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Mobilizing non-traditional public health partners to mitigate the effects of coronavirus infection and to reduce the risk of emerging disease

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Abstract: Partnerships are a cornerstone of modern public health practice, yet in the face of the global Covid-19 pandemic, many traditional public health partners either floundered or lacked the resources to perform adequately. The public health community should begin looking at alternative pathways to fulfilling public health needs when traditional partners are not available. One such partner that has historically been overlooked in providing Public Health support, especially with interventional epidemiology and public health policy, is the Advanced Materials (AM) Community. The AM Community could play a larger role in public health practice by developing and implementing preventive measures for disease, including global pandemics like Covid-19. One such example of how this partnership could work is the Advanced Material Pandemic & Future Preparedness Taskforce (AMPT), which is an international Public-Benefit initiative focused on using Advanced Materials to help solve some of humanity's most pressing challenges. As an international cooperative platform, the multidisciplinary taskforce is building a global infrastructure and an ecosystem network that enables the advanced material community to respond swiftly and effectively under the umbrella of Future Preparedness. Advanced materials have played and will continue to play some role in public health, including for use in diagnostics tests, antimicrobial coatings, and filtering face piece respirators. Technology has advanced to a point where researchers and manufacturers of advanced materials now have clear direction and resources to be partners that the Public Health Community can no longer afford to overlook, especially in times of crisis when new ways of thinking are required to solve pressing challenges.

Keywords: advanced materials; advanced manufacturing; public health; partnerships; Covid-19; pandemics; emergency response

1. Introduction

Partnerships are a fundamental concept in Public Health, as evidenced by their inclusion as one of the 10 Essential Public Health Services [1]. However, in the face of the Covid-19 pandemic, many traditional Public Health partnerships crumbled while facing a threat that was rapidly spiraling out of control. Additionally, during the crisis the Public Health Community missed an opportunity to fully embrace all available resources, especially non-traditional partners with an arsenal of tools and resources at their disposable that could offer solutions to gaps that are not currently being filled by traditional Public Health institutions.

Pockets of innovation have been present throughout this crisis, but the Public Health Community has not had the opportunity to benefit from the full impact of advanced materials solutions due to the lack of a unified and coordinated response. Advanced materials have been a part of public health for nearly a century and have contributed greatly to improvements in quality of care, patient outcomes, and prevention. However, the integral

role that advanced materials has played and can continue to play in promoting public health has largely been forgotten or been overlooked in this current crisis.

This paper highlights worked conducted by the author as a member of the Advanced Materials Pandemic and Future Preparedness Taskforce (AMPT). Materials solutions have always played a significant role in Public Health delivery and must continue to take center stage, even more now as existential threats, especially emerging diseases, become more frequent and potentially catastrophic.

2. Advanced Materials in Public Health

The International Organization for Standardization Technical Committee on Nanotechnologies sub-working group (ISO TC 229 JWG1 SG) defines an advanced material as "Any material engineered, processed or synthesized, to provide enhancement in functionality or presents novel properties compared to conventional materials for a given application in a specific industry." The modern use of advanced materials in Public Health starts in the 1930s with the introduction of ceramics for use in orthopedics and dentistry. However, the large-scale introduction of plastics into the healthcare system in the 1960's tipped the scale in terms of providing durable, cost-effective, and easily mass-produced products for widespread public health use. The use of plastics has become so ingrained in healthcare that the title of a 2019 National Geographic article asks the question, "Can medical care exist without plastic [2]?" Carbon fiber (CF) and carbon fiber reinforced plastic (CFRP) were successfully introduced into prosthetic and orthotic design in the late 1960s and early 1970s. By the mid 1980s, CF and CFRP were routinely used in the manufacture of prosthetics given its extreme light weight, strength, and ability to conform more easily to contours of the human body.

Gloves, masks, and other forms of personal protective equipment (PPE) are a cornerstone of modern public health, and as such, often benefit the most from advances in material design. One of the most important applications of advanced materials in PPE was the development of the non-woven textiles used for N95 respirators, first introduced in 1972 then upgraded to more adequately filter viral particles in 1995. The introduction of nitrile gloves in the mid 1990s provided a key solution to latex sensitivity and allergy experienced by many public health professionals following the widespread use of latex gloves. In the words of textile researchers Dolez and Vu-Khanh, "Decisive progress has been achieved in terms of improvement of PPE, in particular thanks to intensive research in materials science [3]."

