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Herd Immunity and Immunization Policy: The Importance of Accuracy

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INTRODUCTION

Unlike vaccine science, appropriate vaccine policy does not have a clear, evidence-based answer. The best policy for any given country is a complex question, and reasonable minds can differ on whether any type of mandate is appropriate and what form such mandate should take. Any such debates, however, lose their value when the arguments are premised on inaccuracies both in law and in fact. In *Herd Immunity and Compulsory Childhood Vaccination: Does the Theory Justify the Law?*,[1] Mary Holland and Chase E. Zachary criticize vaccine mandates—focusing on childhood immunization requirements for daycares and schools—claiming both that "herd immunity" is unachievable and that voluntary programs will achieve a satisfactory result.[2] The first claim is inaccurate, and the second is unsupported by the authors' analysis. While it is possible to plausibly oppose mandatory vaccination policies, Holland and Zachary fail to mount such a case.

This critique proceeds as follows: Part I highlights one glaring flaw in Holland and Zachary's legal analysis, viz., misunderstanding the nature of society's duty to children, Part II explains why the authors' view of herd immunity is incorrect, and Part III highlights a critical analytical shortcoming in their discussion.

I
VACCINES AND THE LAW: MISUNDERSTANDING THE STATE'S RESPONSIBILITY TO PROTECT CHILDREN

When addressing whether society has a duty to protect children, Holland and Zachary state that:

> The legal foundation for [an] implied duty [of care] is suspect, because there is no clear analog in common law criminal or tort systems for a duty to rescue, even when a person can do so at small or no cost to herself. If the common law is unwilling to impose liability on individuals toward strangers, [it] may be wrong as a matter of law to suggest that a mandatory [vaccination] program may impose a duty on all members of society to protect children.[3]

[1] Mary Holland & Chase E. Zachary, *Herd Immunity and Compulsory Childhood Vaccination: Does the Theory Justify the Law?*, 93 OR. L. REV. 1 (2014).

[2] *See generally id.*

[3] *Id.* at 38 (footnote omitted) (citing Ernest J. Weinrib, *The Case for a Duty to Rescue*, 90 YALE L.J. 247 (1980)).

The authors do not correctly characterize the legal framework behind the state's responsibility to protect children, the basis of which is not a tort-like duty. It may be that the term "duty" confused the authors; "responsibility" might be a better term. *Parens patriae*, the term used to capture the state's duty to its most vulnerable members, is not about whether a state can be sued for failing to protect a child.[4] The issue focuses on the state's—or society's—responsibility to safeguard children's welfare when parents cannot or will not meet some minimum standard.[5] The modern basis of the idea is that children are not property; they have rights and interests of their own, and the state may regulate parents' actions to safeguard those interests.[6]

Parens patriae is a basic and well-established concept. Its application in a specific case may be debatable, but the concept itself is not suspect in the least.[7] In the context of vaccines, the question is whether *parens patriae* justifies mandating vaccines in any way. In *Prince v. Massachusetts*, the Supreme Court—addressing a different issue—stated that a parent "cannot claim freedom from compulsory vaccination for the child more than for himself on religious grounds. The right to practice religion freely does not include liberty to expose the community or the child to communicable disease or the latter to ill health or death."[8]

The Court here highlights the interest of the child to be free of a preventable disease. These interests are given short shrift in Holland and Zachary's analysis. Part of the problem, as demonstrated in the section regarding "Promotion of a Familial Duty to Protect Children," is the seeming assumption that parents' duty to protect their children applies only to protection from the potential harms of vaccines.[9] The

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4 *See* Natalie Loder Clark, Parens Patriae *and a Modest Proposal for the Twenty-First Century: Legal Philosophy and a New Look at Children's Welfare*, 6 MICH. J. GENDER & L. 381, 382, 397–98 (2000).

5 Sarah Collins, Comment, *Unreasonable Seizure: Government Removal of Children from Homes with Drugs but No Evidence of Neglect*, 20 GEO. MASON L. REV. 631, 633–36 (2013).

