Burkard,[3] Harald Huber [4]

We are living in unprecedented times—extreme weather conditions are becoming increasingly common, and greenhouse gas emissions have reached staggering levels. We are in a climate crisis, and it is up to every government, institution, industry and individual to act now.

Climate change poses a serious threat to the healthcare industry, threatening facility closures, supply chain disruptions and the rapid spreading of diseases and traumatic events,[1–3] as seen in 2012, when Atlantic Hurricane Sandy impacted eight countries including the eastern USA (particularly the states of New York and New Jersey). New York University Langone Health and its backup generators flooded, forcing patient evacuations to other regional hospitals. Despite rebuilding its infrastructure by elevating its backup generators, installing a cogeneration facility to produce electricity and steam onsite, and installing submarine doors to handle future surges, the sector was relatively unprepared for the severe COVID-19 supply chain shortages.[4]

The healthcare sector is responsible for 4.4% of global greenhouse gas (GHG) emissions and produces substantial waste,[5] contributing to the increased frequency of environmental disasters.[3] Working towards greater safety and optimal patient outcomes should not come at the cost of the planet's health.[6] As healthcare systems begin mitigating emissions, they must also adapt to climate change and enhance resilience. While climate change is a global crisis, stakeholders are already considering how climate-resilient health systems can become the new

[1]Departments of Population Health and Ophthalmology, New York University Langone Health, New York, New York, USA
[2]Stony Brook University, Stony Brook, New York, USA
[3]HOYA Corp PENTAX Lifecare Division, Tokyo, Japan
[4]Global Marketing, HOYA Corp PENTAX Lifecare Division, Tokyo, Japan

Correspondence to Harald Huber, Global Marketing, HOYA Corp PENTAX Lifecare Division, Tokyo, 196-0012, Japan; harald.huber@pentaxmedical.com

reality, ensuring we can provide care to our community.

ADAPTING TO CLIMATE CHANGE AND CREATING RESILIENT HEALTHCARE INSTITUTIONS

Resilience prepares a healthcare system for climate uncertainties through adequate planning and strengthening its capability to repair infrastructure to maintain medical services during crises.[3 7] It also supports recovery from postclimate shocks, preventing health system closures—temporary or permanent. Well-prepared systems, though they may experience a temporary drop in performance, can rebound and exceed their pre-event state.[8] Healthcare resilience is crucial to ensure the continuity of services, especially when more care is needed to tend to disaster-induced injuries and diseases. The inability to provide care during disasters comes at the cost of patients' lives, making healthcare resilience a social, moral and ethical necessity.

Hospitals can be described as 'a hotel, an office building, a laboratory, and a warehouse', revealing the complexity and interconnectivity of the system that can leave healthcare facilities vulnerable to climate events.[9] To address this intricacy and build climate resilience, a diverse 'resilience task force' is vital, including patients, doctors, nurses, waste management personnel, utility companies, local governments and non-profits, and others involved in the health system. Each brings unique perspectives on who and what needs to be protected, and insight into the vulnerabilities to climate hazards.

Identify your climate risks and brainstorm safeguards

The next crucial step, after forming a resilience task force, is identifying climate hazards that make health systems vulnerable, including droughts, extreme heat, wildfires, flooding, hurricanes and ice storms. These hazards vary based on geography, patient populations and infrastructure (physical and social). Using resources like the US National Risk Index map[10] can aid in identifying natural hazards your health system faces, facilitating better planning. Healthcare systems are intricate, involving various stakeholders and supporting operations across many facilities. If any element fails, the continuity of medical services suffers. Every component—patients, supplies, staff, backup generators, facilities—encompass assets required to maintain effective functioning. Climate hazards present unique risks to each of these assets, which must be identified. Figure 1 shows an example of a risk assessment of potential asset-hazard pairs—these pairs are variable depending on which climate hazards are relevant for that site.

