Since Edward Jenner’s day, there has been a steady improvement in vaccine science, including numerous advances in production, quality, efficacy, and safety. Vaccines have long been regarded as one of the most significant contributions to public health since clean water. Yet, for as long as there have been vaccines, there has been an anti-vaccination movement. The 18th century “anti-vaxxers” posed arguments eerily similar to those raised today. Twenty-first century anti-vaxxers repeat the same antiquated and discredited sentiments as did those in Jenner’s day, only with updated scare-tactics and more embellished “truths.” Although their claims are scientifically illogical, sadly, their propaganda has had a profound influence. The success of the anti-vaccine movements has not only led to a resurgence in measles, which was declared eliminated in the United States in 2000, but also threatens to reverse the progress made against other deadly infectious diseases. Although vaccines have steadily evolved, making great strides in controlling or eliminating many infectious diseases and improving our quality of life, their legitimacy is under ill-informed assault. However, as medical communicators, we can help restore collaboration between healthcare providers, vaccine manufacturers, and the general public by encouraging more effective, scientifically validated communication. Constructive communication strategies might help restore trust in medical authorities and combat the inaccurate narratives from paid celebrities and dubious social media platforms—the modern vehicles for ancient anti-vaccine messages.

Today, vaccines are dominating our health news, as once again, we face infectious diseases we thought were eradicated from our everyday lives. The World Health Organization declared that, next to clean water, vaccines are the single most important public health advancement in modern history.1 Despite this proclamation and our advances in medicine and science, however, the anti-vaccination movement has become more effective than ever. Even with our miraculous strides toward eliminating diseases that once devastated entire populations, we find ourselves, yet again, face-to-face with misinformed “anti-vaxxer” propaganda.

Presently, Ebola is spreading in the Democratic Republic of the Congo (DRC), where, for the first time since its discovery in 1976, a vaccine is available. Despite this momentous breakthrough, we find vaccine implementation hindered and distribution delayed by geographic challenges, financial shortcomings, political obstacles, and—worse still—by warring factions, disinformation campaigns, and anti-vaxxers. Failure to contain this currently isolated crisis could have adverse global impacts. After more than 2,000 Ebola deaths in the DRC, the outbreak has now spread into neighboring Uganda.2 Moreover, as the DRC fights Ebola—and cholera—they are also now fighting measles! Since January 2019, more than 100,000 measles cases, entirely preventable by vaccine, have claimed the lives of an additional 3,000 Congolese.3,4

To find the origins of the anti-vaccination movement, we need only to look at the first vaccine and the public health program that was initiated to rid the world of what was then its most deadly and destructive infectious disease: smallpox.

A HISTORY OF VACCINES
Smallpox, a virus believed to have jumped species from animals to humans, has ravaged mankind since the time of the ancient Egyptians, killing 20% to 30% of an affected population with each outbreak. The disease would devastate a community, leaving its survivors permanently scarred with pox marks from erupted skin pustules anywhere on their bodies. Permanent blindness was also a common complication—but at least the survivors were immune and spared from repeating the horror when it returned. And it did return—repeatedly.5

Before Vaccination, There Was Variolation
For centuries, people realized that if they survived, they would be immune. So much so that early Eastern and Middle Eastern
The practice can be traced back to 1,000 BC in India and to 16th century China. Historians credit Lady Mary Wortley Montagu, a severely scarred smallpox survivor and wife of an 18th century British diplomat posted in Turkey, with introducing variolation to Great Britain. Wanting her children to be spared infection, Lady Montagu had them variolated in Constantinople.6,9

Variolation had much room for improvement (Table 1).5,8 The practice was neither standardized nor regulated, and worse still, left the severity and complications of the illness, which was preferable to becoming infected naturally.5

Variolation had much room for improvement (Table 1).5,8 The practice was neither standardized nor regulated, and worse still, left a significant number of people with syphilis. Although under normal circumstances syphilis was sexually transmitted, this incurable disease, which was considered to be the second biggest scourge of the day, was transferred to healthy individuals through smallpox variolation.5 However, when you consider the consequences of a smallpox outbreak, you can understand why so many people, even knowing the consequences, willingly agreed to variolation. It did not guarantee an ideal outcome, but at least it offered hope (Table 2).8,48,49

