Climate-conscious conferences: redefining medical meetings for a sustainable tomorrow

INTRODUCTION

The medical, scientific and health communities face a sizable conundrum in addressing climate change. While medical and scientific conferences foster knowledge exchange and collaborations necessary to advance healthcare, they contribute significantly to carbon emissions.[1,2] Recognising this unfortunate contradiction, it is now crucial that we prioritise sustainability in the design and execution of medical and scientific meetings, while actively mitigating the negative environmental footprint of these conferences.[3,4]

With climate change contributing in a major way to global health issues, such as respiratory illnesses, heat-related diseases, preterm births, increased infectious disease transmission and even mental health concerns due to population displacement, the healthcare sector's involvement in carbon pollution-intensive conferences presents a paradox, being both noble in its intent and worrying in its unintended consequence.[5-7] Fortuitously, the COVID-19 pandemic had forced the healthcare and scientific sectors to adopt virtual medical conferencing, demonstrating that such virtual conferences are possible and offer important benefits.[8,9] These formats have resulted in a reduction of travel-related emissions by over 90% compared with pre-pandemic figures.[4]

While various aspects of conference-related elements may be considered emissions-intensive, three key elements that merit immediate attention are transport and air travel, venue operations, and conference consumables. In this article, we will address each element individually before concluding with recommendations for improving the sustainability of medical and scientific meetings.

KEY ELEMENTS OF CONFERENCE EMISSIONS

Transport and air travel

Air travel accounts for approximately 3% of worldwide carbon dioxide (CO_2) emissions annually,[4] and up to 85% of total event-related emissions for medical conferences.[3,10] To provide an example of the extremely high potential impact of conference air travel on the environment, one report notes that a single event produced an estimated 10,779 tons of CO_2 emissions from delegate flights. This quantity is equivalent to the annual carbon footprint of over 800 average American citizens,[1] or nearly 9000 average Africans (extrapolated from International Energy Agency figures).[11] In an article from 2012, Ioannidis notes that there are likely more than 100,000 medical conferences each year, including local meetings.[12] While not all conferences contribute significantly to emissions, the high frequency of scientific meetings — estimated at around 270 per day according to Ioannidis — highlights the critical need to reassess traditional conference formats to reduce carbon emissions.[13]

New strategies are now emerging to address the high emissions associated with air travel. One well-recognised initiative is the carbon offset programme offered by airlines. These programmes allow passengers to compensate for their flight-related emissions by investing in projects such as reforestation or renewable energy.[14] However, compelling research published in *Science* suggests that many of these 'offsetting' projects, particularly those aimed at preventing deforestation, have failed to achieve significant, meaningful reductions in emissions.[14] In fact, critics argue that carbon offsets often serve as greenwashing tactics, enabling companies to appear environmentally responsible without implementing substantial operational changes.[14] Additionally, accurately calculating a flight's carbon footprint is inherently complex, as it involves factors beyond fuel consumption, including aircraft manufacturing and airport infrastructure.[14] These myriad, confusing but singularly pivotal issues raise doubts about the accuracy and transparency of such offset programmes. Therefore, at least for now, the onus lies upon the travel consumes to critically evaluate their offset options and even consider broader strategies to reduce their overall carbon footprint. While carbon offset plans do offer some potential as a mitigation strategy, their successful implementation depends on a robust verification system, as well as the time required for such plans to yield meaningful results. In the meantime, medical conference organisers and delegates should consider minimising air travel requirements or partner with airlines committed to more comprehensive sustainability measures. Selecting alternative, low-emission modes of transport is another way to reduce emissions outputs. In 2023, the French Government legislated a ban on short flights between Paris-Orly and Nantes, Bordeaux and Lyon, where a train journey of 2.5 hours or less could serve as an alternative.[15] Additional European research has indicated that while some benefits can be achieved, improvements to high-speed rail networks are likely required to better offset time losses incurred by passengers.[16]

Hybrid models, on the other hand, offer joint in-person and virtual attendance. They reduce travel demands by allowing some participants to attend the meeting remotely. Additionally, organisers are increasingly exploring hub-and-spoke models,

where attendees gather at local or regional hubs that are connected virtually to the main event. This model retains the interactive benefits of in-person gatherings and fosters regional collaborations while curbing the carbon footprint associated with long-distance travel.[1,3] Importantly, studies have shown that regional hubs increase the participation of individuals from underrepresented backgrounds and remote locations, fostering a more diverse and inclusive academic community and supporting wider dissemination of knowledge.[2,3] Expanding on this concept, the hub-and-spoke model could facilitate the creation of enduring content, which can be hosted online for easy access, and support asynchronous learning opportunities.

