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Review

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The Clinician’s Guide to the Anti-Vaccinationists’ Galaxy

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Abstract

In this paper we briefly review three common immunological misconceptions that feature prominently among anti-vaccinationists, and in turn, fuel patient and parental concerns, questions, and fears about vaccines. In particular, this Perspective covers a brief history of the anti-vaccine movement, and three common false immunological claims, namely, concerns over “antigenic overload”, the induction of autoimmunity by vaccines, and the value of “natural immunity” versus vaccine-induced immunity. This is followed by a review of the harms that have been done by anti-vaccinationists, and a call to action. Regardless of the motivation behind such fears and anti-vaccine sentiment, common fears and concerns relevant to vaccines are evident and therefore are the subject of this Perspective. It is hoped that clinicians will find this information useful in answering concerns and misconceptions about vaccines, and in educating their patients.
Preface

Vaccines have been a modern miracle of science that have saved many millions of lives, eradicated one disease (smallpox), controlled many other infectious diseases, and improved our quality of life. Vaccine-preventable diseases now occur in the developed world at a fraction of the rate they occurred before the introduction of vaccines. Despite this, the routine use of vaccines is threatened by a spectrum of fears, mis-information, and anti-vaccinationist propaganda. In this article we discuss some of the most common misconceptions about vaccines and provide information that clinicians might find useful in countering anti-vaccine claims.

Despite the fact that the routine use of vaccines over the last century has led to a marked decrease in the incidence of vaccine-preventable infectious diseases and epidemics, widespread suspicion, mistrust and anti-vaccine sentiment are at surprisingly high levels in the United States, Western Europe and even developing countries within Africa, India and others. Although vaccines have frequently provoked fears and anti-vaccine sentiment since their introduction (as discussed below), the resulting decrease in vaccine uptake might have more severe consequences today than at any other time in the past. The effects of vaccine refusal today are exacerbated by increased risks of exposure due to the extent of global travel unprecedented in the history of humankind, the lack of immune boosting from subclinical infection with wild viruses or bacteria that cause epidemic diseases (such as measles, mumps, rubella and pertussis) owing to the success of vaccination, and increases in the number of individuals with increased susceptibility to these diseases (such as the elderly and immunocompromised persons), and situations in
which humans are crowded together (schools, training camps, sporting and musical
events, airplanes, indoor shopping malls, etc.). Together, these factors result in increased
risks for epidemics of vaccine-preventable infectious diseases, as shown by recent
outbreaks of measles, pertussis, and varicella, among other vaccine-preventable diseases,
in the United States, Europe, and elsewhere [1-8]. For example, recently, two individuals
with measles walked through the Superbowl Village in Indianapolis, and thus far 13
known cases of measles have resulted [9].

Why, despite decades of data demonstrating vaccine safety and efficacy, do anti-
vaccinationists and vaccine fears exist? We acknowledge that a spectrum of anti-vaccine
feelings exists from those fearful of real (but rare) or unsubstantiated vaccine side effects,
to those with differing or conflicting values, those who are un- or mis-informed, those for
whom innumeracy is an issue [10] (those who do not have an in-depth understanding of
probability or statistics), denialists [11] (those who simply refuse to believe the data),
those with low complexity cognitive styles (simplistic assumptions uncritically accepted,
such as those associated with conspiratorial thinking, or whose information comes from
uncritical acceptance of media reports from celebrities, and others), and finally those for
whom the anti-vaccine movement represents a “life cause” often because they or
someone they know has suffered or fears a real or perceived vaccine injury. Regardless
of the motivation behind such fears and anti-vaccine sentiment, common fears and
concerns relevant to vaccines are evident and therefore are the subject of this Perspective.
We believe that clinicians should be aware of these issues so that they might have an
educational role in dealing with these concerns, fears, and misconceptions. While we
hope this information benefits clinicians dealing with individuals from across the spectrum of concern, many of our comments are focused specifically on those at one end of the spectrum that we would label as “anti-vaccine.”

