

Chapter 2

The Four Horsemen: The Evolution of Science and Society

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Abstract This paper may have an unusual flavour. Although I show some of the medical advances of our time, I also present these from the perspective of a doctor who works as a surgeon and has observed society from different angles over the past 25 years. This paper is not meant to be patronizing or overly cynical, but I would like to think there are valuable observations and lessons just by looking at “evolution” of mankind. I chose this title, as in my opinion the Four Horsemen, Famine, Plague, War and Death, are the main factors that drive human evolution. I’ll be reviewing the role of each individually by doing some time travel, setting the scene for the appearance of the horsemen, seeing how society-medicine has coped, or not, and will try to come to some outlook to the future.

Keywords Global industrialisation • Advanced medicine • Infection • Vaccines • History and society

2.1 Remember the Origins

A spark of intelligence led a rag tag band of hominids to get organized first in hunter gatherer groups, which already called for a fair amount of teamwork. This evolved further to agricultural and later urban communities.

This led to a schism in lifestyle between urban and agricultural communities. Trade appeared which set the social dynamics up to this day. The only major change is industrialization of every aspect of life, past, current and likely future.

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2.2 Famine

Eighty per cent of the world's population is urban as for some reason people assume life in cities is better and you can earn more money to buy food; rather than grow it yourself.

This last thought is naïve as food production is very variable. The appearance of food is seasonal, which was well known to my parents and grandparents. We are now upset if we do not have strawberries at Christmas.

In the past the hunger months were June-July; the supplies of the previous year were running out and the August harvest had not started yet. To make matters worse crops can fail, there are biblical pests and weather is unpredictable.

Madagascar is a powerful anecdote. Nearly all the farming land is taken up by crops meant to produce biofuel for behemoth companies. If the trend is continued they will need to import food. According to economists, this should not be a problem as the employment biofuel crops generate allows the locals to pay for the import.

Currently food production is globally industrialized. This does not mean the locals are better off or have easier access to food. Where in the past farming communities were relatively safe from starvation while cities were vulnerable, the opposite is currently true.

Realize the biggest famine is self-inflicted: dieting and eating disorders.

The biggest triumph of the food industry is diet food. For some reason, food with fewer calories is more expensive. The real solution is simpler: Just eat less of whatever you are eating, you will lose weight and as a bonus save money.

2.3 Plague

Sickness and disease have always been a part of life whether of bacterial, viral, prionic and other origin. There are effectively no “new infections”; we just have not discovered all of them yet. The cornerstone of infection control is general health, which in turn leads to good immunity and repair mechanisms. The discovery of infectious agents like bacteria and viruses is relatively new; finding an applicable cure even more recent.

Medicine evolved from an empiric discipline e.g. “Galenic” medicine, based on dogmatic knowledge and doctrine, to an observational discipline in the early eighteenth century. Jenner was one of the first to use a directed preventative measure.

He noticed that milkmaids and cow handlers did not get smallpox. They did get cowpox, a more or less innocuous infection by a closely related virus. Having no idea of what he was doing, Jenner scraped the blisters from the milkmaids and scratched the skin of non-infected people; protecting them from smallpox. Clearly, Jenner did not have to do an ethics application to do this experiment and produced the “scarification” technique and “vaccination.” Vaccination contains the Latin for cow: “vacca.”

The same century Anthony Van Leeuwenhoek, by fluke develops the microscope, which in the nineteenth century allows the birth of microbiology with Pasteur and Koch (Tuberculosis).

Infection control has always been an issue and is also the main reason surgery did not evolve as rapidly as Medicine. Operations were possible in a limited way, but often the patients died of secondary infections.

Up until recently, women were at risk of contracting “childbirth fever,” which is an infection of the womb after delivery. Before antibiotics, this condition was usually fatal.

In the mid nineteenth century a reputed obstetrician noticed his patients contracted “childbirth fever” when his assistants did the delivery after coming from cadaver dissection. He advised hand washing after touching the cadavers and the infection rate dropped by 70%.