Virtual global conferences face challenges in accommodating participants from multiple time zones, which can hinder full participation and engagement in the online format.[17] The hub-and-spoke model ameliorates this issue through having regional hubs in local time zones, ideally allowing attendees to participate in real-time sessions without being disrupted by time zone differences. Furthermore, regional hubs can coordinate sessions around a main conference's timeline for a synchronous virtual experience, optimising engagement from all participants in both local and global discussions.[5]

In Table 1, we summarise the considerations for hosting in-person, hybrid and fully virtual medical conferences. Each format has its unique utility, advantages and challenges, and should be evaluated in the context of delivering a climate-conscious conference.

Conference venue

Hotels and conference centres are substantial contributors to greenhouse gas emissions, with energy consumption levels that can significantly increase the overall environmental impact of a conference.[18] The choice of conference location also affects accommodation emissions. Events held in greener cities serviced by renewable energy sources are considered more eco-friendly; the suitability of specific regions can be evaluated according to their Grids Emission Factor.[19-22] On a smaller scale, when conferences are held in compact, walkable areas, attendees can stay at nearby accommodations within walking or public transit distance, reducing the need for emissions-heavy local transportation. Ideally, participants should be able to commute efficiently without the environment impact associated with car rentals or ride-sharing services.[2,4]

Venues often require continuous lighting, heating, ventilation and air conditioning systems, as well as power for audiovisual equipment for multiple days. A life cycle assessment of an international academic conference found that venue and accommodation use contributed a significant portion of the event's overall emissions, after travel.[5] To mitigate these impacts, conferences can prioritise eco-friendly venues with Leadership in Energy and Environmental Design certification or equivalent standards, to ensure energy efficiency, waste reduction and other environmentally conscious practices.[23-25] One example of an environmentally responsible venue choice is the use of spaces certified under the Eco-Management and Audit Scheme,[26,27] which offers guidelines for reducing energy and waste. These certified locations align their operations with sustainability goals by incorporating energy-saving practices, such as automated lighting and temperature controls, and prioritising renewable energy sources where possible.[3] These venues also often have waste reduction initiatives, such as on-site recycling and composting, which can help reduce the environmental impact of a large gathering.

Another often-overlooked aspect is water and resource management within conference venues. The energy used in water heating, especially in areas with extensive guest facilities, is significant, while single-use toiletries and laundry services increase waste. Venues committed to environmental responsibility often have policies to reduce water usage, such as reusing towels, limiting laundry and installing low-flow fixtures. By partnering with hotels that have adopted such policies, conference organisers can make significant reductions in water and energy consumption.[5]

Table 1. Framework for determining the most suitable meeting format: in-person, hybrid or virtual.

Format	When to choose	Advantages	Challenges
In-person	Ideal for workshops and sessions requiring physical interaction: hands-on engagement, networking, and practical skills requiring physical presence (e.g., surgical training, new equipment demonstrations)	• Maximises networking opportunities and direct engagement	• High carbon footprint due to travel and venue emissions • Expensive and less inclusive for remote participants
Hybrid	For balancing in-person and virtual participation when travel is limited or inclusivity is a priority; suitable for regional hubs and global time zone coordination	• Reduces travel emissions while retaining some in-person benefits • Enhances accessibility for participants in remote locations or with time constraints	• Complex logistics required to balance virtual and in-person components • Requires investment in technology for seamless integration
Virtual	For didactic content delivery; effective for meetings without the need for physical interaction or tactile engagement	• Minimises environmental impact and costs • Fully accessible to global audiences without travel • Creation and hosting of enduring content allows a broader learning opportunity, and longevity of the material to be reviewed by learners after the conference	• Limited engagement for hand-son activities or interactive workshops • Dependent on reliable technology and infrastructure