The title of this article emphasizes the communication divide that exists between scientists/clinicians and anti-vaccinationists. We have found (and we have heard the same from our colleagues) that discussions with anti-vaccinationists are otherworldly and alien as the anti-vaccinationists reject the scientific method and the peer-reviewed literature. Given that many of the claims of anti-vaccinationists appear to be immunological in content, it is fitting that clinicians have an understanding of the anti-vaccinationists’ claims as well as references to the evidence that refute those claims. Thus, with apologies to Douglas Adams [12], we provide “The clinician’s guide to the anti-vaccinationists’ galaxy.”

We begin by acknowledging that experience and history convince us that we have little hope of converting the true anti-vaccinationists into vaccine “adopters.” However, clinicians can play a part in influencing health care practitioners, political leaders, the media, the public, and ultimately patients and parents, to consider the scientific method and peer-reviewed literature. Reassuringly, the evidence indicates that most individual patients and, in the case of children, their parents—whether they follow the recommended vaccine schedule or not—are seeking to weigh benefits and risks for their children in an effort to do their very best for their children [13]. A recent survey shows that more than 80% of parents report healthcare providers are among their top three
sources of vaccine information [14]. Providing patients the right information, at the right
time, will help them make informed decisions, and perhaps prevent undue influence by
anti-vaccinationists.

**History of the anti-vaccine movement**

Anti-vaccinationists have existed since the beginning of vaccine use. Edward Jenner and
Louis Pasteur faced fierce opposition to their vaccines for smallpox and for rabies,
respectively [15,16], just as proponents of variolation (deliberate controlled infection
with smallpox virus) did before them [17]. In Britain, by the 1850s, an anti-vaccination
league had formed to oppose compulsory smallpox vaccination, and in the decades that
followed, similar organized efforts arose across Europe and the United States; indeed,
there are marked similarities between the anti-vaccinationists of the 19th century and
those of today [15]. Examples of shared arguments across the ages include the ideas that
vaccines cause life-threatening disorders themselves, have highly toxic constituents, and
fail to impart durable immunity unlike the diseases they are designed to prevent [15].
Thus, we must understand that opposition began with the first vaccines and we should
expect it to continue—even in the face of overwhelming data and scientific evidence to
the contrary.

Unlike those of the 19th century, no individual or group today actually uses the term
“anti-vaccinationist” self-referentially. Instead, groups take on names such as Generation
Rescue, Global Research, Moms Against Mercury, SafeMinds, The Informed Parent, the
National Vaccine Information Center, Vaccination Liberation, and ChildHealthSafety [18-20].

Indeed, some of the most strident anti-vaccinationist groups claim to support vaccination. For example, the National Vaccine Information Center states in its “Frequently Asked Questions” section that it is not “anti-vaccine” and it “supports the availability of the safest and most technologically advanced vaccines [21].” Many anti-vaccination organizations take on names to suggest that they are information resources rather than the political action and advocacy groups that they are (e.g., the National Vaccine Information Center, AskDrSears.com, VaccineInfo.net, Vaccination News, and ChildHealthSafety).

In this Perspective, we use the term “anti-vaccinationist” to specifically describe those who oppose vaccines in an unscientific manner, and who, through their activities, reject vaccines and vaccination and furthermore deny or unfairly disparage the peer-reviewed scientific literature, the evidence at hand, the scientific method, and even the motives of those who produce, recommend and provide vaccines.

**Common false immunological claims**

A foundational argument of anti-vaccinationists is that vaccines are unsafe, an idea that is supported by those members of the public who feel that they or their loved ones were injured by vaccines. We focus on three of their most common claims that vaccines cause undue harm as a result of: 1) antigenic overload; 2) an unacceptable rate of autoimmune disorders; and 3) less safe immunity than natural infections. As we discuss, these claims are false, and we review the clear and unambiguous data against them. However, the
scope of the anti-vaccinationists go beyond these immunologic claims and we cannot
address all of them here. Of note, however, is that their “immunologic” rhetoric has
impinged upon a sister domain of allergen-immunotherapy and we encourage readers to
access Jason Behrman’s well written article entitled, “The anti-vaccination movement
and resistance to allergen-immunotherapy: A guide for clinical allergists” [22].

