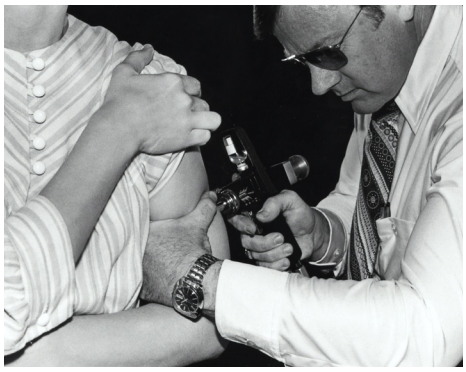
ANTI-VAXXERS

WHY PEOPLE REFUSE VACCINES

TEXT BY SARAH ASBURY



"IF vaccines really are perfectly safe and do not cause any injuries or deaths, then the numbers of antivaxxers would be shrinking. It's not. We are growing in numbers. That should tell you everything."[1]

This is the perspective of a vaccine hesitant Twitter user @KassandraKitson, and they're not alone in their sentiments.

It may be difficult to understand why a growing number of parents are choosing against vaccination as a method of protecting their children from lethal or debilitating childhood diseases [2]. However, the social media of vaccine hesitant parents reveal a clear story. They're motivated by what most parents want – to protect the health of their children. In fact, vaccine hesitant parents are typically well-educated upper middle class individuals [1,3] who actively seek out information about vaccines [4].

Skeptical by public education campaigns that emphasize the benefits of vaccines, vaccine-questioning parents resort to researching vaccine risks online [4–6]. Many unverified or fictitious vaccine risks are discussed on social media by anti-vaxxers [7], who typically lack the biomedical, statistical, or epidemiological training to critically assess scientific studies and scientific media. As a result, vaccine-questioning parents may unwittingly be drawn into a social media misinformation trap that exaggerates vaccine dangers and instils doubts difficult to dispel without comprehensive science education.

For example, VaccineTruths or @Rectitude20, a Twitter user who had over 12,000 followers, shared a post urging parents to ask their doctors about a scientifically unfounded vaccine risk – that vaccines increase the risk of neurodevelopmental disorders (NDD) [8]. The Tweet was first posted in December 2019 before the account was suspended in June 2020.

The Tweet referred to a graph from a study published in a seemingly legitimate scientific journal, the Journal of Translational Science, by lead author and professor of epidemiology, Anthony Mawson, from Jackson State University [9]. However, the study was retracted

by the original publisher, Frontiers of Public Health, due to major flaws in research design [10]. The work also conflicts with the majority of studies conducted in the area.

The body of scientific evidence clearly demonstrates no relationship between vaccination and neurodevelopmental disorders including autism, attention deficit hyperactivity disorder, and learning disabilities [11–14]. This includes a massive report using data collected from 1.2 million individuals – a statistically high-powered study ideal for identifying rare adverse events – which found no relationship between vaccines and autism [11]. However, these reproducible and credible large-scale epidemiological studies have failed to impact anti-vax opinion, and Mawson's publication continues to circulate in the anti-vax community.

Irrespective of well-founded contradicting evidence, there are fundamental flaws in Mawson's methodology that casts doubt on the veracity of their work. Most importantly, data was collected via an online survey: Mawson's team solicited self-reported medical information on vaccination, neurodevelopmental disorders, and preterm birth from mothers with homeschooled children. This method of data collection exposes the work to multiple sources of inaccuracies including a selection bias, a small sample size, and an inability of the researchers to verify their participants' medical history.

"There are all sorts of biases surrounding the recruitment strategy, the statistics are problematic, and the peer review wasn't done appropriately," said Dawn Bowdish, a professor of immunology at McMaster University and the Canada research chair for Aging and Immunity.

"The first issue is that there are no confirmed diagnoses," Bowdish added, referring to the lack physician diagnoses for neurodevelopment disorders (NDD) reported in the study.

Without a physician diagnosis, it is impossible to verify if the children with neurodevelopmental disorders in the study actually fit the diagnostic criteria. This alone makes the relationship between children reported to have NDD and vaccination status dubious.