Empowered with an asset list and climate hazards, the stakeholder team can develop a plan to enhance health system resilience and adaptability. Combined hazards could affect patients, facilities, suppliers and manufacturers. For instance, wildfires could directly affect stakeholders, compounded with air quality issues and the health impacts of loss of homes. Similarly, the U.K. addressed floods as the central cause of disrupting critical infrastructure resilience by building a resilience strategy around flood hazards.[11] Typical flood-related issues include road damage that disrupts supply chains, staffing issues and inaccessibility of health facilities.

Resilience strategies

Resilience strategies can range from clinical efficiency efforts, to building infrastructure improvements, to supply chain diversification. Effective strategies should address all affected components in the healthcare system. As new strategies are implemented, outcomes should be tracked and the strategies should be built on as needed.

Energy sourcing is one approach for infrastructure resilience. On-site cogeneration facilities, like those at NYU Langone and Gunderson Health in the US, create power and steam using natural gas and wood chips, respectively, to fuel their electricity and steam co-gen plants. Solar panels can also be installed to reduce GHG emissions and improve resilience through local power generation. This reduces both electricity bills and air pollution. In places with less reliable grids, on-site renewables extend lifespan by reducing power surges. Lowering on-site energy demands aids resilience as emergency

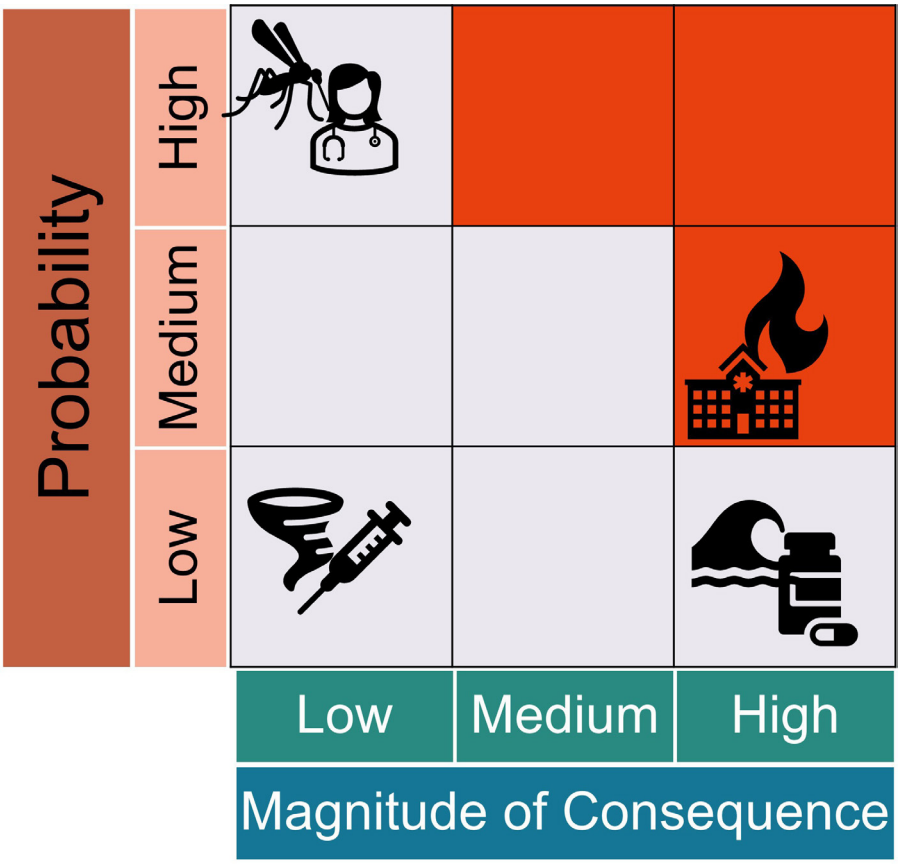

Figure 1 Managing a system's climate risks requires an understanding of the 'assets' of the organisation, including staff, patients, pharmaceuticals, supplies and electricity generation. After determining your site's climate hazards, a resilience committee should characterise the risk for every asset-hazard pair as schematically displayed in this figure. The examples in the figure include, from top left through bottom right: risk of disease vectors (top row), such as mosquito borne illnesses being transmitted to staff creating workforce shortages; risk of wildfire to the hospital or clinic building (middle row); risk of tornadoes disrupting pharmaceutical supply chain (lower row, left box); and risk of flooding or hurricanes disrupting different pharmaceutical supply chain (lower row, right box). Items in the red zones are where a health system has the highest chances of sustaining substantial loss and should be focus areas for resilience planning.