Antigenic overload

Clinicians should be aware that a major recurring claim among anti-vaccinationists is that
children receive too many vaccines (“too many, too soon”) and that this results in
“antigenic overload.” Robert W. “Doctor Bob” Sears writes on his website, “Wait until
their (babies’) immune system is a little healthier before you overload them with so much
[23,24].” The concept of “antigenic overload” holds that humans (particularly infants and
young children) are incapable of responding safely to the “large number” of vaccine
antigens given. As an example of how widespread this notion is, among 236 parents
claiming at least one non-medical exemption for their children in Wisconsin, USA,
64.9% endorsed the statement that “I am concerned that children’s immune system (sic)
could be weakened by too many immunizations;” disturbingly, among 727 parents whose
children were up to date with the recommended vaccines, that statement was still
endorsed by 33.7% of parents [25]. The anti-vaccination argument further suggests that
the timing of the vaccines with regard to children is “too soon” for the “immature
immune systems” of infants and children who are not able to process multiple vaccine
antigens. The concept is simple, winsome and memorable to otherwise scientifically
uninformed parents. The anti-vaccinationists claim that antigenic overload results in a
“cytokine storm” or “immune cascade” that triggers adverse health events [26-28], though no scientific evidence supports such concerns that vaccines result in an antigenic overload that in turn triggers adverse health events. We distinguish this from the very real—but very rare—immunologic phenomenon that vaccines can through antigenic stimulation result in an IgE-mediated allergic or anaphylactic response; although again, the latter is rare and not based at all on the volume of antigenic exposure [29]. While he failed to cite any data to support his concern for antigenic overload, “Doctor Bob” Sears has capitalized on this claim [30]. In his 2007 book entitled “The Vaccine Book: Making the Right Decision for Your Child [31],” Sears offers alternative vaccine schedules that eliminate some vaccines and delay others, often for years after they are currently recommended by the Advisory Committee on Immunization Practices, the American Academy of Pediatrics, and the American Academy of Family Physicians [30,31]. The book has been in the Amazon Top 100 sellers and has been publicized by various high-profile celebrities including the chat-show host Oprah Winfrey on television in the past and is currently on the Oprah website [30,32].

Four major lines of evidence counter the concerns for antigenic overload. First, from the moment of their birth infants encounter numerous microorganisms and their antigens far exceeding the antigenic exposure due to vaccines in quantity and variety [33,34]. Second, pre-licensure studies of vaccine efficacy and safety include studies of the vaccines given in combination with the other vaccines in the routine vaccine schedule [33,34]. The data from these pre-licensure studies fail to support claims of overload in terms of symptoms and signs of illness. Third, post-licensure studies involving tens of thousands to millions
of children receiving the vaccine similarly fail to indicate evidence of antigenic overload or its consequences [33,34]. Fourth, infants and children actually receive far less antigenic “exposure” today with the routine childhood vaccination schedule than they did in the past [33,34]. For example, the smallpox vaccine given circa 1900 contained approximately 200 proteins, and the whole cell pertussis component of the diphtheria-tetanus-pertussis (DTwP) vaccine given in the United States up until the 1990s contained approximately 3,000 proteins [33]. By contrast, the current United States schedule of all 15 recommended vaccines from birth to age 5 years amounts in total to no more than 150 proteins and polysaccharides [33].

**Vaccines and autoimmunity**

A second claim often promoted by anti-vaccinationists is that vaccines can result in autoimmune diseases such as type 1 diabetes mellitus, multiple sclerosis and Guillain-Barre syndrome (GBS)—despite the fact that multiple high quality studies have failed to find systematic evidence of such associations. A recent Institute of Medicine review—by a panel of experts reviewing more than 12,000 published reports, failed to find evidence for the development of any of these three autoimmune diseases as a result of vaccines [35]. French public health authorities suggested an association between hepatitis B virus vaccination in female adolescents and multiple sclerosis, and as a result suspended the further use of the vaccine in this sub-group in 1998 [36,37]. Despite this fear, no association was found, and the suspension was lifted. This was an embarrassment to the French public health authorities who had banned the vaccine based on public pressure and anti-vaccine fears of an association, rather than scientific data. No scientific
association has been reported between hepatitis B virus vaccination and severe autoimmune diseases such as multiple sclerosis [35,38].

Similar studies have found no association between either multiple sclerosis or diabetes mellitus and vaccination [35]. The generally described theoretical basis for these autoimmune events is based on the hypothesis that a vaccine component “mimics” a human protein or cell component (either by sequence or conformational homology), and hence antibody produced to this vaccine component will also bind to its human analogue, and thereby produce damage and disease (or autoimmunity) from either auto-antibodies or T cells reactive to self-antigens. Such a mechanism of molecular mimicry as a cause for vaccine-related autoimmune diseases has not yet been demonstrated for any U.S. or European licensed vaccine component.