Antibiotics became available in the 1920s, which led to a huge improvement in general health of the population and extended longevity. This also led to a dramatic political conclusion in the UK. Bevan assumed, in his original manifest for the creation of the NHS in 1948, that most of the life threatening diseases, which in the day were infectious, would be controlled and no thought was given to the Four Horsemen, who would find other opportunities.

Extended longevity gives new opportunities to Plague and Famine. We are now confronted with prion disease, ebola, H1N1, obesity, heart disease, diabetes and dementia.

2.4 War

Injury is a part of life too and so is the struggle to survive. Our bodies are only to a certain extent self-healing and only cope with very limited damage thresholds. Our ancestors quickly noticed that penetrating injuries were far more efficient in taking out the competition. If you penetrate the skin, you can die of acute blood loss and if that did not work, the secondary infection of the wound would do it. This led to a perpetual race between offensive devices and protection. Sticks and stones to spears and arrows to crossbows, until Marco Polo brought efficient gunpowder back from China along with the first banknotes and pasta.

2.5 Society of Rapid Change

We take a step away from the narrative and look at society. Radical changes happened over time. The industrial evolution of the eighteenth and nineteenth centuries set a new matrix for society. Another technological boost occurred in the 1930s and WW2, leading directly to the second technology wave of the 1960s and the tertiary wave of the late twentieth century, with ever increasing speed.

The industrial revolution began with automated looms, which precipitated poverty in urban areas and created a new dependence and an opportunity for Famine: the need for employment to buy food. The ability to feed yourself or your family depended entirely on your ability to produce.

Urban proximity gave new opportunities for Plague. People migrated to cities where there was no provision of clean water or sewerage. Abject social conditions and poor health led to rampant tuberculosis and social disease like alcoholism.

The industrial revolution also gave War an interesting opportunity. War was now an industry, but the military leaders were not prepared for this. Outdated tactics of troop deployment were used in the industrialized artillery battles of WW1 leading to mass destruction.

During WW1, advances in medicine were made to cope with the overwhelming amount of injured. A fairly new condition appeared; gas attacks, which damaged the soldier's lungs, leading to further development of ventilators. Even then there was a shortage of medical equipment and soldiers sang: "They're gassing us and there's one ventilator for the four of us!"

Application for the X-rays discovered by the Curies came of age leading to trucks called "the little Curies" carrying mobile X-rays equipment on the battlefield.

2.6 WW2 Technology Boost

The destruction of WW1, which had seriously gotten out of hand, led to the punishing post war conditions put to Germany. The conditions also implied scrapping research into weapons, no military research or organizing of any kind. No one said anything about, alternative fuel, rocket engines, combustion engines or materials to the benefit of mankind. This "sleepier science" along with the right political climate and a people with a feel for organizing made astounding progress. Where initially the Versailles treaty was adhered to, it was quickly forgotten when Hitler came to power, and stayed there. Near unlimited funding was given to engineering research and resurrection of industry with a replay of WW1 in mind.

Ferdinand Porsche along with Hitler designed a car, wagen in German, destined to be affordable for the German people, volk in German. Put both together and you get: Volkswagen. The Volkswagen Beetle came to exist. Ferdinand Porsche also designed the Tiger Tank, which ravaged Europe.

In the late 60s and early 70s, fuel injection in motorcars was seen as an innovation, despite direct fuel injection being used in the Messerschmidt 109 since the late 30s.

Werner Von Braun and the SS created the V1 and V2 weapons. The V2 was a challenge. A vertical lift device that would have a sub-atmospheric flight, where there was no oxygen and to get there you needed a volatile and light fuel.

The solution was to use ethanol produced from grain combined with turbine pumps that mixed the ethanol with liquid oxygen. The down side was the

combustion temperature was so high the metal steering flaps melted on the prototypes. The solution was the creation of carbon flaps.

In 2003, 60 years after the V2, Virgin Galactic did a much-publicized sub-atmospheric flight, using the same principles. We are now told biofuel is an innovation and that carbon is an effective replacement for metal.

