Viruses, physics, sci-fi and public health - mysteries and similarities

Dr Julian W Tang
Honorary Associate Professor/ Clinical Virologist
Respiratory Sciences, University of Leicester, Leicester, UK
“One of the amazing things to come out of the COVID-19 pandemic is the massive interdisciplinary collaboration between scientists – including virologists, engineers, epidemiologists, infectious diseases, public health and infection control”
Climate physics and microbiology coming together – adding to other potential man-made disasters...


Never-before-seen microbes locked in glacier ice could spark a wave of new pandemics if released

Smallpox could return as Siberia’s melting permafrost exposes ancient graves

Giant new 50-metre deep 'crater' opens up in Arctic tundra
Science advances one funeral at a time.

— Max Planck —

“A new scientific truth does not triumph by convincing opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.”

Max Planck
COVID-19 – aerosol transmission controversy – had a strong historical basis.
Historical and current controversies in physics

CERN Courier

Quantum Physics
21 March 2020

Einstein and Heisenberg: The Controversy over Quantum Physics, by Konrad Kleinknecht, Springer

This attractive and exciting book gives easy access to the history of the two main pillars of modern physics of the first half of the 20th century: the theory of relativity and quantum mechanics. The history unfolds along the parallel biographies of the two giants in these fields, Albert Einstein and Werner Heisenberg. It is a fascinating read for everybody interested in the science and culture of their time.

At first sight, one could think that the author presents a twin biography of Einstein and Heisenberg, and that’s all. However, one quickly realises that there is much more to this concise and richly illustrated text. Einstein and Heisenberg’s lives are embedded in the context of their time, with emphasis given to

The cosmologist who claims to have evidence for the multiverse

Cosmologist Laura Mersini-Houghton says our universe is one of many – and she argues that we have already seen signs of those other universes in the cosmic microwave background, the light left over from the big bang.

This article has been viewed 576 times in the last 24 hours.

Faster than light travel is possible, scientist claims

By Henry Petitt, The Sun
March 12, 2021 5:50pm Updated

https://nypost.com/2021/03/12/faster-than-light-travel-is-possible-scientist-claims/

When Galileo Stood Trial for Defending Science

The Italian astronomer argued that Earth and other planets revolve around the sun. Then he paid a price.

MARIO LIVIO • MAY 19, 2020


https://www.newscientist.com/article/0-

https://nypost.com/2021/03/12/faster-than-light-travel-is-possible-scientist-claims/

https://www.newscientist.com/article/0-the-cosmologist-who-claims-to-have-evidence-for-the-multiverse/#text=HOW%20did%20our%20universe%20begin,says%20she%20has%20cracked%20it
Imagination is more important
than knowledge.

For knowledge is limited to all
we now know and understand,
while imagination embraces
the entire world and all there
ever will be to know and
understand.”

- Albert Einstein

Image and Reality: Kekulé, Kopp, and the Scientific Imagination

Alan J. Rocke


German chemist August
Kekulé visualized the ring
structure of benzene in 1865.

http://www.inspirationalhunter.com/
albert-einstein-quote-imagination-is-
more-important-than-knowledge/
Both physics and virology have had their fair share of Hollywood movies!
I've also tried my hand at sci-fi – but none about viruses!
Former physicists, turned virologists or public health epidemiologists – useful interdisciplinary skills for COVID-19...

British Columbia CDC Vancouver, Canada (formerly)

McGill University, Montreal, Canada (currently)

https://www.sciencedirect.com/science/article/pii/S0925753520302630#f0005
Over 300 million deaths from bubonic plague, flu, smallpox and HIV/AIDS, alone