### Table 1. Smallpox and the Anti-Vaccine Movement

<table>
<thead>
<tr>
<th>Path of Infection</th>
<th>Natural Infection8</th>
<th>Variolation8</th>
<th>Vaccination8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smallpox Mortality Rate</strong></td>
<td>20%-30%</td>
<td>Approximately 2%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Typical Disease Manifestations</strong></td>
<td>• 1/3 of all survivors were left blind</td>
<td>• Usually a somewhat milder infection, but no guarantee</td>
<td>• Smallpox was completely avoided, and the cowpox infection only produced a few small temporary pustules of the hands</td>
</tr>
<tr>
<td></td>
<td>• Most survivors were left permanently and severely scarred</td>
<td>• Survivors were often left with significant scarring</td>
<td>The cowpox infection that made a person immune to smallpox was not contagious to others</td>
</tr>
<tr>
<td></td>
<td>• Illness was very contagious to others who were exposed to an active infection</td>
<td>• An active, even mild variolation infection was contagious to others, and the transmitted infection could be severe</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Pro- and Anti-Variolation Sentiments

#### The Variolation Conundrum

Although variolation was not without risks to the person variolated (as well as others exposed to them while it ran its course) and did leave a patient with permanent scarring, it seemed a preferable alternative to the disease manifestation via natural infection. Yet there was a significant opposition to the practice, and those arguments sound very similar to the so-called modern anti-vaccine movement.

#### The Pro-Variolation Crowd

Not unlike today’s celebrity endorsements of a position, the variolation proponents had endorsements from Benjamin Franklin, who lost a child to smallpox, as well as Thomas Jefferson, who had his entire family variolated and then vaccinated when that process became available. The importance of infectious diseases and its societal effects were not lost on Gen. George Washington. In 1775, when he was commander of the Continental Army, he recognized the devastating effects disease could have on an army’s readiness, and he ordered all of the Revolutionary War troops that had not previously been diagnosed with smallpox to undergo variolation. The technique they used is described as removing the fresh pus from a smallpox pustule, adding it to water, and soaking a thread and needle in the water. The needle and thread were then threaded under the skin of the person to be inoculated.8

#### The Anti-Variolation Movement

When variolation was introduced in the United States, there was a significant, and on occasion violent, opposition to it. In 1721, during the height of the Boston smallpox epidemic, Massachusetts Rev. John Williams wrote that these inoculations were the work of the devil.48 That same year, a bomb was hurled through the window of a different Boston minister. Attached to the explosive was the message: “Cotton Mather, you dog, dam you! I’ll inoculate you with this; with a pox to you.” Fortunately, the explosive didn’t detonate.49 The attack on the reverend was not a religiously motivated act of terrorism. It was a violent response to Mather’s active promotion of smallpox inoculation. Clearly before there were vaccines and anti-vaccine sentiments, the anti-variolation movement was already actively engaged in their own war against medical progress.
as a milkmaid’s.” However, Jenner was the first to be credited for discovering that acquiring mildly irritating cowpox protected a person from contracting the more lethal smallpox. He successfully demonstrated that a smallpox infection could be prevented by inoculating a person with the material from a cowpox pustule. To distinguish his new process from variolation, Jenner named it vaccination.6,7,11

**Timing Is Everything**

Despite centuries of variolation, smallpox still ravaged 18th century Europe. It claimed more than 400,000 lives each year and left almost one-third of its survivors blind and nearly all permanently scarred.7 During that century, 4 European monarchs died from smallpox, and so many heirs to the Hapsburg throne perished that the lineage changed 4 times.12 Even as Jenner conducted his cowpox experiments, a severe smallpox outbreak devastated the Spanish court, causing King Charles IV to order the entire royal family variolated. In 1798, the king went so far as to issue an edict to variolate every citizen in Spain. This decree was controversial, as the risks and consequences of variolation were notorious. As fortune would have it, King Charles was presented with a copy of Jenner’s work. It so impressed the king that he mandated the variolation decree to be switched to vaccination. So, by 1800, nearly all of Spain had been vaccinated.12,13,14 Unfortunately, despite (or perhaps because of) their enormous success, the seeds of the anti-vaccination movement were planted.11,13,14

Back then, as now, politics played a significant role in public health matters. Smallpox was not the only problem plaguing King Charles’ reign. Napoleon’s armies invaded Spain, and the British, under Lord Nelson, defeated both the Spanish and the French at Trafalgar. Economically, Spain was dependent on its New World colonies; however, because smallpox was sweeping its colonies and disrupting productivity, the Spanish treasury suffered. The king and the entire Spanish monarchy not only had an image problem but also a financial one. A solution to address both was thus designed and deployed: a smallpox vaccine expedition.12,14

The world’s first public health vaccination program was launched. From 1804 to 1810, the Spanish Royal Expedition, popularly known as the Balmis-Salvany Expedition, traversed the Americas and the Pacific, vaccinating hundreds of thousands of people across the Spanish colonies (Figure 1).11