6 Michal Gilad & Tal Gat, *U.S. v. My Mommy: Evaluation of Prison Nurseries as a Solution for Children of Incarcerated Women*, 37 N.Y.U. REV. L. & SOC. CHANGE 371, 394 (2013) ("[T]he state also has an obligation to protect the child's best interests and guard the general interest in the child's well-being under the doctrine of *parens patriae*."); *see also* Schall v. Martin, 467 U.S. 253, 263 (1984) (discussing the doctrine of *parens patriae* in juvenile proceedings).

7 *See* Clark, *supra* note 4, at 381–82.

8 Prince v. Massachusetts, 321 U.S. 158, 166–67 (1944) (footnote omitted).

9 *See* Holland & Zachary, *supra* note 1, at 37.

authors ignore parents' duty to protect their child against preventable, potentially fatal diseases such as *Haemophilus influenzae* type b (Hib), polio, measles, and diphtheria.

This problem is especially glaring as the risk of the diseases in question is an order of magnitude larger than the very rare chance that a modern vaccine will cause a serious, long-term problem. Examining one vaccine, a recent study of measles-containing vaccines highlighted problems caused by the vaccines including fever and febrile seizures.[10] Febrile seizures should not be confused with seizure disorders like epilepsy; febrile seizures are caused by fever, are surprisingly common among children, and, although frightening to parents, generally do not cause long-term harm.[11] The vaccine can also cause temporary low platelet counts in rare cases (about 1:40,000, according to the Center for Disease Control & Prevention (CDC))[12] and, very rarely (about 1.5 to 1.8 cases out of every million doses), can cause a severe allergic reaction.[13]

In contrast, just one of the diseases—measles—has a substantially higher rate of serious complications. According to the CDC: "Before the measles vaccination program started in 1963, we estimate that about 3 to 4 million people contracted measles each year in the United States. Of those people, 400 to 500 died, 48,000 were hospitalized, and 4,000 developed encephalitis (brain swelling) from measles."[14]

The CDC estimates that encephalitis will occur in one out of a thousand measles cases, and measles will cause death in about two out of a thousand cases.[15] Another rare but especially horrible complication of measles is subacute sclerosing panencephalitis (SSPE), in which, years after infection, the measles virus destroys the

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[10] Nicola P. Klein et al., *Safety of Measles-Containing Vaccines in 1-Year-Old Children*, 135 PEDIATRICS e321, e322 (2015).

[11] *Febrile Seizures Fact Sheet*, NAT'L INST. NEUROLOGICAL DISORDERS & STROKE, http://www.ninds.nih.gov/disorders/febrile_seizures/detail_febrile_seizures.htm (last updated Oct. 8, 2015); *see also* Klein et al., *supra* note 10, at e322, e325 (discussing the risk of febrile seizure).

[12] *Measles, Mumps, and Rubella (MMR) Vaccine Safety*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/vaccinesafety/Vaccines/MMR (last updated Sept. 28, 2015).

[13] Klein et al., *supra* note 10, at e326.

[14] *Frequently Asked Questions About Measles in the U.S.*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/measles/about/faqs.html (last updated July 31, 2015).

[15] CTRS. FOR DISEASE CONTROL & PREVENTION, EPIDEMIOLOGY AND PREVENTION OF VACCINE-PREVENTABLE DISEASES 210 (Jennifer Hamborsky et al. eds., 13th ed. 2015) [hereinafter PINK BOOK].

brain from the inside; this incurable complication inevitably leads to decline and a slow, lingering death.[16] SSPE is generally rare, but is more common in children under five.[17] A recent study in Germany found thirty-one children were infected in the years 2003–2009, for a rate of 1:1,700 to 1:3,300 in children under five.[18]

The balance of risks is as dramatic for other diseases, and when discussing the duty to protect a child, it is problematic to focus on the much more rare risk of vaccine injury and ignore the higher risks of the disease. There is a powerful argument that a child has an interest in being free from such diseases, and that the parental duty to protect the health of children extends to protecting them against such diseases, using vaccines. Similarly, the states' *parens patriae* powers can extend to protecting children from these diseases. This was acknowledged by federal and state courts in upholding school immunization requirements.[19]