The introduction of additional material technologies into public health, including engineered nanomaterials, biocompatible polymers, and additive manufacturing, continue to push the envelope in terms of design, reliability, sustainability, and cost. Advanced materials, such as graphene, show much promise in improving antimicrobial and anti-fogging coatings; diagnostic tools and equipment; laboratory equipment; testing supplies; PPE; filtration; sensors; and other applications. This current pandemic could possibly be the catalyst for a renaissance where a fully integrated world of advanced materials solutions supporting public health functions emerges (Figure 1). Glimmers of this rebirth have already been seen with 3-D printed ventilator parts and face shields and face masks using graphene filtration systems, but widespread and universal adoption still seems far off. Perhaps the current pandemic will be the tipping point that drives the Public Health and Advanced Materials Communities closer together.

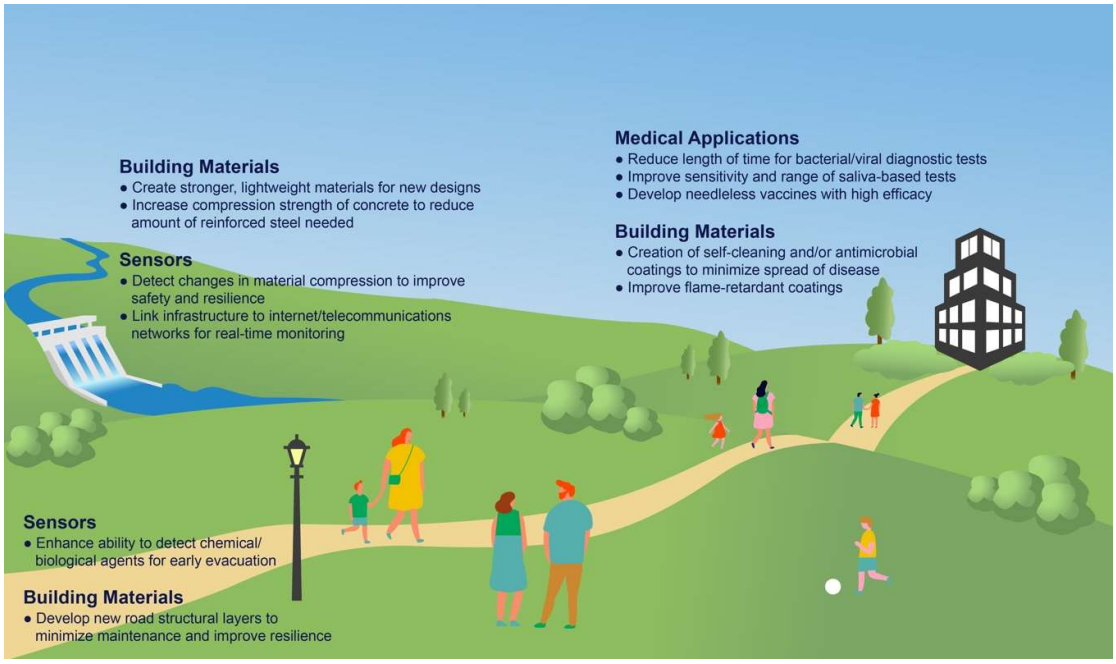

Figure 1. An integrated system using advanced materials to improve public health resiliency [4].

3. A New Model for Partnerships in Public Health

Partnerships play an extremely important role in facilitating Public Health interventions. The recently updated Essential Public Health Services (EPHS) framework includes partnerships as an essential public health service (#4 - Strengthen, support, and mobilize communities and partnerships to improve health [5]). This service includes four key actions:

- Convening and facilitating multi- sector partnerships and coalitions that include sectors that influence health
- Fostering and building genuine, strengths-based relationships with a diverse group of partners that reflect the community and the population
- Authentically engaging with community members and organizations to develop public health solutions
- Learning from, and supporting, existing community partnerships and contributing public health expertise [5].