https://www.archives.gov/exhibits/influenza-epidemic/records-list.html

https://www.visualcapitalist.com/history-of-pandemics-deadliest/
Antimicrobial-resistant threats
- CRE
- MRSA
- C. difficile
- N. gonorrhoeae
H3N2v influenza
Cyclosporiasis
E. coli O157:H7
Measles
Human monkeypox
Listeriosis
Bourbon virus
2009 H1N1 influenza
Adenovirus 14
Anthrax bioterrorism
Chikungunya
Hantavirus pulmonary syndrome
Acute flaccid myelitis
Zika virus
Yellow fever
Marburg virus
MDR/XDR tuberculosis
Plague
Dengue
HIV
Human African trypanosomiasis
Cryptosporidiosis
Powassan virus
E. coli O104:H4
Drug-resistant malaria
Diphtheria
Akhmeta virus
MERS-CoV
Rift Valley fever
Typhoid fever
SFTSV
bunyavirus
E. coli O157:H7
H5N6 influenza
H10N8 influenza
H7N9 influenza
H5N1 influenza
SARS
Nipah virus
Hendra virus
Nipah virus
Enterovirus 71
Ebola virus
Human monkeypox
Lyme disease
Hepatitis C
vCJD
Lassa fever

https://www.ibtimes.co.uk/rare-disease-day-2016-10-rarest-conditions-world-1546263 (HPV - Epidermodysplasia verruciformis)

https://www.babycenter.com/health/illness-and-infection/measles_1417820 (measles)

https://www.thecut.com/2014/10/strange-polio-like-illness-is-paralyzing-kids.html (polio/EVD68)


https://journals.healio.com/doi/10.3928/00904481-20150512-11 (cCMV)
And particle physics and virology have their own – very similar looking – classification systems

https://www.phyzarre.com/super-kamiokande.html

https://personalpages.manchester.ac.uk/staff/j.gough/lectures/TIB/4pathogens1/page4.html
Are viruses alive? Some say no because:

- Viruses are polyphyletic
- There are no ancestral viral lineages
- Because today’s viruses infect phylogenetically distant hosts doesn’t mean that they are ancient
- Viruses don’t have a structure derived from a common ancestor
- Viral metabolic genes originate from cells
- Viral translation genes originate from cells
- Viruses steal genes from cells
- Most gene transfer goes from viruses to cells
- Just because viruses are simple doesn’t mean that they are old

Even though viruses are not living and should not be included in the tree of life, they play an important role in evolution of their cellular hosts by regulating population and biodiversity.

Tracking collision or transmission events?

DECODING DECAYS
Physicists might be able to infer the presence of short-lived heavy particles by seeing the more stable particles they decay into. For instance, here is one way that the 'leptoquark' — a hypothesized transient particle that takes on properties of both leptons (such as electrons) and quarks — might be produced and decay.

Proton

Quark

Collision

Antileptoquark

Anti top quark

Anti tau

Tau

Top quark

Leptoquark

If more of these particles are produced than expected, it could imply the presence of a leptoquark.

The basic reproduction number (R0) is a measure of the average number of people that would be infected by an infectious individual in which no control measures are implemented.

The effective reproduction number (R_effective) measures the average number of people that would be infected by a single infectious person, taking into account the public health interventions implemented to control the spread of the virus.

https://www.nature.com/articles/d41586-022-01388-6

Deliberate vs. accidental collisions – or transmissions?

Boron rods slow down a nuclear (fission) reaction

Vaccines slow down viral transmission
Tools to track/visualise particle or virus ‘collisions/events’

https://towardsdatascience.com/particle-tracking-at-cern-with-machine-learning-4cb6b256613c

TRACK SPREAD of ZIKA VIRUS in USA & WORLDWIDE | 31 CASES IN USA


Viral phylogenetic tree and sequence analysis

Season 3's main plot follows Jack Bauer’s attempts to retrieve a deadly virus from terrorists in Mexico.
https://en.wikipedia.org/wiki/24_(season_3)

In Mission: Impossible 2, Ethan Hunt leads a mission to retrieve a deadly virus before it is released by terrorists. At one point, his girlfriend injects herself with the virus and is released into a city population to spread the virus further – unless Ethan can inject her with the antidote in time
https://en.wikipedia.org/wiki/Mission:_Impossible_2

Thinking more about virus transmission events...

https://www.science.org/content/article/anthrax-genome-reveals-secrets-about-soviet-bioweapons-accident

https://www.ph.ucla.edu/epi/bioter/sverd/sverd_fig3_a.html
An attempt to genetically re-engineer the measles virus to cure cancer becomes lethal, infecting 99% of the world’s population, turning those it does not kill into vampiric, albino, cannibalistic mutants called Darkseekers.