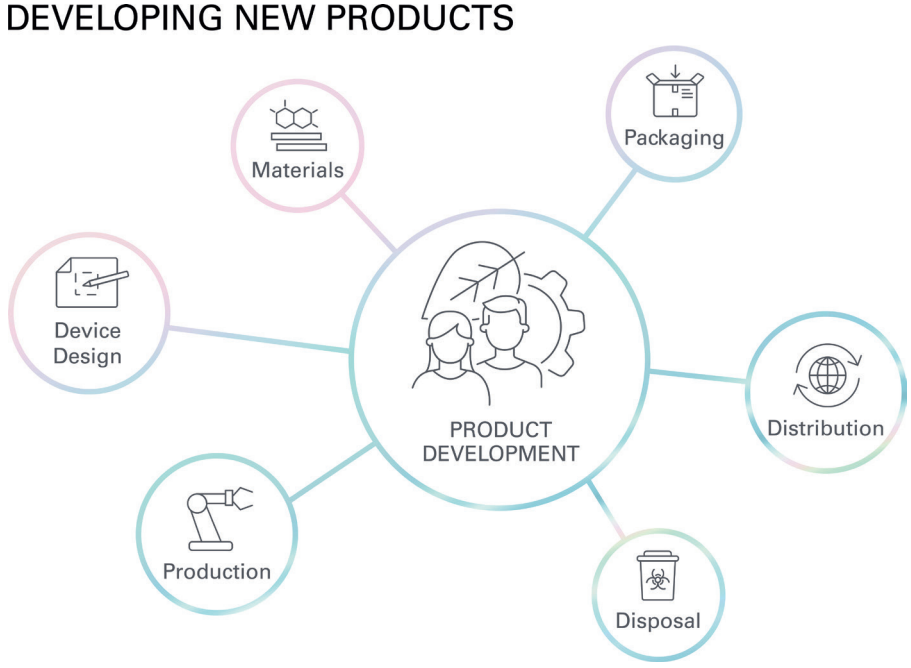

Figure 2 Endoscopy design principles taking materials, packaging, device design, distribution, manufacturing and disposal into account during the product development process.

sourcing energy is easier when a health system inherently consumes less.

Supply chain resilience is equally important, with strategies like reducing and optimising supply use, using reusable items and single-use device reprocessing to keep stock of supplies somewhat local, and sourcing from enough vendors as to have a diversity of supply, all of which reduce GHG emissions as we emit less by reducing and reusing. Empowering procurement and supply chain departments with forecasting resources (understanding material requirements over time for the facility), suppliers that respect the institution's sustainability and resilience goals, and reliable relationships bolsters healthcare resilience. Collaborative interhospital stockpiling within a region strengthens supply chain resilience. Implementing these strategies ensures an effective response to future challenges.

These considerations are especially relevant in the resource-intensive field of gastrointestinal (GI) endoscopy, which is a significant contributor to healthcare's overall environmental footprint.[12 13] Although there is room for improvement, there has been significant progress in green endoscopy. Industry bodies, such as the European Society for Gastrointestinal Endoscopy and the European Society for Gastroenterology and Endoscopy Nurses and Associates,[12] are collaborating to raise awareness about the field's impacts and how to mitigate these. Organisations are using the United Nations' Sustainable Development Goals (SDGs)[14] to think holistically about approaches to climate change and sustainable development. At the same time, new design principles need to be conceptualised, so GI innovations meet the needs of current and future generations. Resilience strategies should also be employed by other system stakeholders, not just the healthcare systems and facilities themselves. Individuals (patients and staff) and communities can engage in a similar process, as can businesses and industries.