Catering and single-use items

Sustainable catering and waste management practices at the venue could also be included as a critical step in reducing emissions. Traditional catering at large events significantly contributes to environmental impact due to carbon-intensive food choices (e.g. meat and diary), food waste and single-use items.[28] The environmental toll of meat and dairy consumption is well documented.[29,30] Hence, many conferences are moving towards plant-based meal options and reducing portion sizes to minimise food waste.[31] The international federation of medical students' associations (IFMSA) annual meeting implemented vegetarian meals and encouraged attendees to bring their own reusable containers, effectively reducing waste from single-use items like plastic bottles and cups.[3]

Food waste is another issue in conference catering, often due to the overestimation of food needs, buffet-style meals that encourage over-serving and a lack of systems to redistribute leftovers. To mitigate this, conferences can adopt measures such as pre-portioning meals or offering plated service options to better control portion size and reduce excess. The IFMSA conference also set an example by reducing plate sizes to help limit food waste, an established strategy for minimising the amount left uneaten.[3] Promoting local and seasonal food options is another sustainable catering approach. Sourcing food locally not only supports regional economies but also reduces emissions associated with long-distance food transportation.[2]

Reducing reliance on printed materials and minimising resource use in venues is another area that could contribute to an eco-conscious event. Digitalising conference programmes, abstracts and promotional materials limits paper waste.[32] The availability of electronic materials also provides more flexible and accessible information sharing that can extend beyond the event, creating a sustainable legacy of conference resources.[5] Figure 1 simplifies the challenges and possible solutions for sustainable conferences.

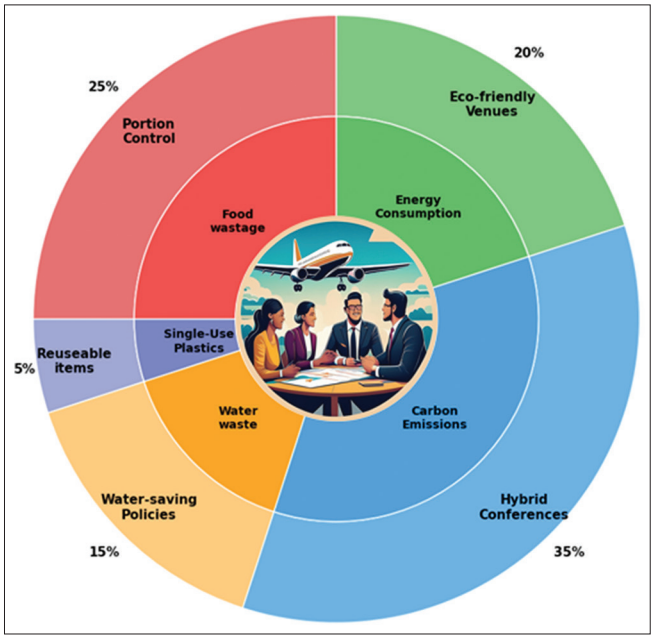

Figure 1: Diagram shows the environmental challenges of conferences and the mitigation strategies.[1-5] [Created with DALL-E and Python]

CHALLENGES OF HYBRID AND VIRTUAL CONFERENCES

Virtual meetings are not universally suitable.[33] While they may be effective for didactic purposes, many conferences inherently require hands-on engagement, particularly those focused on practical surgical training or the proliferation of new instruments and implants, which require hands-on testing.[34] Tactile and kinaesthetic input cannot be transmitted through a screen, regardless of visual and audio fidelity.[34,35]

Global technological disparity is another obstacle to virtual conferences, particularly for attendees in developing regions with inadequate infrastructure.[36] Issues such as difficulties in live-streaming video and audio can lead to a suboptimal experience for participants.[36] A traditional conference inherently overcomes this barrier, but an effective middle ground could exist in hub-and-spoke conferences,[37,38] by limiting travel to the regional level rather than en-masse international travel.[39]

Despite the growing reliance on virtual and hybrid formats, it is evident that in-person conferences will never be entirely replaced.[33] Likewise, virtual meetings are here to stay, albeit with inherent limitations that restrict their suitability to specific didactic contexts.[38] The hybrid model, which has become a standard practice in the post-COVID-19 era, combines in-person conferences with options for virtual participation.[8,40] This approach addresses accessibility challenges and offers some environmental benefits, all while preserving the vital element of interpersonal engagement.[41]

Interestingly, hybrid conferences introduce a new layer of social complexity.[42] Moderators now face the daunting task of accommodating both physical and virtual audiences while managing them equitably.[42] Live-streaming issues can disrupt schedules and hinder virtual attendees from fully engaging in real time.[42] Time zone differences inevitably complicate participation for virtual audiences.[43] Question-and-answer sessions during conferences may disproportionately favour in-person attendees, who can clarify points conversationally with the panellists, rather than sequentially via virtual inputs.[43]