Alice is a former security specialist and covert operative who battles the Umbrella Corporation, whose bioweapons have triggered a zombie apocalypse.

During his career as a Soviet bioweaponeer, in the late 1970s and 1980s, Alibekov managed projects that included weaponizing glanders and Marburg hemorrhagic fever, and created Russia's first tularemia bomb. His most prominent accomplishment was the creation of a new "battle strain" of anthrax, known as "Strain 836", later described by the Los Angeles Times as "the most virulent and vicious strain of anthrax known to man".

Oncolytic herpes simplex virus vectors and chemotherapy: are combinatorial strategies more effective for cancer?

Ryuichi Kanai, MD, PhD, Brain Tumor Research Center, Department of Neurosurgery, Massachusetts General Hospital, & Harvard Medical School, Boston, MA, USA

Adenovirus Vectors for Gene Therapy, Vaccination and Cancer Gene Therapy

William S.M. Wold and Karoly Toth

1Saint Louis University School of Medicine, Department of Molecular Microbiology & Immunology, St. Louis, MO, USA
Between 1949 and 1969, open-air tests of biological agents were conducted 239 times:

- In the 1950s, army researchers dispersed *Serratia* on Panama City and Key West Florida with no known illnesses resulting.

- *Bacillus globigii*, never shown to be harmful to people, was released in San Francisco, New York, Washington, D.C., and along the Pennsylvania Turnpike, among other places.

- In New York, military researchers in 1966 spread *Bacillus subtilis* variant *Niger*, also believed to be harmless, in the subway system by dropping lightbulbs filled with the bacteria onto tracks in stations in midtown Manhattan. The bacteria were carried for miles throughout the subway system. Army officials concluded in a January 1968 report that: "Similar covert attacks with a pathogenic disease-causing agent during peak traffic periods could be expected to expose large numbers of people to infection and subsequent illness or death."

- In a May 1965 secret release of *Bacillus globigii* at Washington’s National Airport and its Greyhound Lines bus terminal, more than 130 passengers were exposed to the bacteria and traveled to 39 cities in seven states in the two weeks following the mock attack.


The 2001 anthrax attacks occurred in the United States over the course of several weeks beginning on September 18, 2001, one week after the September 11 terrorist attacks. Letters containing anthrax spores were mailed to several news media offices and to Democratic Senators Tom Daschle and Patrick Leahy, killing five people and infecting 17 others.

In New York, military researchers in 1966 spread Bacillus subtilis variant Niger, also believed to be harmless, in the subway system by dropping lightbulbs filled with the bacteria onto tracks in stations in midtown Manhattan. The bacteria were carried for miles throughout the subway system. Army officials concluded in a January 1968 report that: "Similar covert attacks with a pathogenic disease-causing agent during peak traffic periods could be expected to expose large numbers of people to infection and subsequent illness or death."

The Army tested 'germ warfare' on the NYC subway by smashing lightbulbs full of bacteria


Kevin Loria  Nov 15, 2015, 5:00 PM
How could a virus infection create a zombie?!

Zombies exhibit ataxic gaits (fast or slow - *spinocerebellar ataxia*), inability to talk (*expressive aphasia*), inability to recognize faces from their past (*prosopagnosia*), fixation on what is in front of them (*Bálint's syndrome*), insatiable appetites (for human flesh and brains – *hypothalamic damage*)

https://www.mentalfloss.com/article/53422/real-life-neuroscience-behind-zombies

Luckily, we don’t have any viruses that cause these effects so far – could they be bioengineered? Possible, but very difficult.

Furious rabies may come closest:

weakness or discomfort, fever, or headache
anxiety, confusion, and agitation
delirium, abnormal behavior, hallucinations, hydrophobia (fear of water), and insomnia


HSV-1/2, VZV, JCV, EVD68, EV71, etc.
measles, rubella
human viruses

WNV/SLE/JE/TBE
– insect vectors

Rabies/Nipah –
mammalian zoonoses/vectors

https://www.mentalfloss.com/article/53422/real-life-neuroscience-behind-zombies
‘Needle-spiking’ may have other consequences such as the transmission of HIV, HBV, HCV if the needle has been used on others already...