Furthermore, in *In re Christine M.*, a New York family court found that not vaccinating a child during a measles outbreak amounted to neglect:

> [T]he legislative [sic] has already made a determination that inoculation of school age children against, inter alia, measles constitutes sound and necessary medical care. . . . [A] parent's knowing failure to provide such immunization, barring a bona fide religious exemption [Public Health Law section 2164(9)], can constitute medical neglect . . . . Moreover, a parent's knowing failure to have a child immunized against measles in the midst of a measles epidemic or outbreak clearly places that child's physical condition in imminent danger of becoming impaired . . . .[20]

In re Christine M. highlights that a parent's duty to protect his or her child can extend to immunization against disease, and that it may well

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16 *Id.* at 211.

17 *See* William J. Bellini et al., *Subacute Sclerosing Panencephalitis: More Cases of This Fatal Disease Are Prevented by Measles Immunization than Was Previously Recognized*, 192 J. INFECTIOUS DISEASES 1686, 1687, 1690 (2005).

18 Katharina Schönberger et al., *Epidemiology of Subacute Sclerosing Panencephalitis (SSPE) in Germany from 2003 to 2009: A Risk Estimation*, 8 PLOS ONE 1, 2, 8 (2013).

19 *See* Zucht v. King, 260 U.S. 174, 176 (1922). For an even stronger statement, see *Brown v. Stone*, 378 So. 2d 218, 223 (Miss. 1979) ("The relationship of parent and child is one in which the law concerns itself more with parental duties than with parental rights."). Courts have, however, also upheld a state's power to provide exemptions, provided the exemptions themselves are constitutional. *See, e.g.*, Dalli v. Bd. of Educ., 267 N.E.2d 219, 222–23 (Mass. 1971).

20 *In re* Christine M., 595 N.Y.S.2d 606, 613 (N.Y. Fam. Ct. 1992).

be legitimate for the state to step in and protect the child against disease over parental objections, at least in high-risk circumstances.

A second legal problem, only mentioned briefly—paralleling the short discussion it was given in Holland and Zachary—is the assumption that vaccination mandates undermine informed consent,[21] a concept that they seem to misunderstand. Informed consent governs a patient's autonomy in relation to her physician.[22] It protects a patient's right and ability to make medical decisions for herself and limits the ability of a physician to simply indulge his will.[23] This does not directly address the ability of the state to regulate personal conduct. Under informed consent, a doctor may be liable in tort if he or she fails to provide a patient with certain types of information upon which to base a decision.[24] A doctor may even be found guilty of criminal battery if he acted without consent.[25]

These protections, however, do not mean that such decisions will be free from consequences. A patient has the right, alongside the principles of informed consent, to refuse medical treatment.[26] For example, if a patient refuses to take medication to control epileptic seizures, a doctor may not force a patient to use the medication, but patient's refusal may lead to being denied a license to drive.[27] Likewise, one case decided that an individual may refuse treatment for tuberculosis, but may also be confined if he does.[28]

Applying the informed consent requirement to vaccination, doctors must provide parents the information needed to give informed consent before vaccinating their children. When these principles are applied, it is clear that the existence of state immunization mandates, or tort

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21 *See* Holland & Zachary, *supra* note 1, at 47–48.

22 *See* Richard A. Epstein, *Medical Malpractice, Imperfect Information, and the Contractual Foundation for Medical Services*, L. & CONTEMP. PROBS., Spring 1986, at 201, 201–03.

23 *See* Jaime Staples King & Benjamin W. Moulton, *Rethinking Informed Consent: The Case for Shared Medical Decision-Making*, 32 AM. J.L. & MED. 429, 438–39 (2006).

24 *Id.*

25 *Id.* at 439.

26 *E.g.*, Cruzan v. Dir., Mo. Dep't of Health, 497 U.S. 261, 278 (1990).

27 *See State Driving Laws Database*, EPILEPSY FOUND., http://www.epilepsy.com/driving-laws (last visited Oct. 10, 2015).