The full scope of these challenges and their impact remains unclear. The diversity of objectives between conferences and the varying wants of their audiences makes systemic evaluation challenging.[44] Yet, as medical conferences

continue to evolve, these growing pains are to be expected. At this pivotal juncture, securing feedback from organisers and attendees is critical.[45] By continuously refining hybrid models, we can close the gaps in accessibility and sustainability, ensuring these events remain impactful and inclusive for all.[45]

GLOBAL CARBON REMOVAL STRATEGIES

The Paris Agreement and COP29 (also known as the 2024 United Nations Climate Change Conference) represent international attempts to establish a global framework to limit global warming on both the national and corporate fronts. To this end, Climeworks AG advocates a portfolio approach to carbon removal, urging organisations to diversify their investments in removal technologies and align them with the durability of their emissions.[46] This approach ensures readiness for stricter future climate policies while mitigating delivery and price risks in an evolving carbon market.[46] Early investments in innovative technologies, forging long-term supplier partnerships and scaling high-quality solutions are fundamental to fulfilling the objectives of the Paris Agreement.[46] Aramco proposes its carbon capture, utilisation and storage strategy, which focuses on reducing CO_2 emissions by capturing it from sources like power plants and directly from the air, storing it underground or converting it into useful products.[47] As part of its circular carbon economy model, Aramco supports nature-based solutions such as reforestation and has explored converting captured CO_2 into useful products.[47]

CLIMATE-CENTRIC APPROACH TO MEDICAL CONFERENCES

It is evident that not everyone agrees on the plans for climate change action. Nonetheless, much remains to be done, and it is in the medical, scientific and health community's interest to act in mitigating the damaging effects of climate change. It would be remiss of the medical profession not to contribute meaningfully to the global effort to achieve net-zero carbon goals. Moreover, medical and scientific meetings represent an important material and symbolic opportunity in this regard.

Climate change is a real and urgent crisis. Climate-conscious conferences must align climate-preserving efforts with interim milestones, starting with smaller-scale investments in emerging technologies and rapidly increasing commitments as the market matures. Early investments should not only support the development of innovative solutions, but also help suppliers move down the cost curve, making high-quality carbon removal more accessible and affordable over time. Organisers of medical meetings can adopt cross-organisational functional collaboration, including engaging sustainability teams to monitor emissions, procurement teams to identify and partner with climate conscious vendors, legal teams to structure long-term offtake agreements with these vendors and, most importantly, finance teams to integrate carbon removal costs into conference budgets. Senior management involvement is crucial to ensure alignment with organisational goals and drive urgency in implementing carbon removal strategies. Drawing on valuable interdisciplinary inputs, conferences can avoid costly mistakes and position themselves as leaders in sustainable event planning.

Finally, beyond the commonly discussed strategies, the medical community has the opportunity to explore novel strategies to make medical meetings more climate-conscious. For instance, if a healthcare conference were held in a location or country that has unique challenges — such as infectious diseases that significantly contribute to the global burden of disease (e.g. malaria), high rates of maternal mortality or morbidity or conditions such as thalassaemia — doctors attending the conference could contribute by teaching at the local hospitals, doing rounds with doctors and trainees, or even assisting and training local doctors in surgery. This would create a multiplier effect for the medical community and contribute to the greater global good. At this early stage of developing novel strategies for climate-conscious medical meetings, we may not have the measurement tools and metrics to quantify such innovative yet clearly beneficial offset measures. However, this should not deter us; it means we must start these conversations and develop the tools necessary to measure the total benefits delivered for the amount of carbon consumed.

CONCLUSION

Adapting medical and scientific conferences to prioritise sustainability is imperative for aligning the healthcare sector's practices with its core mission of protecting health. We must participate in this movement and be part of the urgent need for consistent, collaborative and decisive efforts to combat climate change. By embracing hybrid formats, implementing eco-friendly practices and fostering inclusivity, the medical community can significantly reduce its environmental footprint while enhancing accessibility. As the medical profession advocates for climate-conscious meetings, enhancing sustainable conference models is not only an ethical responsibility, but also a crucial step toward a healthier and more sustainable future for the public we serve.

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