In the future will all night-clubbers need HIV, HBV, HCV protection?!
Martian meteorite ALH84001, recovered in Antarctica. Some scientists have suggested that physical and chemical features in this meteorite provide evidence for microscopic fossil life on Mars. That interpretation remains controversial. Photo courtesy of JPL/CALTECH/NASA.

Microbes and space travel – hope and hazards

Julian Wei-Tze Tang*,1, Andre Henriques2 & Tze Ping Loh1

1C/O Clinical Microbiology, S/J Sandringham Building, Leicester Royal Infirmary, Infirmary Square, Leicester, LE1 5WW, UK
2CERN (European Organisation for Nuclear Research), Geneva, Switzerland

“With plans to return Martian soil and rocks to Earth in the near future for examination, the possible presence of extraterrestrial life-forms in these samples is both a hope and a hazard.”

Dealing with the unexpected – new particles, new viruses?


https://www.the-medium-is-not-enough.com/2008/03/movies_you_should_own_the_andromeda_strain.php
False positive this time – but what about next time?

Returning Mars Samples to Earth

Returning Mars Samples to Earth

NASA and the European Space Agency (ESA) are planning ways to bring the first samples of Mars material back to Earth for detailed study.


HOUSTON, TEXAS Following years of rigorous study, the inside story of whether meteorite ALH 84001 the so-called "Mars rock" harbors evidence for past Martian biology remains steeped in debate.

It was a NASA-led research team that announced in August 1996 that the potato-shaped meteorite found in Antarctica might sport fossilized bacteria. They argued that "lines of evidence" pointed to the likelihood that a primitive form of microscopic life that flourished on the red planet three billion years ago had been found.

Now, fast-forward from 1996 to five-and-a-half years later.

It turns out that rock-solid evidence is hard to come by.

Mars Samples in Orbit (Illustration): This illustration shows NASA's Mars Ascent Vehicle (MAV), which will carry tubes containing Martian rock and soil samples into orbit around Mars, where ESA's Earth Return Orbiter spacecraft will enclose them in a highly secure containment capsule and deliver them to Earth.
Science fact vs. fiction

JWST will look for ‘life signatures’ on exo-planets – but most likely form of life discovered will be microbes?

Microbes and space travel – hope and hazards


https://prop-replica.weebly.com/blog/star-wars-return-of-the-jedi-ewok

Extra terrestrial pathogens could be Category 5 on this UK biohazard classification system.
Acanthamoeba polyphaga mimivirus was isolated from the water of a cooling tower in Bradford, England. Mimivirus readily infects many Acanthamoeba strains, including its preferred laboratory host Acanthamoeba castellanii. Metagenomic surveys indicate that close relatives of the Mimiviridae family are prevalent in the sea, where they probably infect marine heterotrophic protists and regulate plankton populations.

Although mimivirus was isolated in the context of a pneumonia epidemic and initially thought to be an emerging human pathogen based on positive serology, subsequent more specific PCR-based studies failed to detect mimivirus in large numbers of pneumonia patients.

Alien viruses on Earth?
Researchers, in fact, named it Mimivirus — short for "mimicking microbe" — to reflect its large size and apparent Gram-staining properties. The virus has a capsid diameter of 400–500 nanometers (nm) and a total particle diameter, including fibers extending out from the capsid, of approximately 750 nm.

https://www.nature.com/scitable/topicpage/discovery-of-the-giant-mimivirus-14402410/#
https://knpr.org/npr/2017-04/giant-virus-genes-hints-about-their-mysterious-origin
https://www.freimages.com/photo/cooling-tower-1235460

PROCEEDINGS B
Viral spillover risk increases with climate change in High Arctic lake sediments

Audrée Lemieux¹,², Graham A. Colby¹, Alexandre J. Poulain¹ and Stéphane Anti-Brosou¹,²

¹Department of Biology, and ²Department of Mathematics and Statistics, University of Ottawa, Ottawa, Ontario, Canada