They established vaccine boards, headed by government and Catholic Church officials, to keep vaccine production and programs continuing in every Spanish domain they visited. King Charles’ edict even provided vaccines to all citizens and residents throughout the Spanish Empire—free of charge.11,13,14

**Orphans: The Original Biomedical Vials**

As Jenner predated modern pharmaceutical practices—even predating the pharmaceutical industry—keeping his vaccine viable was a challenge from the start. Jenner devised a process whereby material was extracted from a pustule, preserved on a glass slide, and sealed with paraffin while under a vacuum. However, the process was not as effective or efficient as passing the virus directly “arm to arm” from a cowpox-infected individual to an uninfected individual. The Spanish authorities agreed, and arm-to-arm transmission became the distribution method of choice.12,13,15

Throughout history, there have been 2 societal groups long viewed as expendable: prisoners and orphans. Prisoners were large, took up space, ate a lot, and required armed guarding; orphans were small, ate less, and could be tended by a capable nun (yet another sacrificial group). So, with the Royal Medical Committee’s agreement, the Church’s blessing, and the king’s decree (but no ethical regard), orphans became the world’s first official biomedical transportation “containers.”7,11,16

Because the virus inside a pustule was only viable for 4 to 10 days and the voyage took weeks, serial inoculations would need to occur throughout the Atlantic crossing. Calculations were made, and 22 orphans, the orphanage rector, the medical team, and the crew boarded the ship to the colonies. Upon reaching Colombia, Balmis and Salvany, the expedition leaders, split up to expedite the mission (Figure 1). Salvany took a
group overland through South America, and Balmis sailed to Mexico and across the Pacific. Balmis left the original orphans who had sailed with him from Spain under the care of a bishop in Mexico. Both leaders acquired new orphans as needed throughout their voyages and overland treks. Once an orphan had fulfilled their purpose, they were left among the locals (unless prior arrangements had been made for them to return home).7,11

People who were vaccinated became immune to smallpox, avoiding even the mild case of smallpox to be expected with variolation, and, as a bonus, did not acquire syphilis.11 One would presume then that vaccination—a sure way to prevent the most dreaded disease known to humankind—would be an instant success, but one would be wrong: with vaccination came the anti-vaccine movement. Although vaccines and vaccination programs have evolved dramatically since Jenner’s day, surprisingly, the positions of the anti-vaxxer movements have not.11,15

THE ANTI-VACCINATION MOVEMENT

The First Anti-Vaxxers

The religious leaders of Jenner’s day were already split between those who supported and those who opposed first variolation and then vaccination. Even among practitioners of variolation, vaccination was met with mixed acceptance. Money played a significant role. Variolation had been a popular and profitable business for many of its practitioners. From the start, Jenner made his vaccines available free of charge to all physicians and set up vaccination clinics in his community for those who could not afford to be vaccinated.8,7,11 Profit is a strong motivator, and when interfered with, progress is often the enemy of the profiteer.

On more than a few occasions throughout their journey, the vaccine teams of the Spanish Royal Expedition met resistance in particular colonies in which the vaccine had arrived in advance. In those colonies, profiteers who obtained Jenner’s vaccine set up lucrative vaccination businesses. They were not receptive to having a public health campaign interfere with their profits—not even one with a king’s decree. It required intervention on the part of both royal and religious authorities to overrule the for-profit vaccine practitioners. Fortunately, with their backing, the Balmis-Salvany expedition succeeded in completing their objectives in every Spanish domain they entered.11,14,17

(As a side note, even though the anti-vaccine agitators, including the men of God, raised many religious and even financial objections to the first vaccination campaign, ironically, no one raised any ethical objections to their use of orphans as “biomedical vials.”18)

As Was Then, So Is Now

We fear it is not possible for any argument or any form of suasion to stay the tide of folly and ignorance which is now raging against one the most beneficent discoveries ever permitted to man. The chief actors in the anti-vaccination movement are men upon whom all statements of fact and argument would be wasted.19

This excerpt was from an editorial titled “The Anti-Vaccination Agitators,” published in the British Medical Journal on October 9, 1869.19,20 From the release of the first vaccine, the anti-vaccination movement plagued the medical community (Figure 2).50,51 So much so that in 1910, Sir William Osler, fed up with the activists, dared them to expose themselves to smallpox—and promised to pay personally for the resulting funeral expenses. His offer received no takers.21