Furthermore, "there's a selection biases for homeschooled parents," Bowdish said. When designing a study, the sample population should represent the population that the findings will be extrapolated to – in this case the general population. Over-selecting a particular subpopulation facilitates discovery of idiosyncrasies unique to that subpopulation rather than answering the research question for the entire population.

"There's data suggesting that children who have neurodevelopmental issues are more likely to be homeschooled than the general public, because they struggle in the conventional school system," Bowdish said.

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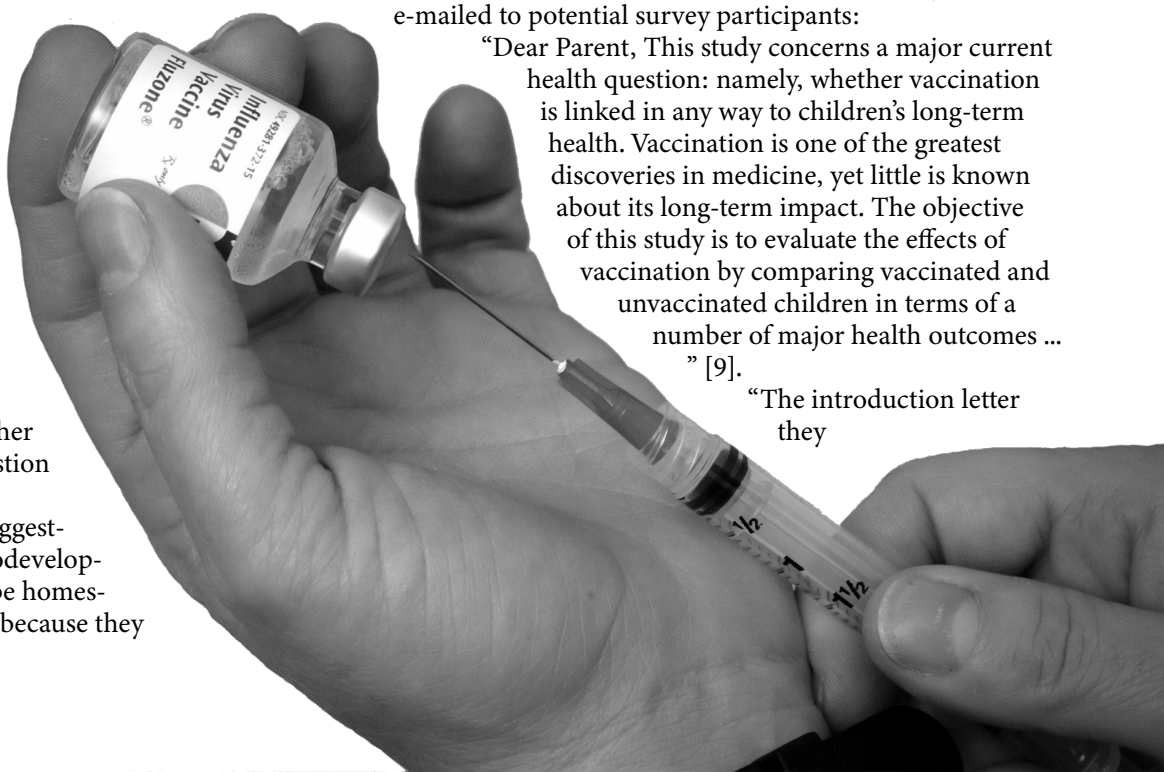
Homeschooling populations also have higher frequencies of parents who are anti-vax [15–17], because school vaccination mandates provoke vaccine-refusing parents to seek alternative schooling [18].

Using a homeschooled population makes it difficult to disentangle whether a lower frequency of NDD in unvaccinated children is a genuine finding, or an unexplained correlation between NDD and vaccinations in the homeschooled population. Simply put, it is statistically inappropriate to use a homeschooled population to broadly conclude that there is a biological relationship between vaccines and NDD risk.