The host spectrum of viruses is quite diverse, as they can sustainably infect a few species to several phyla. When confronted with a new host, a virus may even infect it and transact sustainably in this new host, a process called 'viral spillover'. However, the risk of such events is difficult to quantify. As climate change is rapidly transforming environments, it is becoming critical to quantify the potential for spillovers. To address this issue, we resorted to a metagenomics approach and focused on two environments, soil and lake sediments from Lake Hazen, the largest High Arctic freshwater lake in the world. We used DNA and RNA sequencing to reconstruct the lake's virophere in both its sediments and soils, as well as its range of
Crystal structure of a hachimoji double helix built from four naturally-occurring bases, G (green), A (red), C (blue), T (yellow), and four synthetic bases, B (cyan), S (pink), P (purple), and Z (orange). Notable is the geometric regularity of the pairs, a requirement for evolution.

https://physicsworld.com/a/hachimoji-dna-doubles-the-genetic-code/

**HACHIMOJI – 8-base DNA**

**Four more building blocks**
The researchers, led by Steven Benner of Firebird Biomolecular Sciences LLC and the Foundation for Applied Molecular Evolution, both in Alachua, Florida, have now used organic chemistry to design and make four more such building blocks that fit the size and shape of the G:C and A:T pairs and bind with them. These building blocks are P and B, which are analogues of purine, and Z and S, which are analogues of pyrimidine. These duplexes form P:Z and B:S pairs.

**Hachimoji DNA also supports life**
Like natural DNA, hachimoji DNA supports life in that it pairs in a predictable way and copies to make a hachimoji RNA. RNA is important for life since it is via this molecule that DNA transfers information before it is sent to proteins.

**Engineering enzymes to transcribe DNA into RNA**
To transcribe hachimoji DNA into RNA, the researchers adapted a natural enzyme (T7 polymerase) so that it could accept unnatural genetic molecules. This is one of the main challenges when working with such synthetic DNA systems, says Benner. “Our colleague Andrew Ellington and his team at the University of Texas at Austin re-designed the T7 polymerase, which transcribes natural DNA to natural RNA, by changing amino acids in the protein and finding ones that accept hachimoji DNA to make hachimoji RNA.”

https://www.science.org/doi/10.1126/science.aat0971
In both physics and virology – we need to find ways to deal with uncertainty – either for science or public health purposes.
Like particle physics/cosmology - discovering the origins of zoonotic or human virus infections or outbreaks is important – for source control and public health purposes – and to protect both the humans and animals – MPX, SARS, Nipah, Ebola, Zika, Hanta, etc.

Lassa fever virus – an Arenavirus – one of the viral haemorrhagic fever viruses

Rodent vector – sheds virus in urine and faeces that dries then is inhaled by people living in the environment

Haemorrhagic conjunctivitis

Lassa fever is endemic to West Africa where the mortality is relatively low – humans are a dead-end host

(From CDC website: http://phil.cdc.gov/phil/details.asp. These images are in the public domain and thus free of any copyright restrictions. As a matter of courtesy we request that the content provider be credited and notified in any public or private usage of this image.)
Possible zoonotic reservoirs/sources?

Unnatural wet markets putting animals together that would normally never meet – poses possible hazards
We are what we eat – along with anything that we pick up along the way…and not only coronaviruses

Bats, mosquitoes, birds are common zoonotic virus vectors – for rabies, dengue, avian influenza, etc. and are usually not sick (i.e. asymptomatic carriers).

Humans disrupting the ecosystem – have already had massive impacts on the welfare of humanity...

Closest phylogenetically to bat SARS-like CoVs – initially – but more recently, the pangolin is *no longer* thought to be the intermediate host.

Many false leads and red herrings along the way to determining the true natural reservoir/host.

Fruit bats as reservoirs of Ebola virus

Bat species eaten by people in central Africa show evidence of symptomless Ebola infection.

The first recorded human outbreak of Ebola virus was in 1976, but the wild reservoir of this virus is still unknown. Here we test for Ebola in more than a thousand small vertebrates that were collected during Ebola outbreaks in humans and great apes between 2001 and 2002 in Gabon and the Republic of the Congo. We find evidence of asymptomatic infection by Ebola virus in three species of fruit bat, indicating that these animals may be acting as a reservoir for a deadly virus.