CHANGING THE WAY WE THINK: IMPLEMENTING NEW DESIGN PRINCIPLES AND THE SDGS

Medical device manufacturers are thinking increasingly holistically about their sustainability endeavours. Through focusing on the innovation of products and processes, the modus operandi is being challenged. Initiatives, such as carbon offsetting programmes, or frameworks, such as the 'three Rs' (reduce, reuse, recycle) for waste reduction, allow for more environmentally friendly solutions to be created.[12 13] The United Nation's Sustainable Development Goals or SDGs typify the complexity of these endeavours and the climate crisis; they set out 17 interlinked goals that are fundamental for a sustainable future. Medical solution providers are using these SDGs to inform their climate change response and think holistically about their sustainability endeavours. For example, our company focuses on smart packaging to minimise freight volume, use recycled materials, reduce waste, and replace plastics (SDG 9: Industry, Innovation, and Infrastructure and SDG 12: Responsible Consumption and Production). We further contribute to these SDGs through our product portfolio. By offering innovative solutions, our company makes it easier for the endoscopy industry to reach its sustainability goals. For example, our endoscope drying and storage system[15] significantly reduces energy consumption by shortening the usual drying process to just 1–3 min, while drying the endoscope channels completely. In terms of SDG 4, Quality Education, our company has set up the Forward Academy. This provides a platform for medical professionals to gain knowledge about advanced endoscopic treatments and procedures. It also allows them to exchange best-case practices that address sustainability and waste management across their endoscopy units. Ultimately, these all contribute to SDG 3, Good Health and Wellbeing, ensuring that our innovative solutions are right for the planet and its people.

The SDGs provide a common language and useful global framework to structure sustainability endeavours. Corporations can use this system-level thinking to inform their product development processes, encouraging innovations that are future-proof and address the current climate crisis. One example is what was used by PENTAX Medical when setting up a new principle (figure 2) for its research and development process.[16] The principle takes materials, packaging, device design, distribution, manufacturing and disposal into account during the product development process. This holistic way of thinking challenges product management and engineering departments to consider all elements when developing innovative and sustainable solutions, while simultaneously seeking ways to minimise or compensate carbon emissions.

Innovation to improve patient safety, hygiene and sustainability standards

The aforementioned principle was applied inaugurally in developing a solution for the automated precleaning of endoscopes.[17] When reviewing the manual precleaning process of flexible endoscopes, we found that this process often requires significant resource use. To support healthcare practitioners in solving this issue, the solution was designed as a fully sustainable alternative to manual precleaning. It does not need consumables like brushes or detergents while managing automated channel precleaning in only 2–7 min. Moreover, the solution significantly reduces water consumption by 70%–89% (evaluated by internal tests against standard manual precleaning procedures by PENTAX Medical). The significantly reduced turnover times allow healthcare practitioners to use

their reusable endoscopes more efficiently and may allow for a smaller fleet of endoscopes in the endoscopy unit.

SUSTAINABLE AND RESILIENT GI CARE

Every stakeholder in the healthcare sector—from an endoscopy unit, to clinic, to hospital, to manufacturer—needs to address their resilience and adaptability while also implementing sustainable strategies.

Health systems should also collaborate with other system and community stakeholders to establish their resilience strategies. Community resilience is essential in crises, with community members being more likely to provide immediate aid to their neighbours. Intersystem collaborations should also be considered, like the Hospital Preparedness Programme.[18] With a comprehensive regional plan, patients can be triaged into more appropriate care centres, based on condition and accessibility. Critical resources such as workers and supplies can be pooled and routed to where they are needed most. With individual resilience planning and development, individual health systems can be the location communities can depend on, even in the worst climate events.

Medical device manufacturers must also commit to holistic ways of thinking, sharing best practices and sustainability plans, and continuously evaluating how all aspects of their products are impacting the climate crisis. Only with design principles fully centred around sustainability and resilience will green endoscopy truly come to fruition.