However, there are also subtler flaws stemming from their methodology. Part of that is in the introductory letter e-mailed to potential survey participants:

"Dear Parent, This study concerns a major current health question: namely, whether vaccination is linked in any way to children's long-term health. Vaccination is one of the greatest discoveries in medicine, yet little is known about its long-term impact. The objective of this study is to evaluate the effects of vaccination by comparing vaccinated and unvaccinated children in terms of a number of major health outcomes ... " [9].

"The introduction letter they



gave to the participants gave away the major hypothesis of the study," Bowdish said. "And that biases people."

Bowdish explained that biasing survey participants prior to administering the survey increases the risk that the dataset is inaccurate because surveyee responses can be subjective.

For example, pre-term birth is a well-documented risk factor for NDD [19–22], yet Mawson's study found no relation between them. This may indicate that having surveyees self-report medical information curated low quality data. For instance, asking mothers to self-report pre-term birth may provoke subjective responses. "37 weeks is considered term. But if you had a baby at 37 weeks a mother might still say she had her baby pre-maturely if she had it early [in the week] but that is actually within the normal range," Bowdish said.

Mawson's study did not provide the survey questions for vaccination, NDD, or pre-term medical information in their publication, and therefore the extent of survey bias is challenging to assess. It is also possible they did not include enough children with NDD to statistically discern a significant relationship between pre-term birth and NDD, as only 49 of the 666 children had reported NDD. Regardless, Bowdish said that the lack of relationship between NDD and pre-term birth may be a litmus test that their dataset is precarious.

Despite the flaws in data quality, population sampling, and survey methodology, Mawson's study was nonetheless published – a possible oversight in the scientific peer review process.

Effective peer review is crucial to credibility, because other experts in the field assesses whether or not the paper conducted meticulous unbiased science. Typically "peer reviewers are people who have expertise in the field. Often, you have more than one, because you want to cover different areas of expertise," Bowdish said. "For example, one reviewer might have knowledge of the statistical tests, but not actually understand the content of the biology ... another might have expertise in the biology but not in the statistics."

Tampered peer review is a serious infringement on the reliability of a study.

Tampered peer review is a serious infringement on the reliability of a study. Bowdish believes that the reviewers selected for Mawson's work did not adequately encompass the expertise needed to review such a paper. For example, the reviewers included a chiropractor, who lacked expertise in neurodevelopmental disorders, epidemiology, and vaccinations. Another was an epidemiologist, who lacked expertise in vaccine safety and neurodevelopmental disorders.

Despite the oversight in peer review, the study's extensive flaws provoked a retraction by the original publisher, Frontiers of Public Health. According to Bowdish, papers can be retracted for many reasons, including misinterpretation of conclusions and biases in the peer review process. If a study has been retracted "it should be struck from the record," Bowdish said. "Because if it's retracted, there are issues so large that it's not trustworthy."

Mawson's team later re-published their study in the Journal of Translational Science, which also reportedly retracted the study [10]. However, there is no retraction warning when accessing the text through their publisher website [9], which leaves readers – like vaccine-questioning individuals who read VaccineTruther's tweet – unaware of the paper's scientific negligence.

While Mawson's study is an example of misinformation caused by rifts in the scientific and peer review process, vaccine misinformation can also originate from misinterpretations of study findings.

Twitter user @susan_welch7 tweeted a link [23] to a science news article titled "Mayo Clinic Doctor: Measles is a Natural Cancer Killer – why are we trying to eradicate it," written by alternative medicine journalist Bryan Hubbard on his website and magazine *What Doctor's Don't Tell You* [24]. Hubbard's article refers to clinical researcher Stephen Russell's research on oncolytic viral therapy – an emerging form of cancer therapy using laboratory-modified viruses that infect and kill tumour cells [25].