Human Ebola outbreaks that occurred between 2001 and 2005 in Gabon and the be because PCR-positive bats were recently infected and were tested before they developed a detectable immune response. Alternatively, it could be that differences in the virulence of Ebola virus strains led to different immunological responsiveness and viral replication patterns. Of the bat species collected at Likouala in February 2003, 7 of 31 (22.6%) and 0 of 10 (0%) were PCR-positive and IgG-positive, respectively; but five months later the corresponding results were 4 of 184 (2.2%) and 12 of 160 (7.5%). These opposite trends in the PCR and serological results are consistent with

Figure 1  Fruit bats as potential carriers of Ebola virus. a, Dates and locations of animal-trapping sites (blue) and of Ebola virus outbreaks among humans (red stars) in Gabon and the Republic of the Congo. b, Phylogeny of Ebola viruses inferred from RNA polymerase sequences. Values below branches are bayesian posterior probabilities (lefthand slash; values less than 0.5 not shown); bootstrap percentages were obtained by maximum parsimony (right-hand slash; values under 50% not shown). (GenBank accession numbers, DQ 205409–205415.) Sequences of the subtype Zaire (red) share five nucleotide signatures in positions 1,755 (T), 1,800 (G), 1,857 (T), 2,002 (A) and 2,003 (C) of the complete coding sequence of the gene encoding RNA polymerase. c, Geographic distribution (inside coloured lines) of the fruit bats_Hypsipetes monstrosus (blue), Epomops franqueti (red) and Myonycteris torquata (yellow).

FIG. 1. Network illustrating the known interrelationships between the individuals studied. The social contacts shown indicate that the individuals were all involved in the “nightclub scene” in Doncaster. The probable indirect IDU contact between Don1 and Don1 involved a male drug user with whom Don1 had a relationship (1984–1989), and who may have shared needles with Don1; Don1 had a confirmed social relationship with Don1. “Confirmed sexual contacts” were those confirmed by both partners; the unconfirmed contact was confirmed by only one partner. Male patients are indicated by an asterisk (*).
The true real-life mystery of influenza seasonality:

Multi-country: https://www.nature.com/articles/s41598-019-39871-2
What factors drive this distinct annual seasonal oscillation in human influenza case numbers?
Sunspots and influenza

Yearly means of daily sunspot relative numbers compared with dates of influenza pandemics. The record up to 1971 is from Hope-Simpson; the dashed curve shows the situation for the period 1971–89.

Vitamin D promotes antiviral and immunomodulatory signaling via various cascades – so deficiency reduces host immune defences against viral infections

HYPOTHESIS

Impact of Atmospheric Dispersion and Transport of Viral Aerosols on the Epidemiology of Influenza

G. W. Hammond, R. L. Raddatz, and D. E. Gelskey

From the Cadham Provincial Laboratory; the University of Manitoba and the Atmospheric Environment Service, Environment Canada, Winnipeg, Manitoba, Canada

Vitamin D and Influenza

Maria E. Sundaram and Laura A. Coleman

Marshfield Clinic Research Foundation, Marshfield, WI

NATURE • VOL 343 • 25 JANUARY 1990

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Vitamin D promotes antiviral and immunomodulatory signaling via various cascades – so deficiency reduces host immune defences against viral infections
Bad weather drives people indoors and closer together enhancing viral transmission – but only up to a point...

Table 3. Association between acute respiratory illness (ARI) and rainfall by household crowding

<table>
<thead>
<tr>
<th>Household crowding</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>2.97</td>
<td>(1.87–4.70)</td>
</tr>
<tr>
<td>All households</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3 people/room</td>
<td>1.11</td>
<td>(0.25–5.00)</td>
</tr>
<tr>
<td>≥3 people/room</td>
<td>3.31</td>
<td>(2.03–5.38)</td>
</tr>
<tr>
<td>≥3 to &lt;4 people/room</td>
<td>4.20</td>
<td>(1.58–11.18)</td>
</tr>
<tr>
<td>≥4 to &lt;5 people/room</td>
<td>4.22</td>
<td>(1.79–9.94)</td>
</tr>
<tr>
<td>≥5 to &lt;6 people/room</td>
<td>1.55</td>
<td>(0.54–4.47)</td>
</tr>
<tr>
<td>≥6 people/room</td>
<td>3.58</td>
<td>(1.18–10.87)</td>
</tr>
</tbody>
</table>

OR, Odds ratio; CI, confidence interval.

