A Social Antiviral System

The Next Step Beyond Biotech

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Scientists have studied the germicidal effects of the Sun's energy for decades. They've recognized that viral transmission is far less likely to occur outdoors because of the sun's energy. Microbial pathogens, like virus and bacteria, are highly susceptible to the phototoxic effects of visible light, ultraviolet light, and the other frequencies of the electromagnetic spectrum. Industry has attempted to recreate the sun's germicidal effects indoors, with systems that artificially emit ultraviolet light to disinfect surfaces. Why haven't these systems been able to completely stop the spread of this viral pandemic?

The answer lies in the limitations of these systems. There are four primary limitations that prevent these systems from completely stopping aerosolized viral transmission. These systems are distance to source dependent, dependent on exposure time, most cannot be safely used when humans are present, and none have focused their disinfecting power to the personal airspace surrounding the human face. Protecting this airspace is critical since it surrounds the mucosal membranes of the eyes, nose, and mouth. These membranes are the only means for aerosolized viral particles to enter the human body. If we protect this airspace, and solve these limitations, then we can create systems that completely stop aerosolized viral transmission.

Most of these systems cannot operate when humans are present because they emit the whole spectrum of ultraviolet light, most of which is harmful to human eye and skin cells. Other systems emit only certain segments of ultraviolet light like FAR UVC, which is safe to humans. Yet the effectiveness of these systems is still limited by distance to source and exposure time.

The distance to source problem exists because these systems typically emit ultraviolet light from a fixed position, like a wall or ceiling. The germicidal disinfection of ultraviolet light decreases exponentially as the distance to source increases. This creates an effective range for these systems, somewhere around eight feet. Objects or persons outside this range will not receive the maximum disinfecting effect of ultraviolet light. The fixed position of these systems also creates the exposure time problem. Maximum disinfecting effect requires that objects remain within effective range for extended periods of time, up to 30 minutes. Human beings as mobile and dynamic creatures, rarely stay in the same position for an extended period. Thus, even if humans were to get close enough to an emitting source, they may not remain there long enough to be disinfected.

Disinfecting power of ultraviolet light has not previously been focused to the human face because of safety concerns. Even though most of the ultraviolet spectrum is harmful, there is one segment which can safely be titrated to a dosage that is safe for humans yet still harmful to viruses. A "virus kill human safe" dosage of UVC 222nm at 2mJ/cm could be safely directed to the human face. Directing this power to this area would effectively shield the mucosal membranes in the eyes, nose, and mouth from aerosolized viral particles.

It may be possible to obtain "virus kill human safe" dosages of other segments of the electromagnetic spectrum. Identifying these dosages and matching their disinfecting power to aerosolized viral threats could give birth to a new defense science.

"Virus kill human safe" dosages can be deployed in a manner that solves both the distance to source and exposure time problems. Items we already possess can be retrofitted into "beacons" which emit disinfecting power. Our watches, phones, and clothing could easily be made into beacons with the addition of a few inexpensive electronic components.

Distributing disinfecting power amongst numerous beacons will also provide greater protection than a fixed and centralized emitting source. When persons gather and socialize, the power of the beacons will overlap. This overlap will create amplified strength for all who are within the field of protection. This distributed disinfection field will increase in strength as people increase in number.

There is a danger to constantly scrubbing and sanitizing the airspace that surrounds the human face. Constant sterilization of this airspace could weaken the normal development of our natural immune system. A constantly sterile environment reduces the body's natural ability to fight infection by robbing it of natural and necessary interaction with virus and bacteria. We must augment our defense against aerosolized transmission without shutting down our natural interaction with the microbial world. A Social Antiviral System could raise and lower its defenses as necessary, without causing the human immune system to atrophy from nonuse.

For a system to know when it must raise and lower its defenses, there must be active sensing and communication within that system. Sensors embedded in each beacon can read the viral nuclei in the ambient air. Beacons can communicate this information with venues like schools, restaurants, bars, and concerts. City and state governments can gather this information and automatically tune an appropriate response for the level of threat. This tuning can be accomplished through geolocation features and the internet of things. By instantly detecting viral threats and responding to them automatically, this system could prevent outbreaks from becoming pandemics.

We may need to start thinking about aerosolized viral particles as an enemy military force rather than a biological organism. Scientists are now able to use experimental methods to produce gain of a desired function in a virus. These methods have generated viruses with properties that do not exist in nature. There has been artificial manipulation of viral pathogenicity, virulence, replication efficiency, and transmissibility. Furthermore, viral aerosolized particles may not only travel like projectiles but may also float and remain suspended in the air for extended periods of time. If particles can behave this way, then it may be possible that infections can occur without any proximity to infected persons.

These threats may render all our current defenses including therapeutics and vaccines useless. The world needs new technologies to counter and protect against these novel threats. Innovation has changed the nature of warfare and the course of history. Early military campaigns could only be waged when enemy forces physically confronted each other. An invading army could not be stopped until it had already arrived.

A change occurred when weapons were created that allowed the enemy to be intercepted long before hand-to-hand combat was necessary. The bow and arrow superseded the sword, the cannon superseded archery, which was then replaced by tanks, planes, and rockets. Today much of warfare is conducted by drones over the horizon. Technological innovation has allowed threats to be eliminated sooner at a greater distance from home.

Now we must take the next step and bring this type of innovation into the world of biological threats. We must confront aerosolized viral pathogens long before they enter our bodies. These pathogens travel towards us and can be eliminated at distance before they reach us.

We have resigned ourselves into believing that these pathogens will inevitably reach us can only be confronted within our bodies with therapeutics and vaccines. This belief is not unlike the belief that soldiers must only engage in hand-to-hand combat. Just as modern armies developed planes, rockets, and drones to intercept the enemy at a distance, we must develop antiviral weapons that interdict and neutralize aerosolized viral pathogens before they reach us.

Global pandemics will be the problem of the next decade. This problem will persist because the scientific understanding of the behavior of aerosolized viral particles is still in its infancy. The behavior of aerosolized viral particles is a physical phenomenon not a biological phenomenon. Winning the war against the virus demands involvement of the most fundamental field of science, physics. In short, we need our physicist to get involved to save humanity from the next plague. There is a need for counter measures that address these physical phenomena. We have contemplated a concept that can stop aerosolized viral transmission and prevent viral outbreaks from ever developing into pandemics.