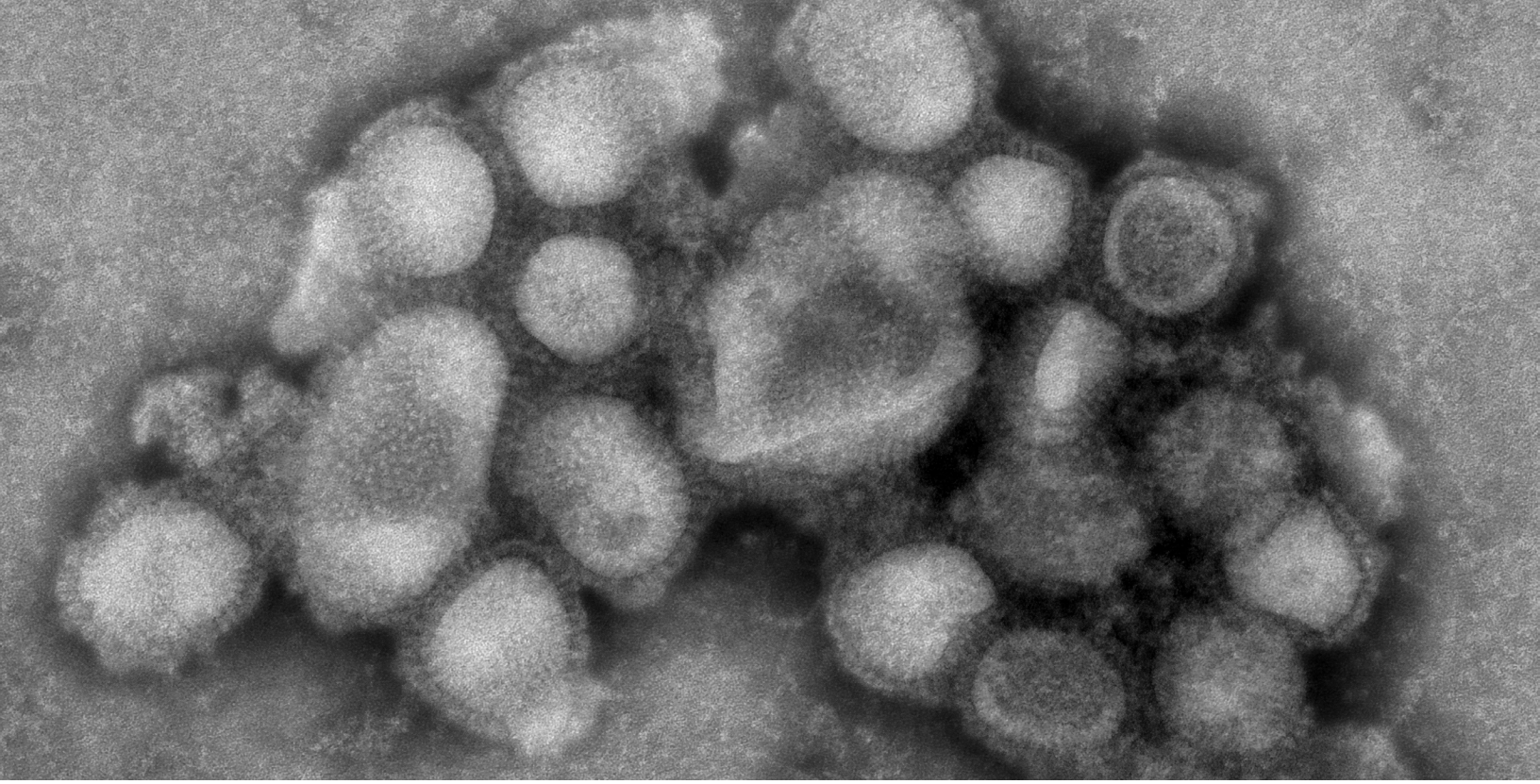
"Health authorities may want to think twice about eradicating measles," Hubbard writes. "Researchers are discovering that the virus can fight cancer."

Oncolytic viruses engineered from measles can be useful for treating blood cancers, which originate from immune cells [26]. However, the behaviour of the measles-derived oncolytic viruses differ significantly from its naturally circulating counterparts. Therapeutic viruses are typically genetically engineered or modified in the laboratory to enhance its ability to kill tumour cells and prevent the virus from infecting healthy tissues, as it would in a natural measles infection [27].

In Russell's study, the measles virus was used to target myeloma, a form of blood cancer [25]. Viruses were modified to allow them to selectively enter myeloma cells through a cancer-specific protein. This modification does not exist in naturally occurring measles [28].