28 City of Newark v. J.S., 652 A.2d 265, 278–79 (N.J. Super. Ct. 1993). Similar laws exist in a number of states. *See generally* OSCAR A. CABRERA ET AL., CTRS. FOR LAW & PUB.'S HEALTH, EXPRESS TUBERCULOSIS CONTROL LAWS IN SELECTED U.S. JURISDICTIONS (2008), http://www.cdc.gov/phlp/docs/Centers_Report-Express_TB_Control_Laws-Final.pdf.

liability if one's negligent failure to vaccinate infects another, does not violate or interfere with the informed consent requirement.

II
GETTING THE SCIENCE RIGHT

For conciseness, this Article focuses on Holland and Zachary's major flaw in attempting to characterize the science: the argument that herd immunity is unattainable.[29] As a general proposition, this is simply wrong. Holland and Zachary base their claim on an ersatz theoretical analysis and then apply it to two major examples, measles elimination and the varicella (chickenpox) program, in an attempt to show that herd immunity has been demonstrated a failure in these instances.[30] Their initial premises are wrong, and their description and analysis of the examples are highly misleading and incorrect.

A. Flawed Premises

Holland and Zachary attempt to distinguish *herd immunity* from the *herd effect*, but their definition does not match their source. They define, by fiat, herd immunity as "refer[ring] to the complete removal of a disease from society."[31] This overstates the definition adopted by T. Jacob John and Reuben Samuel in the paper Holland and Zachary rely upon, which highlights and includes reduced transmission as a result of herd protection.[32] In other words, achieving herd immunity does not necessarily mean zero cases; for example, as Holland and Zachary mention, diseases can be imported.[33] Signifying reduced transmission is also the way the term is used in other sources.[34] What achieving herd immunity levels *does* mean is that an isolated case or several cases will not spread far and can be readily contained. For example, measles was declared eliminated in the United States in 2000 and rubella in 2004, even though isolated cases—especially via

29 *See* Holland & Zachary, *supra* note 1, at 4.

30 *See id.* at 19–28.

31 *Id.* at 8–9.

32 T. Jacob John & Reuben Samuel, *Herd Immunity and Herd Effect: New Insights and Definitions*, 16 EUR. J. EPIDEMIOLOGY 601, 602–03 (2000).

33 Holland & Zachary, *supra* note 1, at 20.

34 *See, e.g.*, Daniel R. Feikin et al., *Individual and Community Risks of Measles and Pertussis Associated with Personal Exemptions to Immunization*, 284 JAMA 3145, 3150 (2000); Paul Fine et al., *"Herd Immunity": A Rough Guide*, 52 CLINICAL INFECTIOUS DISEASES 911, 911 (2011) ("[I]ncidence of the infection would decline if the proportion immune exceeded . . . ."); Susan van den Hof et al., *Measles Epidemic in the Netherlands, 1999–2000*, 186 J. INFECTIOUS DISEASES 1483, 1485 (2002).

importation—were still occurring.[35] To assert that herd immunity for these diseases was not achieved because of these cases is incorrect.

Holland and Zachary's "definition" of *herd effect* also does not correctly reflect their source. They define it as a decrease in the ability of a disease to spread because some members of society have immunity.[36] John and Samuel, however, define it as "the reduction of infection or disease in the unimmunised segment as a result of immunising a proportion of the population."[37] In other words, the focus of the herd effect in the context of public health is on active efforts to immunize the population with the goal of reducing disease. It is not herd immunity, but less.

Holland and Zachary also claim that several limitations of the theory of herd immunity mean that it is invalid in practice, but, as described in the following pages, this claim does not fit the data.[38] Nor does the paper they rely on, *"Herd Immunity": A Rough Guide*,[39] support the conclusion that these real-world limitations mean that herd immunity does not work. In fact, Paul Fine et al. highlight that achieving herd immunity meant the concept had to be refined and rethought in response to these challenges.[40] For example, imperfect immunity does not mean herd immunity is impossible; it means that "[i]f vaccination does not confer solid immunity against infection to all recipients, the threshold level of vaccination required to protect a population increases."[41] The theoretical challenges also mean that practical public policy needs to be adjusted to achieve herd immunity.[42] In other words, these problems may suggest a need to refine the theory and adjust practice, but they do not negate the idea.

