Viral Mutations and the Risk of 'Second-hand Malnutrition'

by Michael Passwater

OMNS (Sept **** 2021) The *New York Times* recently quoted Michael Osterholm, an expert epidemiologist at the University of Minnesota, acknowledging, "We still are really in the cave ages in terms of understanding how viruses emerge, how they spread, how they start and stop, why they do what they do."[1] While it is true of many topics that new studies often lead to more questions than answers, this topic has special importance to the human experience. We must accelerate our understanding of the complex interactions between humans and viruses to survive and to improve our experience on Earth.

Fortunately, over the past three decades, brilliant pioneers including Ethan Will Taylor, Melinda Beck, and Caroline Broome have been diligently pointing the way out of the cave. The biochemistry is complicated, the genetics is even more complex, and the terminology is unfamiliar. But the message is too important to hide in a library. It demands attempts to understand and communicate their findings. It may require a shift in thinking, and a shift in actions.

Readers of the *Orthomolecular Medicine News Service* appreciate the importance of good nutrition to keep our bodies healthy. Let's shift our attention for a moment to explore the impact of nutrition on an invading virus.[2,3] RNA viruses are responsible for many of the most devastating infectious diseases of our time – Ebola, Dengue, Influenza, Hepatitis C, Polio, Zika, SARS, MERS, and SARS-CoV-2, among others. However, in addition to being so incomplete that they are fully dependent on invading host cells to replicate themselves, RNA viruses are also primitive in ways that make them unstable. Their replication process is rapid, error-prone, and devoid of the nucleic acid and protein folding proof-reading enzymes used by advanced organisms to minimize mutations and mis-translations during nucleic acid replication and protein production. As a result of this instability, truly pure strains of a virus are rarely found in nature. Viruses tend to exist as mixtures of closely related variants, sometimes referred to as a "quasi-species".

Melinda Beck and colleagues performed experiments with coxsackie and influenza viruses exploring the impact of host nutrition on these viruses.[4-11] They injected a virus (quasi-species) considered to be avirulent (not producing illness) into nourished mice (specifically, selenium and vitamin E sufficient mice), and injected the same virus into selenium and vitamin E deficient mice. The nourished mice did not become ill, and consensus viral genomes from these mice reflected the initial avirulent virus injected. Accordingly, injecting the virus harvested from the first round of nourished mice into additional nourished mice continued to not produce illness. However, the malnourished mice injected with the initial virus died, and virus isolated from these mice were found to have mutations increasing their pathogenicity. This mutated virus was then injected into nourished mice, and they died too.[6,7]

Caroline Broome and colleagues explored this concept in humans using oral live attenuated poliomyelitis vaccines.[11] The test groups were given 0, 50 or 100 micrograms (mcg) of selenium as sodium selenite daily for 6 weeks before being exposed to the attenuated virus, and for 9 weeks following exposure. The people receiving 100 mcg of selenium per day cleared the virus sooner, and virus isolated from this group contained fewer mutations.

The researchers suggested three factors as possible explanations of their findings:

1) Decreased immune function in the selenium and vitamin E deficient mice, allowing minor populations of more virulent strains of the overall avirulent quasi-species to escape eradication by the immune system.

2) A shift in the intracellular redox balance towards oxidation, allowing faster viral replication. Lower intracellular glutathione concentrations are associated with higher viral titers. [12,13]

3) Increased oxidative stress leading to new viral mutations as a result of direct oxidative damage to the viral RNA.

Selenoproteins are important for immune function, including interferon production, phagocytosis (white blood cell destruction of invading virus or other pathogen), and the creation and maintenance of immune memory cells. Without adequate selenoproteins, immune responses to infections and vaccinations are suboptimal and resulting cellular and humoral immunity, if achieved, lasts for a shorter duration. [11,14] Ethan Will Taylor and colleagues have shown that RNA viruses destroy host selenoproteins and other components of DNA synthesis to favor self-replication of the RNA virus.[15-18] Like pirates taking a seaside village's treasures and using it for their own purposes, an RNA virus can disrupt the host cell's defenses and use the host nutrients, nucleic acids, and assembly mechanisms to mass produce itself. In 2009, Dr. Taylor detailed the cellular metabolism disruption that results from HIV and other RNA viruses leading to NAD+ depletion, ATP depletion, and necrosis.[15] In some cases, immunosuppression also results due to depletion of the tryptophan pathway.

Glutathione peroxidases and thioredoxin reductases are selenoproteins essential as direct antioxidants, and to recycle other antioxidants such as ascorbic acid (vitamin C) and tocopherols (vitamin E).[19] Ascorbic acid, in turn, also helps to minimize nucleic acid mutations, and to maintain redox balance among its many roles throughout the body. Reactive oxygen species (O_2^-) and reactive nitrogen species (NO, $ONOO^-$) play a large role in causing RNA virus mutations, and also damaging host cells and nucleic acids.[12,13] Pre-infection insufficiency or disruption (acquired deficiency induced by the virus) of the host antioxidant network increases the severity of the current illness, and leads to RNA virus mutations which increases the risk of severe illness to other hosts in the future.[20-28]

Maybe more is known about the emergence of pathogenic viruses than we realize? It turns out the same good nutrition that keeps people strong, also keeps viral genomes

more stable and less pathogenic.[29-35] Similar to the unpleasant reality that a non-smoker frequently in proximity to a smoker may become ill from second-hand smoke, a well-nourished person may be vulnerable to illness from exposure to mutated viruses arising from viral replication in malnourished hosts.

Addressing micronutrient as well as macronutrient insufficiencies and imbalances throughout our communities and food chains is critical to public health.

Recommended adult doses to reduce risk of serious viral infections [28-34]:

Vitamin C, 500-1000 mg, 3 times daily (more to bowel tolerance if sick)
Vitamin D3, 5,000 IU (125 mcg)/day (maintain plasma vitamin D level in the 40 – 80 ng/mL range)
Vitamin K2, 100 mcg/day
Niacin / niacinamide 200 - 1000 mg/day (in divided doses, start with smaller doses, increase over weeks)
Magnesium 400 mg/day (in malate, citrate, chelate, or chloride form)
Zinc, 20 mg/day
Copper 2 mg/day (along with zinc, in chelate, orotate, or gluconate form)
Selenium 100-200 mcg/day
Vitamin E 400 IU (268 mg)/day

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