Having a measles infection will do nothing to prevent cancer. Although there are rare isolated cases where a natural measles infection has contributed to tumour regression, which seems to have misled some people into thinking natural measles can be a "cancer cure." But this tumour regression is a rare phenomena restricted to patients with blood cancers only [29,30] and is likely an inadvertent effect of a severe measles infection non-specifically wiping out all immune cells – including cancerous ones.

The ability of measles to eradicate immune cell populations is part of why the infection can be so devastating [31].



Even when a patient recovers from measles, their immune system is weakened and loses its ability to recognize bacteria and viruses its seen before, leading to more infections in the future [32].

"[Measles patients] essentially go back to being a baby immunologically," Bowdish explained. "People who get measles are much more likely to need antibiotics in the next few years because they get serious infections. There is a very real link to dying from other infections."

Laboratory-modified oncolytic viruses like the ones developed through Russell's research are exciting new cancer therapies, but they are not credible evidence for keeping the naturally circulating measles strain like Hubbert suggests. There are real dangerous health consequences of the measles infection. Articles like Hubbert's may appear credible because they cite a scientific study, but they represent a major threat to science communication, incurring doubt to confuse and disorient readers from factual medical information.

Both Mawson's study and Hubbard's news report demonstrate how misleading academic studies and scientific news can be distorted to convince parents they should be skeptical of vaccines. Certainly, the purported scientific findings on vaccine dangers expressed in both of these articles would be deeply disconcerting to a parent concerned about vaccine risks, and are challenging to debunk without comprehensive experience in health science research.

The heart of the issue, as described by Bowdish, is that "if you need a PhD to be able to interpret the literature, then how are we going to make this more manageable for the lay public?" What can be done then, to curb the science misinformation crisis – especially in the context of vaccines?

> **"Because if it's retracted, there are issues so large that it's not trustworthy."**

Canadian guidelines now recommend healthcare professionals provide parents a balanced perspective on the benefits and risks of vaccines, which is a shift from previous strategies that focused largely on benefits of vaccines or debunking anti-vax claims [5]. There are indeed rare side effects to vaccines that should be recognized – although these risks are lower than risks associated with severe complications from vaccine-preventable diseases [2,33]. When parents are provided with a reputable unembellished understanding of vaccine risks, they will ideally be less likely to seek out potentially unreputable vaccine risk information online, such as Mawson's study or Hubbert's article.

As the open-access science movement grows, journals and scientists should also openly adopt writing lay abstracts for the general public to decrease the opportunity for misinterpretations like the Hubbert article. A 2019 3M survey on Canadian perceptions of science found that science scepticism was increasing: about one in three individuals were skeptical of science, with trust in individual scientists remaining around 60 per cent [34]. Researchers writing lay abstracts

directly to the general public, instead of relying on science journalism, may not only be helpful for reducing science misinformation but also bolster public trust in the science [35].

Finally, as more complex medical research becomes available through the internet, scientific literacy education should be leveraged to improve the public's ability to make evidence-based personal medical decisions. By educating people scientific studies exist on the characteristics that constitute quality scientific evidence, they may be less likely to be mislead by poorly designed studies.

Research from Stanford University found that high school students with strong scientific reasoning skills were more resistant to vaccination misinformation [36]. When presented with a biased science article, the students were able to identify misleading words, biased language, and flaws in logic. High schoolers that were the most susceptible to misinformation were the ones who lacked strong reasoning skills and were inclined to believe faulty logic and weak arguments based on the author's credentials alone.

By including a brief component on scientific reasoning and media literacy in public high school education, it could give future generations the tools to assess the vast medical information now accessible in the digital age.

Vaccine refusing parents who are convinced by unreputable information accessed on social media ultimately represent a fissure in science communication between the general public and the scientific community. There are unique science communication challenges brought on by the information flood that accompanied the digital age. Our methods of scientific communication and science education must evolve to face these challenges, to decrease the momentum of fear-based movements – such as anti-vax – which are rooted in science misinformation.