A less known race between the US and the Nazis was that for nuclear power, Tritium vs. Uranium, which culminated in the detonation of two nuclear bombs to avoid the need for invasion of the Japanese mainland and save Allied lives.

2.7 The Second Wave

The economic boost represented by the reconstruction of Europe and the appearing of new technologies led to a second wave. The post war climate created the space program and the need for observation and listening devices. The golden age of the 60s had arrived. The space race, telecommunications via Telstar, but also the tension of the cold war, in which the balance between East and West was partially restored by the Rosenbergs. Microelectronics became implantable and Medtronic produces the first Cardiac Pacemaker.

Communications, particularly after the appearance of the transistor, played an ever-increasing role. Television, embryonic in the 1940s in Germany, gave a near non-stop feed to people. The Vietnam War was televised leading directly to the protests of the late 60s.

With delay and because of government control, communications were slower to evolve in the East but ultimately led to the collapse of the Soviet Union, starting in Gdansk in 1980.

2.8 Tertiary Wave

The appearance of home computing gave everyone the computing power previously reserved to academics and the military. Arpanet turned into Internet and allows anyone to do or see anything at near light speed.

A current trend is a return to biology. Once the number crunching was done, attention turned to individual genes, mastering biological code and interfering with stem cells.

If measuring progress by direct applications to improve quality of life or tackle common disease is done, you will find progress is slow.

Although creating publicity there are few direct applications, which are usually limited to rare diseases.

The astute person is likely to have asked him- or herself what the point of this historical dialogue is.

There are cycles in time and a common denominator. The industrial revolution was driven by, well industry, and the profit to be made of influx of often colonial funds.

In the 1930s, Nazi politics were funded by industry and the Nazis ultimately took over the state structure and funding.

The US space program was heavily funded to send a political message to the East.

This day and age governments are bankrupt and can no longer afford spectacular shows of engineering, medicine or war. Governments find they need to look at private funding again to fund the previously mentioned.

The contrast in social dynamics and lifestyle, result of the industrial revolution, has never been replicated.

An example is the space program; at a massive expense, an inflated V2 was built by the same team. The Apollo program made it to the moon but the missions were narrow minded without lateral thinking. I can only imagine what difference the discovery of water on the moon would have made then.

To make matters worse, we have not come any further. The space shuttle was a step back to solid fuel boosters, leading to the Challenger disaster and currently the world needs to rely on outdated, disposable, 60s Russian rockets to maintain the ISS.

The bottom line is; the money dried up and the private sector is again a convenient partner but fickle partner. Private industry only funds, preferably low risk, rapid return projects. This also means the rate of progress and what will progress is determined by the deliverables in profit.

2.9 Medical Industry

I have been a surgeon for 25 years and have dealt with medical industry in several fields. Currently my clinical practice is the surgical treatment of movement disorders in children. I do this with either implantable drug delivery pumps or Deep Brain Stimulation (DBS).

These systems originated in the 1980s and actually have remained unchanged since. The only real change in either system is the battery life, which has tripled over 20 years; evolution driven by the mobile phone industry, not by medical requirement.

The current drug delivery pumps have a programmed death to force the user to replace the pump and are not used to their full potential. There are a variety of drugs that could be used for a variety of conditions but this is of little interest to the corporations.

Mary Shelley came up with the idea of Deep Brain Stimulation mid nineteenth century by writing "Frankenstein's monster." Although spectacular and a great treatment in adults and children, the primary indications for DBS are rare and so medical industry is artificially expanding the uses of the same device.

Medical industry follows the cycle I previously described. They build on old established technology, make minor changes that do not need regulatory review, re-license the same device for new applications to recover investment and maximize profit.

Medical industry is overseen by several organizations. Often a first step is CE marking, which allows a product to be sold and used in Europe, which is a lesser risk than doing this in the US.

The gold standard is the US Food & Drug Administration approval but this can take 10–15 years and involves clinical trials that need to be funded by the company seeking approval.

The World Health Organization also has regulatory capacity and has recently come under scrutiny for corruption during the “flu pandemic.”