The threshold for herd immunity, most simplistically, varies by how contagious a disease is and the effectiveness of the vaccine in vaccinated populations. The more contagious the disease, the higher the percentage of people that need to be immune in order to achieve

35 Mark J. Papania et al., *Elimination of Endemic Measles, Rubella, and Congenital Rubella Syndrome from the Western Hemisphere: The US Experience*, 168 JAMA PEDIATRICS 148, 149 (2014).

36 Holland & Zachary, *supra* note 1, at 8–9.

37 John & Samuel, *supra* note 32, at 603.

38 Holland & Zachary, *supra* note 1, at 19; *see also* discussion *infra* Parts II.A, II.B.

39 *See* Holland & Zachary, *supra* note 1, at 10–19 (relying in part on Fine et al., *supra* note 34).

40 Fine et al., *supra* note 34, at 913–14.

41 *Id.* at 913.

42 *Id.* at 914.

herd immunity; the more effective the vaccine, the higher the likelihood of reaching that percentage.[43]

While there may be difficulties in complete elimination of a disease from society in some contexts—pertussis being a good example—substantial disease reduction or even elimination can, and has, been achieved for certain diseases.[44] This is part of what allows the anti-vaccine movement to remain endemic. As the Court observed in *Bruesewitz v. Wyeth LLC*, "vaccines became, one might say, victims of their own success. They had been so effective in preventing infectious diseases that the public became much less alarmed at the threat of those diseases, and much more concerned with the risk of injury from the vaccines themselves."[45]

For many diseases, herd immunity has led to their virtual disappearance from the United States, or at least their dramatic reduction. Sources of evidence include the drop in the number of cases of these diseases after vaccine introduction, as well as more direct studies. For example, in the years since vaccines became available, cases of polio, Hib, diphtheria, and other diseases that we vaccinate against dropped dramatically. In the years leading up to the development of the Salk vaccine, there were increasingly frequent summertime waves of tens of thousands of cases of wild-type polio—which the United States has not had a single case of since 1979.[46] Likewise, Hib incidence dropped from an average of twenty thousand cases per year in the prevaccine era to an average of twenty known type b cases per year from 2003 to 2010, and fourteen known cases, and another thirteen estimated cases, in 2011.[47] Annual diphtheria cases also dropped from between one hundred thousand to two hundred thousand before introduction of the toxoid vaccine to one to two per year between 1980 and 2011.[48] Most recently, rubella was declared eliminated in the Americas, directly due to vaccination.[49]

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43 *News & Views: Herd Immunity and Vaccine Duration*, CHILD. HOSP. PHILA. (Nov. 3, 2014), http://www.chop.edu/news/herd-immunity-and-vaccine-duration#.Vf8FtbRIKop.

44 For example, measles and rubella have been eliminated in the United States. Papania et al., *supra* note 35, at 149.

45 Bruesewitz v. Wyeth LLC, 562 U.S. 223, 226 (2011) (footnote omitted).

46 PINK BOOK, *supra* note 15, at 301 ("The last cases of paralytic poliomyelitis caused by endemic transmission of wild virus in the United States were in 1979, when an outbreak occurred among the Amish in several Midwest states.").

47 *Id.* at 123–24.

48 *Id.* at 112.

49 *Americas Region Is Declared the World's First to Eliminate Rubella*, PAN AM. HEALTH ORG. (Apr. 29, 2015), http://www.paho.org/hq/index.php?option=com_content

Measles, an extremely contagious disease, previously infected, on average, an estimated three to four million people a year in the United States.[50] Thanks to an extremely effective vaccine, the number of cases fell to fewer than two hundred by 1997.[51] As pointed out in the CDC's *Pink Book*, since the adoption of a second dose of measles, mumps, and rubella (MMR) for school children, "measles outbreaks in school settings are now uncommon."[52] For the most part, for an extended period of time the combination of an effective vaccine and high immunization rates protected those few children left unvaccinated because of parental choice, medical problems, or failure of the vaccine to induce a protective response: this is what herd immunity does. In recent years, we have seen more outbreaks—many in unvaccinated communities where herd immunity is undermined.[53]