By promoting more public health campaigns with balanced perspectives, encouraging scientists to communicate their research to general audiences, and strengthening scientific reasoning education, we may be able to reduce health misinformation in the digital age.

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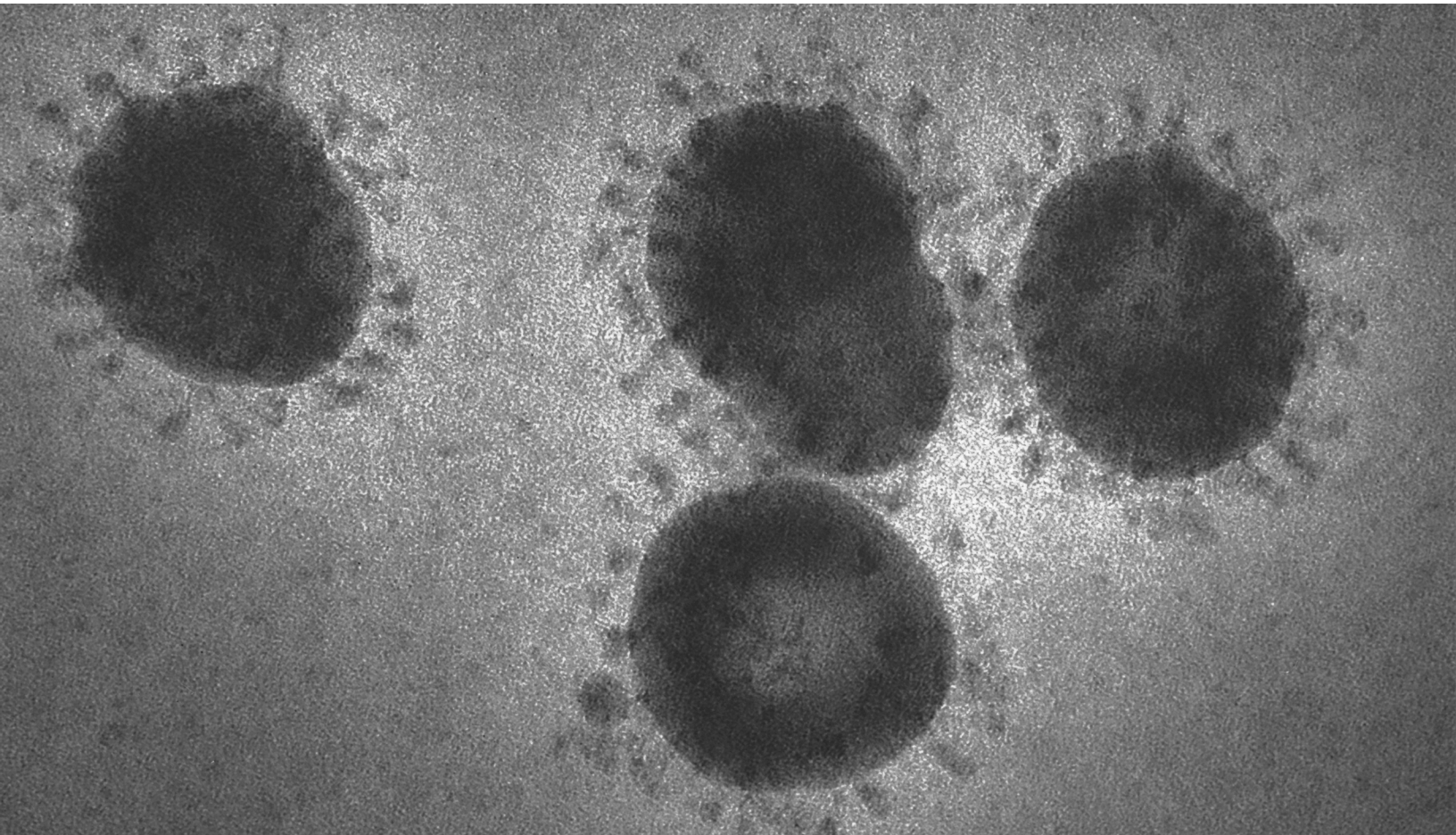

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