In the UK there is an extra filter on top of all the others: the National Institute for Clinical Excellence (NICE). NICE is an organization that responds very slowly to requests and essentially disguised cost cutting. NICE was taken to court by the breast cancer patients because NICE refused to approve Herceptin, the drug that really makes a difference.

I would like to take you through two different approaches to medicine. One is the management of head injury and the other is space medicine.

After a head injury, usually the result of a road traffic accident, we pile medical technology onto the patient.

The patient will be ventilated, given artificial coma, have a pressure monitoring device, receive Mannitol etc. Despite all these measures there is no change in the outcome of head injury. Head injury remains a devastating problem with dire consequences. There is some research funding for the management of head injury and medical industry looks favourably at this common disorder because it involves equipment and devices.

Space medicine looks at injury in a completely different way. The space program has its roots in the military with an emphasis on risk avoidance as in industry, who use the sometimes absurd HAZOP protocols. This approach is necessary as there are limited options for emergency care in space and evacuation is hazardous. An injured person is unlikely to survive re-entry.

The lesson to be learned is prevention. Avoid having a head injury by wearing a seatbelt, looking after your vehicle, do not drink and most of all do not be stupid.

A back to reality message is that “high end” medical technology is of no use to most people, you will never need it. The biggest contributions to health in the past have been sanitation and access to clean water.

What most people will be confronted with is heart disease, obesity, high blood pressure, in essence lifestyle diseases, with directly impact on longevity. As in head injury, you are for a large part responsible for contracting these lifestyle diseases.

What does longevity mean? Humans have a limited display date and this increased dramatically in the twentieth century. The mean was 35 years around 1900 and is currently around 80 years in Western Europe, –7 years in the US because of the absence of reliable healthcare. The maximum appears to be 120 years after which the system is worn out and the repair mechanisms are exceeded. If you want to live up to 120 you will need to invest in you.

In Zen Buddhism you may be asked to solve a Koan, which is a reputedly unsolvable question: what is the sound of one hand clapping or does a falling tree make noise when there is nobody there?

The real answer to the Koan is: the question does not make sense, which is a very useful motto for every researcher. The answer to the Koan of longevity is not, do you want to live longer but, would you like a better life.

Eighty per cent of the world could do with an improvement of their quality of life, whatever this means to the individual.

2.10 Conclusion

Where does this leave us as individuals? Hitler said it was a great advantage to leaders that men did not think. This motto made it possible for a criminal organization to overtake one of the most advanced and powerful countries in the world, with all mayhem ensuing. Our society is heavily industrialized, industry feeds us, entertains us, dictates which products we use socially or medically and we face corporatism, without appeal.

Human nature has not changed. We have a very short span of attention and want quick fixes; an attitude which led to the collapse of the banking system. One overwhelming novelty is that the planet has acquired a nervous system. The Internet has given us awareness.

Far from trying to pass a “New Age” message, I believe that in view of the current state of things we should individually and generally ask ourselves the right questions, educate, collaborate, plan for longer term, think laterally, question corporatism and use common sense. Do you need to drive, do you need to eat all this, drink all this, should we build unprotected nuclear reactors in earthquake zones?

We need to realize that our actions and thoughts are now interconnected at each level. Each level duplicates the other; whether we fight off a virus infection or take to the streets in protest it is a form of response. The awareness allows people to compare lifestyle, thoughts and social dynamics and make up their own mind. Just think of the role of Facebook in the Egyptian revolution and Wikileaks.

Interdisciplinary programs are an essential in this setting. The psychologist has input for the engineer’s project as will the doctor and the designer. A mathematical solution may solve a medical problem. There are ideas hidden on computers and solutions on scraps of paper in drawers that will never see the light of day if we do not take initiative and leave it all to industry or grant giving bodies.

2.11 Death

Finally; there is one horseman missing: Death. Death is what you call a “Dude.” Death can be relaxed about everything, does not need to stress about finding new opportunities like War, Plague or Famine because every time, everything, everywhere, dies.

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