In times of crisis, it may be necessary to expand or adapt Public Health resources to meet community needs, especially looking beyond traditionally available partners, and this is the situation we have seen with the current Covid-19 pandemic.

AMPT is an international Public-Benefit initiative focused on using Advanced Materials to help solve some of humanity's most pressing challenges. As an international cooperative platform, the multidisciplinary taskforce is building a global infrastructure and an ecosystem network that enables the advanced material community to respond swiftly and effectively under the umbrella of Future Preparedness. AMPT was formed in April 2020 by a small group of researchers and industry leaders from a handful of countries who realized that they each had something to contribute in terms of how to mitigate effects of the pandemic but had no way to effectively share their collective resources.

During the pandemic, traditionally strong relationships between governments and government agencies showed signs of stress, making it difficult for institutions to use traditional means of collaboration often used in times of crises. Therefore, these individuals found a way to organize an international network to share potentially beneficial advanced materials solutions and to identify pressing public health issues in short order (Figure 2).

Over the course of just a few months, AMPT grew to over 100 members with chapters in 15 countries.

Figure 2. An overview of AMPT, illustrating current Public Health challenges and potential advanced materials capabilities to address those challenges.

There are currently 8 working groups in AMPT. One of the first to be formed was the Applied Public Health & Environmental, Health, and Safety Working Group (APHEHS WG) — of which the author is the chair. The mission of the APHEHS working group "is to identify advanced materials solutions that can reasonably and safely be implemented in a short period of time to mitigate public health challenges while assisting with overcoming barriers to the implementation of these technology solutions [6]." The focus is primarily on products that could mitigate the effects of SARS-CoV-2 and Covid-19. The goals of the group are as follows:

1. Identify barriers to research and development and create workarounds to those issues
2. Concentrate on solving the most pressing public health challenges, ones that can be resolved with: existing, but untested technologies; late-stage research; or commercialized technologies that have been approved for other uses
3. Ensure solutions have intended results, receive proper vetting and comply with applicable laws, regulations, and standards

The APHEHS working group is composed of a small group of industry and academic experts whose backgrounds include toxicology, materials science, and public health management. The working group emerge out of a need to answer two challenges that arose from discussion among both the Public Health and Advanced Materials communities: (1) what testing is needed to approve developing products for use in human populations, and how can this be fast-tracked; and (2) how to test efficacy or products against SARS-CoV-2 or suitable surrogates.

AMPT is not a unique concept in terms of Public Health partnerships, but this particular model is not common, and Covid-19 brought an opportunity for something like this to emerge. As early as 2015, the Robert Wood Johnson Foundation, a prominent health organization based in the United States, recognized that "… a paradigm shift is occurring in America: there is growing realization that controlling the increase in health expenditures and improving the health of our nation's population will require major changes in traditional policies, practices, and organizational models [7]." Additionally, the group noted that for partnerships to have enduring impact, they should include not only include hospitals and public health departments as core partners but also "engage a broad range of other parties from the private and public sectors." AMPT appears to be fulfilling that vision.

4. Conclusions

The unfolding Covid crisis appeared to manifest out of nowhere, but in reality, this disaster was decades in the making. These issues have not been lost within the Public Health Community even though they have not been adequately addressed. In January 2020, WHO released its urgent health challenges for the next decade, and five of those challenges are extremely relevant to the current situation:

- Delivering health in conflict and crisis
- Stopping infectious diseases
- Preparing for epidemics
- Investing in the people who defend our health
- Harnessing new technologies [8]

Existing and past policies have led to this point and continuing to follow the same path will not lead to an improvement of the immediate situation nor will it provide a foundation for improving the public health of the future. Adopting new ways to address public health challenges is the only way to prevent another disaster of this scale from occurring.

The Advanced Materials Community has no centralized place to effectively mobilize and support the public health community, and Public Health has few advocates who can see the benefit of using advanced materials to not only address the current crisis but the inevitable fallout and even future crises. It is paramount that the two communities become reunited amidst champions who can understand their own field's capabilities and weaknesses and are willing to do the same for the other side. It is only through these types of relationships, utilizing all available resources, that the world can hope to prevent or at least reduce the impact of the disaster it is still experiencing and will continue to experience for months and possibly years to come.

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