As is the case today, opposition to vaccines then was not only manifested in financial, skeptical, and theological arguments but also in political and legal ones.21 In the mid-19th century, after Britain passed laws making it mandatory for parents to vaccinate their children against smallpox, anti-vaccine activists formed the Anti-Vaccination League. Their mission: to protect the liberties of the British people, which were being “invaded” by Parliament’s intrusive vaccination laws.22 The pressure these agitators exerted on the Parliament eventually compelled passage of an act removing penalties for not abiding by the vaccination laws and allowing parents who did not believe in vaccines to opt out.23

Today, the situation remains much the same. In the United States, mandatory vaccination requirements for school attendance and other licensed childcare facilities traditionally maintain our herd immunity. However, in recent years, there has been a rise in vaccination exemptions because of philosophical or personal beliefs.24,22 Because of these leniencies (which led to the worst measles outbreak in more than 20 years), in May this year the California State Senate passed a bill (SB-276) to tighten California’s school immunization law.26 Opponents of the bill called it unprecedented and a dangerous intrusion on the personal liberties of parents and their children. Some agitators called Senator Richard Pan, California’s bill sponsor, a tyrant and encouraged supporters to abandon the bill and save their souls. Others went so far as to label it a crime against humanity.27

Historically, the origin of misinformation starts with valid scientific debate28 based, one would hope, on accurate data presented after a rigorous peer review. Unfortunately, today’s debate around the safety and efficacy of vaccines calls that assumption into question. The premise of the current anti-vaccination movement is a fraudulent journal paper published in 1998 by British physician Andrew Wakefield. Even though
the Lancet eventually retracted Wakefield’s article in 2010,29 12 years of damage had already been done. By the time of retraction, the debate was spun to conform to the anti-vaxxer agenda. Through the power and momentum of social media and other news sources, fear of vaccines and myths against them were already well established worldwide.

Heard of the Herd?
Herd immunity is fundamental to the success of vaccination programs. Control of many vaccine-preventable diseases is contingent on a significant proportion of the population being immune.30 Depending on the disease, the percentage of individuals required to be vaccinated to achieve herd immunity in a community ranges from 30% to 95%.31 Individuals who do not vaccinate, whether they like it or not, are part of the herd; they are just unprotected herd members, relying on the rest of us who do vaccinate for their preservation.

Not only are unvaccinated children at higher risk of developing vaccine-preventable diseases than vaccinated children, they put at risk genuinely exempt children (eg, those too young to be vaccinated) as well as the medically exempt (eg, immunodeficient) populations of all ages.32,33

Victims of Their Success
Even though vaccines are one of the most successful contributors to global health34 and are among the top 10 most significant public health achievements of the 20th century,35 the advent of effective immunization has led to the re-emergence of anti-vaccine agitation. Ironically, because morbidity and mortality from vaccine-preventable diseases are at an all-time low,36 the reactions from vaccines (adverse health events attributed to the vaccine) appear to be more common than the diseases. This paradox has led many cynics to perceive vaccines as unnecessary and even harmful.37

As those deadly childhood infections that were so abundant in bygone days become rare (thanks to the schedule of vaccines available today), people grow complacent. They forget the devastation that so many of these diseases once wrought on populations worldwide. As complacency grows, so does distrust in vaccines—and with that, a resurgence in the anti-vaccination movements.21,38 Anti-vaccine sentiment gains momentum when the media allows widespread dissemination of false information, erroneous science, and anecdotal claims of harm from vaccines. With the amount of insanity disguised as science or good parenting posted all over social media and the Internet today (Figure 2), vaccination opposition can only be expected to become invigorated and gain momentum.

Hesitation Matters
The rise of global vaccine hesitation poses a dire threat to the health and lives of communities everywhere. For example, as a direct consequence of not reaching the immunization threshold for MMR (mumps, measles, rubella) vaccines, people of all ages have fallen victim to recent outbreaks of measles, which had been declared eliminated in the United States in 200039-43 (Figure 3).52

Research has shown that even pro-vaccination folks can become confused by all the anti-vaccine propaganda, leading them to question their choices. Because so many people lack a rudimentary understanding about vaccines, they are particularly vulnerable to the anti-vaxxer’s disingenuous crusades28,44,45 (Table 3).