Nonetheless, rare temporal associations (not the same as causality) between autoimmunity and vaccines do exist, such as the possible association between GBS and the 1976 swine influenza virus vaccine [39], idiopathic thrombocytopenic purpura and the measles-mumps-rubella (MMR) vaccine [40], Acute Disseminated Encephalomyelitis (ADEM) and rabies vaccines made from rabbit CNS tissue [41] and myopericarditis and the smallpox vaccine [42,43]. The last two disorders are also associated with the respective wild-type virus infection and therefore it is not surprising that they are rare consequences of vaccination. The mechanisms for such effects are unclear and the topic of current study, and are likely different with regard to each vaccine, but to the extent such effects do exist (on the order of one excess case per million doses given), they are so
rare that more thorough studies of these associations have been impossible owing to the extremely low numbers of affected individuals, despite hundreds of millions of vaccine doses given [44,45]. In an attempt to address this issue, a new field of study entitled “adversomics” has developed. Adversomics aims to use the tools of immunogenetics, systems biology, immune profiling and bioinformatics to discover individual and common mechanisms for such vaccine side effects [46,47]. However, even with these new techniques, it is still unlikely that rare side effects can be studied adequately owing to the very, very low numbers of cases available for study.

As mentioned above, theoretically, molecular mimicry seems a possible mechanism whereby a vaccine antigen could result in the development of an autoimmune phenomenon, such as was proposed for the induction of arthritis after administration of the Lyme disease vaccine. The potential mechanism for how Lyme vaccine could induce arthritis has been recently discussed in detail [48], but can be simply summarized in that no data, including two large controlled studies, support such concerns, and no evidence supports the induction of arthritis by this vaccine [48-50]. In fact, the sheer volume and diversity of antigens presented during “natural” infection support the counterclaim that infections are more likely than vaccines to result in autoimmune phenomena, as is readily clinically observed—such as influenza virus infection causing GBS [51] and Campylobacter and other infections causing GBS [52]. It is therefore the case that infections, rather than the vaccines that protect against such infections, are far more likely to be potential inducers of autoimmune diseases [53,54].
Further, other immunologic consequences must result from vaccination if vaccines were somehow to lead to autoimmunity. These include the presence of T and B cells reactive to self, the presentation of self-antigens by HLA molecules in quantities sufficient to trigger immune reactions to self antigens—including quantities sufficient to activate autoreactive T and B cells, the down regulation of regulatory T cells that act to modify autoreactive immune responses, the production of cytokines necessary to lead to activation of autoreactive T and B cells, and others. Once antigen-bound autoantibodies are produced they can bind with Fc receptors and induce activation of the complement system. Either of these processes can cause activation of inflammatory cells and production of proinflammatory mediators, presumably leading to autoimmune disorders. To date, no evidence supports the idea that currently licensed vaccines lead to these consequences. Additional concerns have been raised that newer vaccine adjuvants could lead to some or all of the aforementioned phenomena [55]. While possible, no vaccine adjuvants currently licensed in the U.S. or Europe have been attributed as causative of autoimmune disease, and more data are needed as additional newer vaccine adjuvants are developed [45].

Natural immunity versus vaccine-induced immunity

A third common claim made by anti-vaccinationists is that immunity induced by “natural infection” is safer than vaccine-induced immunity. The data dispute such claims. For example, as discussed previously, the risk associated with developing GBS associated with the influenza virus vaccine could plausibly be as high as one case per million doses of vaccine administered [56] – though no such association has been confirmed since the
1976 pandemic vaccine [35]. By contrast, in the United States wild influenza virus kills approximately 1 in every 8,300 Americans per year (predominantly older persons), and in the United States from 2009-2010, the pandemic H1N1 influenza virus infection resulted in the loss of 2,000,000 years of life [57]. The influenza virus vaccine does not cause myocarditis, pneumonia, bronchitis, sinusitis, or significant amounts of lost work and school time, whereas it is quite clear that “natural” influenza can—and does—commonly cause these preventable morbidities.

