

## When Does Practice Change?

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We live in interesting times.

In my job, I have the luxury of reading across a wide spectrum of biological literature. It is an exciting time to be a biologist, with new discoveries at every turn. This raises an interesting question for those in the front lines of aerospace medicine and human performance: when does practice change? We must be swift to adapt to genuine progress while being skeptical of fads and false leads. I don't know how to do that, and I believe our regulatory processes are going to struggle increasingly with the accelerating pace of discovery.

To illustrate the dilemma, consider Robin Warren and Barry Marshall, who received the Nobel Prize in Physiology or Medicine for their discovery and proof that peptic ulcers are caused by *Helicobacter pylori*. They made an excellent case, with powerful proofs, in 1982–1985. The acceptance of this medical fact did not occur until 1994, when it was endorsed with an official consensus from NIH. That Nobel Prize was awarded in 2005, 20 years after the publication of sound evidence and the existence of a cure in the form of antibiotics. Dr. Marshall's Nobel lecture is well worth a listen, if you have not heard it (<https://www.nobelprize.org/mediaplayer/index.php?id=614>).<sup>7</sup>

Dr. Marshall mentions Daniel Boorstin's observation that the greatest obstacle to knowledge is the illusion of knowledge. In 1982, everyone knew that ulcers were caused by lifestyle (stress, diet, alcohol, and drugs) and by genetic predisposition.

Do those causes sound familiar? Diabetes, obesity, cardiac illness, hypertension, depression, dementia, and many other diseases are known to be "lifestyle diseases," possibly with a genetic component. But what if we are wrong.

The easy availability of activity monitoring has led to the discovery that exercise has little to do with obesity, although it does have other benefits. Most health organizations have backed off claims that dietary fat and cholesterol cause heart disease, as evidence fails to back up these well-established, accepted explanations. Salt restriction has little benefit in hypertension. Vegetarians do not avoid or mitigate depression. And so on.

Meanwhile, we have sequenced better than 96% of the human genome and found no easy answers there, although we are not through with that yet.

We have also discovered that easily 90% of the organisms that colonize us and our environment, the bacteria, viruses, phages, archaea, fungi, and protozoa, have gone unrecognized and cannot be cultured in the benign laboratory conditions that we have used for a century or more, and cannot be monocultured because they compose a complex web of interdependent systems, which in some cases cannot survive in/on any other host but human.

We have even found prions, infectious agents that are not themselves alive.

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What follows are some interesting headlines from recent months and years, suggesting some alternate causes for the things we think we understand. I don't know which ones are going to play out, and which will turn out to be false leads, or how long it will take to find out, or how much longer beyond that we will have to wait for established facts to be dethroned. I do know the pace of discovery is only accelerating, and we need to figure out the process by which we can be convinced when advances occur, and learn to employ them.

- Type II diabetes may be caused by prions.<sup>10,11</sup>
- Alzheimer's disease may be caused by fungal and/or bacterial infection.<sup>4,8,9,12,13</sup>
- Atherosclerosis may be initiated by bacterial infection.<sup>5,6,14</sup>
- Mental illness may be caused by infection, subtle infection unlike the ones we have known for a long time, like syphilis and rabies. The idea that the brain is sterile, like the idea that the stomach is sterile, is no longer tenable.<sup>2,3,12,13</sup>
- Celiac disease may be caused by infection by the reovirus simultaneously with the dietary introduction of gluten in a population with a genetic predisposition.<sup>1</sup>

Similar stories are developing for autoimmune diseases, which may be initiated by an infectious process even if their progression does not depend on infection. With *Helicobacter pylori* and the human papillomavirus clearly indicted in the initiation of cancers, the door is open to finding more infectious cancer causes.

These "lifestyle" diseases take a toll, on health, on performance, on time and energy, and on self-esteem. Our target population, generally healthy and well cared for when it comes to diseases and debilities that we understand, nonetheless suffers from "lifestyle" diseases. Many common disqualifying medical conditions may turn out to be within our control. It will take vigilance, judgment, and careful multidisciplinary review of evidence to recognize the advances when they occur. Perhaps most difficult of all, we need to somehow cultivate the ability to differentiate knowledge from the illusion of knowledge.

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AEROSPACE MEDICINE HISTORY, *continued*

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