Contributors All authors wrote the first draft of the manuscript. Floriane van Alphen (Omnicom PR Group) edited the draft paper. All four authors revised and approved the final version of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; internally peer reviewed.

© Author(s) (or their employer(s)) 2023. No commercial re-use. See rights and permissions. Published by BMJ.

Check for updates

To cite Thiel C, Pak E, Burkard R, *et al*. *Gut* 2023;**72**:2206–2209.

Received 6 October 2023
Accepted 9 October 2023
Published Online First 16 November 2023

Gut 2023;**72**:2206–2209.
doi:10.1136/gutjnl-2023-331277

ORCID iD
Harald Huber http://orcid.org/0009-0006-8858-4953

REFERENCES

1 Tennison I, Roschnik S, Ashby B, *et al*. Health care's response to climate change: a carbon footprint assessment of the NHS in England. *Lancet Planet Health* 2021;5:e84–92.
2 Sherman JD, Thiel C, MacNeill A, *et al*. The green print: advancement of environmental sustainability in healthcare. *Resour Conserv Recycl* 2020;161:104882.
3 Smith AB. 2010–2019: a landmark decade of US. Billion-dollar weather and climate disasters. National Oceanic and Atmospheric Administration; 2020. Available: https://www.climate.gov/news-features/blogs/beyond-data/2010-2019-landmark-decade-us-billion-dollar-weather-and-climate
4 Scala B, Lindsay CF. Supply chain resilience during pandemic disruption: Evidence from healthcare. *SCM* 2021;26:672–88.
5 Karliner J, Slotterback S, Boyd R, *et al*. Health care's climate footprint: how the health sector contributes to the global climate crisis and opportunities for action; 2019. 48. Available: https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf
6 Lagasse RS, Sherman JD. Safety & sustainability: More than doing the right thing. *ASA Newsl* 2020;84:10–2.
7 Zamiela C, Hossain NUI, Jaradat R. Enablers of resilience in the healthcare supply chain: A case study of US healthcare industry during COVID-19 pandemic. *Res Transp Econ* 2022;93:101174.
8 Caretta A, Arfanuzzaman RBM, Morgan SMR, *et al*. Water. In: *Climate change 2022: impacts, adaptation, and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change*. 2022.
9 Preparedness PAHOE, Program DRC. Principles of disaster mitigation in health facilities. Pan American Health Org; 2000. Available: https://iris.paho.org/bitstream/handle/10665.2/817/92%2075%2012304% 207.pdf?sequence=1&isAllowed=y
10 FEMA. National risk index for natural hazards. 2023. Available: https://www.fema.gov/flood-maps/products-tools/national-risk-index
11 Achour N, Price ADF. Resilience strategies of healthcare facilities: Present and future. *Int J Disaster Resil Built Environ* 2010;1:264–76.
12 Rodríguez de Santiago E, Dinis-Ribeiro M, Pohl H, *et al*. Reducing the environmental footprint of gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) position statement. *Endoscopy* 2022;54:797–826.
13 Sebastian S, Dhar A, Baddeley R, *et al*. Green endoscopy: British Society of Gastroenterology (BSG), Joint Accreditation Group (JAG) and Centre for Sustainable Health (CSH) joint consensus on practical measures for environmental sustainability in endoscopy. *Gut* 2023;72:12–26.
14 United Nations. Sustainable development goals. Available: https://sdgs.un.org/goals
15 PENTAX Medical. PlasmaTYPHOON™+ and PlasmaBAG™ system, Available: https://hygiene.pentaxmedical.com/en/products/plasmatyphoon-and-plasmabag-system
16 PENTAX Medical. Sustainability, Available: https://www.pentaxmedical.com/pentax/en/92/3/Sustainability
17 PENTAX Medical. AquaTYPHOON™, Available: https://hygiene.pentaxmedical.com/en/products/aqua-typhoon
18 Wulff K, Donato D, Lurie N. What is health resilience and how can we build it? *Annu Rev Public Health* 2015;36:361–74.