Although wild “natural” virus infection can lead to superior immunity, per se, compared to vaccine-induced immunity at the individual level, a quantifiable price is paid by the population for only a small gain. For example, “natural” measles virus infection in an otherwise healthy host provides lifelong immunity but causes death in about 1 out of every 3,000 cases, as well as myriad other non-lethal and disabling complications. By contrast, the measles vaccine is, when appropriately administered as licensed, not associated with death (or at least despite billions of doses of vaccine having been administered, a risk of death is not detectable by statistical methods), or with other measurable complications of a life-threatening nature. In addition, with many, but not all, vaccines, the administration of booster doses can overcome the possibility of shorter-lived immunity induced after only one or two doses of vaccine. Furthermore, this is relevant at the public health level as those children and adults with immunocompromising illnesses cannot receive live viral vaccines, and therefore depend upon high coverage rates of the measles vaccine and high levels of immunity in the general population (so-called “herd immunity”) for protection from natural infection.
In the case of varicella (chickenpox), it is recommended that all children in the United States receive two doses of vaccine. The latest data (2009) from the National Immunization Survey shows that 89.6% of all children 19 to 35 months of age have received their first dose; the second dose is due at 4-6 years of age, but we have no national figures on the rate of uptake of the second dose [58]. Before we began routine vaccination against it, wild varicella zoster virus infection was the most common cause of vaccine-preventable death among children in the United States [59]. From 1990 to 1996, an average of 103 deaths from varicella were reported each year in the United States; since the addition of the vaccine to routine childhood immunizations in 1995, the number of deaths has been declining each year [60]. This compares with approximately 25 deaths a year in England and Wales, where routine vaccination against chickenpox is not practiced [61]. Furthermore, a major risk worth considering is that once infected with wild varicella zoster virus, infection becomes latent and chronically persistent in all persons infected. This results in the development of herpes zoster (shingles) in 20–30% of infected people later in life when reactivation of the virus occurs due to stress, immunocompromise or immunosenescence. By contrast, the rates of herpes zoster following varicella vaccination are substantially lower than after natural infection [62-64].

Thus, in summary, studies support the overall immunologic safety of routine childhood and adult vaccinations. No data support the concept of antigenic overload, and we are in fact exposing individuals to fewer antigens with the current vaccinations than in decades
past. Although rare phenomena suggestive of autoimmune sequelae have temporally occurred in association with routine vaccination, these risks, even if real, are dwarfed by the benefits of vaccination as well as the recognition that such autoimmune phenomena are more likely to occur after natural infection than after vaccination. Finally, the nature of the immunity offered by a vaccine against wild disease is sufficient to prevent infection and is far more safely obtained than immunity from natural infection.

**Harms done by the anti-vaccine movement**

We would be remiss to discuss these fallacies of the anti-vaccine movement without also addressing the impact that such fallacies have upon vaccination efforts. Public health officials hail routine vaccination as one of the top ten public health achievements of the 20th century [65], but anti-vaccinationists have successfully campaigned to block legislation for school and day-care mandates and other public health interventions designed to increase vaccination uptake. For example, it has been documented that pressure from the anti-vaccine movement worldwide resulted in nations that discontinued use of the pertussis vaccine, with 10 to 100 times more morbidity and mortality from pertussis than the countries that continued vaccination [66]. “Doctor Bob” Sears’ alternative vaccination schedule has resulted in significant under-vaccination, putting children at risk from circulating diseases, which is measurable in terms of increased rates of measles and pertussis [7,30,67,68]. Similarly, the impact of Andrew Wakefield, now widely recognized as fraudulently claiming an association between the measles virus vaccine and autism (see below), is evident in the perceptions of parents choosing to exempt their children from vaccination; in a Wisconsin survey of parents who refused
vaccination, 31% reported their reason for concern was autism [25]. Anti-vaccinationists create among otherwise informed and willing parents hesitancy that results in delay and, in turn, disease outbreaks [7, 66, 69]. With relatively cheaper and more global means of communication through the Internet, anti-vaccinationists now have the opportunity to spread their message more extensively [70, 71].