The OR represents the odds of a 25.4 mm (average) increase of rainfall on days –1 to –6 preceding an ARI episode compared to the odds of rainfall on days –1 to –6 preceding control days.
As in physics, we also need to be aware of spurious correlations in viral epidemiology also – though these may also indicate that we are missing something important...

![Graph showing correlation between number of people who drowned by falling into a pool and films Nicolas Cage appeared in.](https://occaminvesting.co.uk/problems-with-smart-beta-part-8-backtesting/)

Data sources: Centers for Disease Control & Prevention and Internet Movie Database
The method used by the fictional genetics company, Ingen, involved finding dinosaur DNA still inside fossilised mosquitoes preserved intact in amber, which is sap that seeps from trees and often covers unwary insects.... While it’s true we do find superb life-like insect fossils in *amber the same age as when dinosaurs lived* the insects do not contain even small fragments of their own DNA preserved, let alone the DNA of any dinosaur it may have bitten.
Creation of 1918 A/H1N1 pandemic influenza from buried corpses in Alaska

https://www.cdc.gov/flu/pandemic-resources/reconstruction-1918-virus.html

**Top:** Mouse lung tissue infected with a human seasonal H1N1 flu virus.

**Bottom:** The 1918 virus replicates quickly and causes severe disease in the lung tissues of mice, mimicking what was seen in humans in 1918

**Top:** Replication of a human seasonal flu virus called Tx/91 in cell culture.

**Bottom:** Effect of exchanging the polymerase (PB1) gene of this same virus with that of the 1918 virus, greatly enhancing its replication rate.

Dr. Terrence Tumpey working in BSL3 enhanced laboratory conditions. This includes (but isn’t limited to) use of a powered air purifying respirator (PAPR), double gloves, suit, and working within a Class II biosafety cabinet (BSC).

Johan Hultin excavating a body from the Brevig Mission burial ground.

Influenza virus. Hemagglutinin (HA) is a surface protein of the virus that plays a role in allowing an influenza virus to enter and infect a healthy cell.
7 of the 8 complete gene segments (NA, NP, NS, M, PA, PB1, PB2) of the 1918 Spanish influenza A(H1N1)pandemic virus free to download from NCBI GenBank. 8th gene segment (HA) is also available – but only as a partial sequence: ‘Brevig Mission’

But care is needed – a ferret inoculated with this reconstructed 1918 pandemic H1N1 virus bit its handler

UNFROZEN FLU

Accident With 1918 Pandemic Virus Raises Questions About Pathogen Research

through the world at the end of World War I. To prevent it from sparking another pandemic, 1918 influenza is studied under biosafety level 3 conditions, the second-tightest of biosafety controls available. The researcher at Mount Sinai School of Medicine (now Icahn School of Medicine at Mount Sinai) was wearing protective equipment, including two pairs of gloves. But the ferret bit hard enough to pierce through both pairs, breaking the skin of his left thumb.

The flu is typically transmitted through respiratory droplets, and an animal bite is unlikely to infect a scientist. But with a virus as devastating as 1918 flu, scientists are not supposed to take any chances. The researcher squeezed blood out of the wound, washed it with an ethanol solution, showered, and left the lab. A doctor gave him a flu shot and prescribed him Tamiflu. Then, after checking that he lived alone, a Mount Sinai administrator sent him home to quarantine for a week, unsupervised, in the most densely populated city in the United States. As documents obtained by The Intercept show, staff told him to take his temperature two times a day and to wear an N95 respirator if he got sick and needed to leave for medical care.

Then, at a conference in Malta in September 2011, Prof. Ron Fouchier (Erasmus MC Rotterdam, The Netherlands) presented data from experiments in which his laboratory had modified a human isolate of H5N1 avian-origin influenza to acquire some mutations expected to adapt it to human-to-human transmission and then introduced the resulting virus into ferrets.

Soon after, the laboratory of Prof. Yoshihiro Kawaoka (University of Wisconsin-Madison, USA) reported a related set of experiments, this time using a virus created by reverse genetics from a human H1N1 virus and the hemagglutinin gene of a zoonotic H5N1 isolate.
Lab accidents – where people become infected – allowing the virus to escape into the wider population...