THE ROLE OF THE MEDICAL WRITER
The benefits of vaccination extend far beyond the prevention of diseases. Vaccination makes good economic sense and
Table 3. Frequently Cited Anti-Vaccination Websites and Their Claims

<table>
<thead>
<tr>
<th>Website</th>
<th>Claims</th>
</tr>
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<tbody>
<tr>
<td><a href="http://www.facebook.com/StopMadatoryVaccinationNow">www.facebook.com/StopMadatoryVaccinationNow</a></td>
<td>“The history of vaccination is a history of collateral damage. The German documentary ‘Wir Impfen Nicht!’ - ‘WE DON’T VACCINATE!’ was produced by the German freelance journalist Michael Leitner. It demonstrates by means of official documents and statistics that no vaccination has ever had a positive, protective effect.” “WE DON’T VACCINATE!’ investigates the claims made by doctors, multinational corporations or public health officials, who promote vaccination as a safe and effective preventive medical intervention.”</td>
</tr>
<tr>
<td><a href="http://www.vaccinepapers.org">www.vaccinepapers.org</a></td>
<td>“Vaccinepapers.org provides detailed, science-based and objective information about the dangers of vaccines. We are most concerned about aluminum adjuvant toxicity and immune activation-mediated brain injury. Vaccinepapers.org is the first to make this hugely important scientific research accessible to the public.”</td>
</tr>
<tr>
<td><a href="http://www.stopmandatoryvaccination.com">www.stopmandatoryvaccination.com</a></td>
<td>“Vaccination is a medical treatment administered to an otherwise healthy individual. Virtually all other invasive medical interventions occur only once someone has fallen ill. Vaccination, like most medical treatments, involves some risk. And therefore it should be undertaken only after careful consideration of its risks versus its benefits. The dangers of vaccines are real, can be substantial and life-long, and for some, life ending.”</td>
</tr>
<tr>
<td><a href="http://www.thepopleschemist.com">www.thepopleschemist.com</a></td>
<td>“Parents should question vaccine safety and effectiveness by using vaccine exemption. Instead of using an unproven hypothesis to question parents who have opted out, pro-vaccine parents should be questioning the safety and effectiveness of vaccines. With dozens of vaccines being forced on the public, some healthy skepticism could go a long way toward raising a vibrantly healthy child... herd immunity is nothing more than a silly catch-phrase used to scare and bully parents into vaccinating their kids. Don’t fall for it parents, keep using the vaccine exemption forms to legally avoid them.”</td>
</tr>
<tr>
<td><a href="http://www.facebook.com/StopMadatoryVaccinationNow">www.facebook.com/StopMadatoryVaccinationNow</a></td>
<td>“Myth: The diseases for which one is vaccinated are deadly and without vaccination, we would have epidemics of these diseases with untold numbers of deaths. Do you know what is in a vaccine? Do you know why ALUMINUM - a powerful neurotoxin - is added to vaccines? Do you know why the brains of some children SWELL UP and then irreversible damage OR DEATH - is created after a vaccination? Get the truth before we are censored out of existence: watch Vaccines Revealed, a free 9-part series featuring over 20 vaccine experts: <a href="http://bit.ly/2o0b5Cp%E2%80%9D">http://bit.ly/2o0b5Cp”</a></td>
</tr>
</tbody>
</table>

Figure 3. States reporting measles cases in the United States in 2019. From January 1 to August 22, 2019, 1,215 individual cases of measles have been confirmed in 30 states. This is an increase of 12 cases from the previous week. This is the highest number of cases reported in the U.S. since 1992 and since measles was declared eliminated in 2000.\(^2\)

\(^a\) Cases as of July 18, 2019. Case count is preliminary and subject to change. Data are updated every Monday on the Centers for Disease Control and Prevention website.

CONCLUSION

As the authors of this article, we are not attempting to provide answers; our goal is to generate productive conversations. We are telling the story of the origin of vaccines and the anti-vaccination movement in the hope they may inspire conversations that lead to constructive and positive outcomes.

From studies conducted on competing media messages shown to parents about the safety of vaccines, we know that people respond to personal experiences, value systems, and levels of trust in healthcare professionals when deciding whether or not to vaccinate.\(^7\) Thus, to combat the scare tactics peddled by the
anti-vaccination agitators and persuade on the real risks and benefits of vaccines, perhaps we need to focus on those exact things: experience, values, and trust.

In our opinion, these data suggest that emphasis might need to be placed on building relationships within communities. As medical communicators, we have an opportunity to initiate understanding and collaboration between industry, healthcare providers, and the general public. We can try to encourage physicians to listen to their patients’ concerns without judgment and communicate vaccine messages that do not appear dictatorial or dogmatic. Maybe with sensitivity and empathy we can help parents move toward trusting medical professionals and health authorities again, and away from relying on the opinions and subjective truths of celebrities and their friends on Facebook. Perhaps then, such formidable viruses as measles and Ebola can be eradicated from our global communities once and for all.

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