The impact of the anti-vaccinationists is not just a problem of wealthy countries, but threatens developing countries as well through the use of the Internet, which publicizes their false claims and lowers public confidence in vaccination throughout the world; this further raises the risk of pandemics and extensive outbreaks [72]. But most investigations into the psychosocial aspects of vaccination acceptability so far have been carried out in industrialized nations, and attention must be given to developing countries in this respect [73].

Most recently, the anti-vaccine movement readily and uncritically endorsed and accepted the fraudulent claims of Andrew Wakefield that receipt of the MMR vaccine was related to the development of autism spectrum disorders. In 1998, Wakefield and colleagues published in *The Lancet* an article entitled, “Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children [74].” The article claimed to report a newly identified association “of a pattern of colitis and ileal-lymphoid-nodular hyperplasia in children with developmental disorders.” Furthermore, while admitting they did not “prove an association between measles, mumps, and rubella vaccine and the syndrome described,” they proposed the possibility of a causal link and
furthermore suggested that we might find an increase in the syndrome they described following the introduction of the MMR vaccine [74]. The authors went on to state that virological studies were underway to test for a causal association between the MMR vaccine and the syndrome described [74].

Later in a comment in The Lancet [75] published in 1999, Wakefield cited a virology study published in 1995 as evidence for an association between measles virus and chronic intestinal inflammation [76]. In an effort to claim scientific rigor and academic integrity and accuse another of lacking both, he also cited a second study in which he participated from 1998 that did not detect measles virus RNA in inflammatory bowel disease [77]. However, to counter the negative study, he then cited a third study which he stated was strongly positive [78].

Wakefield’s claim of a lack of scientific rigor and of academic integrity was directed at the authors of one of the early epidemiological studies that demonstrated the lack of an association between MMR and autism [79]. In his argument, Wakefield used autism-incidence data from the UK and California (USA) to show what he claimed were “identical temporal trends … with the rise in autism from a steady baseline value, coinciding with the introduction of MMR vaccine as the single strategy in both countries that use the same diagnostic criteria for autism.” This was followed by a report co-authored by Wakefield in 2000 that this new autism-variant has certain features characteristic of persistent measles virus infection [80].
Numerous studies followed, however, demonstrating no association between MMR vaccination and autism [79, 81-89]. Despite these studies and evidence-based recommendations to dismiss the claims made by Wakefield by the U.S. Institute of Medicine [90] and others [91], and despite an early comment by investigators at the U.S. Centers for Disease Control and Prevention warning of the possibility of a cataclysmic “snowballing” of concern resulting from this publication, pandemonium ensued [81]. Such claims have now been thoroughly debunked, and Wakefield has been stripped of his medical license and censured [92-94]. Nonetheless, many from the anti-vaccine movement consider Wakefield a hero of the cause, and refuse to accept such data as fatally flawed and untrue. Indeed, J. B. Handley, co-founder of the autism support group called Generation Rescue, which disputes vaccine safety, told reporters, “To our community, Andrew Wakefield is Nelson Mandela and Jesus Christ rolled up into one ... He’s a symbol of how all of us feel [95].” Michael Shermer has written about this phenomena of why people have and maintain beliefs, despite data to the contrary, and has termed such phenomena “belief-dependent realism” (beliefs come first, explanations are then constructed to support such beliefs) composed of two processes: patternicity (finding meaningful patterns in meaningful and meaningless data), and agenticity (infusing patterns with meaning, intention, and agency). This, he maintains, leads to a positive feedback loop of belief confirmation, despite ample data challenging such beliefs, and a cognitive process that convinces one their beliefs are truths [96]. One of us (GAP) has written about the cognitive biases and preferred
cognitive styles people use in thinking about vaccines, and we have recommended approaches to dealing with these different styles [97].

Over the past 13 years since Wakefield first made these claims, the U.K., the U.S., Western Europe and other countries have experienced a decrease in measles and MMR vaccine uptake concomitant with increased rates of measles and mumps outbreaks [98-101]. Currently, in 2011, Europe is suffering major outbreaks of measles numbering more than 10,000 now in France and thousands more across the continent resulting in transmission to other continents including the Americas, Australia, and New Zealand [102-106]. The outbreaks in Europe now involve 33 countries. Even now—with the recognition that Wakefield had defrauded The Lancet, its readers, the scientific community, and the public—there are continued worries, even among a large percentage of parents whose children are up to date with the recommended vaccines, that vaccination might cause autism. Why do such concerns persist? Autism only becomes clinically apparent at an age typically only after a substantial number of vaccines are given, thus making vaccines suspect. Why vaccines? They are, for that parent, one of the few, if not the only, technologically sophisticated “treatments” the infant has received since birth. Why autism? It has emerged on the vanguard of parents fears; it is a devastating condition with no cure or prevention and really no understanding of its cause.