Pandemic flu virus from 1957 mistakenly sent to labs

Apr 13, 2005 (CIDRAP News) – The revelation that samples of the influenza virus that caused the flu pandemic of 1957-58 were inadvertently sent to thousands of laboratories has raised fears of a new pandemic and triggered an urgent effort to destroy the samples.

Samples of the influenza A (H2N2) virus were sent to 3,747 labs, the vast majority of them in the United States, the World Health Organization (WHO) said in a statement last night. The WHO recommended that all the samples, which were sent for use in lab proficiency testing, be destroyed immediately.

The Reemergent 1977 H1N1 Strain and the Gain-of-Function Debate

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ABSTRACT

The 1977-1978 influenza epidemic was probably not a natural event, as the genetic sequence of the virus was nearly identical to the sequences of decades-old strains. While there are several hypotheses that could explain its origin, the possibility that the 1977 epidemic resulted from a laboratory accident has recently gained popularity in discussions about the biosafety risks of gain-of-function (GOF) influenza virus research, as an argument for why this research should not be performed. There is now a moratorium in the United States on funding GOF research while the benefits and risks, including the potential for accident, are analyzed. Given the importance of this historical epidemic to ongoing policy debates, we revisit the evidence that the 1977 epidemic was not natural and examine three potential origins: a laboratory accident, a live-vaccine trial escape, or deliberate release as a biological weapon. Based on available evidence, the 1977 strain was indeed closely matched to decades-old strains to likely be a natural occurrence. While the origin of the outbreak cannot be conclusively determined without additional evidence, there are very plausible alternative hypotheses for the laboratory accident hypothesis, diminishing the relevance of the 1977 experience to the modern GOF debate.
LHC, the Large Hadron Collider is the most powerful particle accelerator. It has been found that LHC also has the potential to give rise to microscopic black holes. Well, it is just a hypothesis given by some scientists that these kinds of black holes would destroy the earth.

A study about microscopic black holes conducted in 2003 concludes:

• The microscopic black holes are so small that they would decay rapidly in just 10\(^{-27}\) seconds. Therefore, they won’t survive for a longer time.

• Even if we can stabilize it, then the rate of absorption would be so slow that the earth would live for billions of years.

• But, the research predicted that the energies at LHC are insufficient to create a microscopic black hole.

So, in every manner, we are safe from the black holes. In reality, this is not going to happen. The black holes are too far to affect us.
And.... accidents do happen – in both particle physics and virology!

13 July 1978, 36 years-old Russian scientist Anatoli Bugorski at the Institute for High Energy Physics in Protvino, near Serpukhov, Russia, noticed a problem. To see what’s wrong, Bugorski put his head inside the channel, unaware that the accelerator was still running, as the safety warning system was switched off. As soon as his head crossed the invisible proton beam he felt no pain, but he reportedly saw a flash “brighter than a thousand suns.”

The beam had entered through the back of his head and exited through his nose, destroying brain tissue and nerves and leaving the left side of his face paralyzed, and deafness in his left ear. He also developed frequent seizures. But his intelligence remained as sharp as ever.

Bugorsky returned to work 18 months later, but promised to appear regularly in the Moscow clinic at least twice a year. Bugorski continued pursuing science, completed his PhD and held the post of coordinator of physics experiments at the U-70 proton synchrotron where the incident occurred.

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Anatoli Bugorski’s swollen face after the accident. The figure on the right shows the path of the proton beam through his skull.
Proton beam therapy
Proton beam therapy is a type of radiotherapy that uses a beam of high energy protons, which are small parts of atoms, rather than high energy x-rays (called “photons”) to treat specific types of cancer, such as highly complex brain, head and neck cancers and sarcomas.

Proton beam therapy enables a dose of high energy protons to be precisely targeted at a tumour, reducing the damage to surrounding healthy tissues and vital organs which is an advantage in certain groups of patients or where the cancer is close to a critical part of the body such as the spinal cord.

Proton therapy has been useful in treating certain cancers. But advanced x-ray treatments for other cancers have seen excellent results with a low risk of major side effects. For these tumors, clinical trials are needed to find out whether proton therapy is better than x-rays. This is important because of the higher cost of proton therapy.

Thank you CERN!
(and for the many other spin-off benefits)