The problem, however, is bigger than the concern for autism. In a comparison of parents claiming non-medical vaccine exemptions for their children with parents of vaccinated
children in the U.S., substantial percentages of parents in both groups had persisting concerns about vaccine safety, particularly with relation to their benefits [25]. In a recent national survey, nearly 80% of primary care physicians in the United States reported at least one vaccine refusal a month and 8% of physicians reported that more than 10% of their patients’ parents refused vaccination [107]. Furthermore, perhaps fueled by fears of “antigenic overload” and by “Doctor Bob” Sears’ alternative schedule [30,31], nearly 90% of primary care physicians reported at least one request for spreading out vaccines and 20% reported that more than 10% of their patients’ parents had requested this [107]. Spreading out childhood vaccination can result in a delay in achieving immunity, permitting both a personal lack of protection as well as decreasing herd immunity. This is combined with the human tendency for delays to result in omissions and, for some vaccines, a delay might result in the inability to receive the vaccine at all (e.g., rotavirus vaccine has maximal ages for both starting and completing the series.)

**Conclusions and call to action**

Current data across all vaccines, across all age groups, and across all formal recommendations, indicate that vaccines are overwhelmingly safe in the vast majority of patients for whom they are recommended, and that they are effective and appropriate for the recommended use in each age group [35]. We recognize that no man-made product, including vaccines, is absolutely and completely safe or perfectly effective, but at both the individual and population levels vaccines that are licensed for use in the United States and elsewhere demonstrate extraordinarily high levels of safety and extremely rare rates of serious life-threatening side effects, with correspondingly great individual and
population-level benefits. Anti-vaccine concerns centered around false immunological
claims of harm or antigenic overload are specious and without scientific data to support
such claims. On the contrary, the available scientific data richly support the
immunological value of vaccines in substantially decreasing morbidity and mortality
owing to infectious diseases, and in improving the health of both individuals and
populations. Misinformation and lack of scientific understanding must be countered for
the public good, and the false information anti-vaccinationists spread countered. It is
hoped that clinicians can and will lend their expertise to this issue for the good of the
public health by first being informed themselves, and second, countering the false
immunologic claims commonly promoted by anti-vaccine groups. This commentary
provides a basic review of three of the most common anti-vaccine claims, and hence
could serve as an outline of topics that could inform further research, teaching seminars,
and continuing education courses for clinicians. By being informed about the charges
brought forward by anti-vaccine proponents, especially those of a quasi-immunological
nature, clinicians can assist in providing data-driven information to health providers and
the public, assist in research where data gaps are apparent, and provide data for the
scientific basis for accepting or refuting claims of vaccine safety and function. The only
rational way in which to proceed in devising individual and public health policy in
regards to the use of vaccines requires high quality studies and resulting data, interpreted
carefully and based on the scientific method. In this regard, physicians have a duty and
an important role to play in education, and the public health and vaccine debates.
Disclosures:
Dr. Poland is the chair of a Safety Evaluation Committee for an investigational vaccine trials being conducted by Merck Research Laboratories. Dr. Poland offers consultative advice on new vaccine development to Merck & Co., Inc., Avianax, Theracloine Sciences (formally Spaltudaq Corporation), MedImmune LLC, Liquidia Technologies, Inc., Emergent BioSolutions, Novavax, Dynavax, EMD Serono, Inc., Novartis Vaccines and Therapeutics and PAXVAX, Inc.

Doctor Jacobson is a member of a safety review committee for a post-licensure study funded by Merck & Co. concerning the safety of a human papillomavirus vaccine. He is also a member of a data monitoring committee for an investigational vaccine trial funded by Merck & Co. He also serves as a principal investigator for two studies, including one funded by Novartis International for its licensed meningococcal conjugate vaccine and one funded by Pfizer, Inc. for its licensed pneumococcal conjugate vaccine.
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