The reason that widespread outbreaks of vaccine-preventable diseases have not been seen is mostly because herd immunity works. As pointed out by Holland and Zachary, vaccination rates have never been 100 percent; moreover, no vaccine is 100 percent effective (although most childhood vaccines are in the range of 75 percent to 99 percent effective, depending on the vaccine).[54] And yet, the incidence of these diseases has dropped dramatically.[55]

&view=article&id=10798%3Aamericas-free-of-rubella&catid=740%3Anews-press -releases&Itemid=1926&lang=en ("This achievement culminates a 15-year effort that involved widespread administration of the vaccine against measles, mumps and rubella (MMR) throughout the Western Hemisphere.").

50 PINK BOOK, *supra* note 15, at 214. Three to four million people is equivalent to an entire birth cohort in the United States. CTRS. FOR DISEASE CONTROL & PREVENTION, DETAILED TECHNICAL NOTES: UNITED STATES 2014 NATALITY tbl. I-2 (2015), ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/DVS/natality/UserGuide2014.pdf.

51 PINK BOOK, *supra* note 15, at 216.

52 *Id.*

53 Maimuna S. Majumder et al., *Substandard Vaccination Compliance and the 2015 Measles Outbreak*, 169 JAMA PEDIATRICS 494, 494 (2015); *see also* Preeta Kutty et al., *Measles*, *in* MANUAL FOR THE SURVEILLANCE OF VACCINE-PREVENTABLE DISEASES 7-2 (6th ed. 2013), http://www.cdc.gov/vaccines/pubs/surv-manual/chpt07-measles.pdf ("The outbreaks mostly involved individuals who were exposed to imported measles cases or were infected during a resulting chain of transmission and who were either unvaccinated or had unknown vaccine status. Lack of adherence to existing recommendations for measles prevention among groups at high risk (for example, individuals who travel internationally), can spread measles to susceptible populations, including infants too young to be vaccinated and groups who routinely oppose vaccination.").

54 The mumps vaccine, one of the least effective vaccines, is estimated to be seventy-eight percent effective in practice. Steven A. Rubin & Stanley A. Plotkin, *Mumps Vaccine*, *in* VACCINES 419, 435 (Stanley A. Plotkin et al. eds., 6th ed. 2012) ("The effectiveness of mumps vaccines determined in field studies (Table 22-9) is lower than efficacy determined in clinical trials. Effectiveness of a single dose of the Jeryl Lynn strain of mumps vaccine

Voluminous literature documents the effects of herd immunity in protecting people against vaccine-preventable diseases. In one study, Susan van den Hof et al. demonstrated that an individual is more likely to get measles if immunized and living in a highly unvaccinated community than if unimmunized and living in a highly vaccinated community.[56] This is because an unvaccinated child in a community with high vaccination rates is protected by the "herd."

Studies using a variety of methods have also demonstrated that vaccinating children against a variety of preventable diseases can protect adults as well.[57] Other studies have documented that outbreaks are more likely in communities with lower vaccination rates[58] and that states that allow easily obtained exemptions have had

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(given as a monovalent vaccine or as a trivalent MMR) under conditions of routine use is approximately 78% (95% CI, 75%-82%), compared with 95% or more demonstrated in efficacy trials."). Meanwhile, the Hepatitis B vaccine is ninety-five percent effective in children, but is slightly less effective in adults. PINK BOOK, *supra* note 15, at 159 ("After three intramuscular doses of hepatitis B vaccine, more than 90% of healthy adults and more than 95% of infants, children, and adolescents (from birth to 19 years of age) develop adequate antibody responses."). The MMR's effectiveness against measles is also discussed later in this article. *See infra* note 77.

55 Sandra W. Roush et al., *Historical Comparisons of Morbidity and Mortality for Vaccine-Preventable Diseases in the United States*, 298 JAMA 2155, 2156 tbl.1, 2158 tbl.2 (2007); Willem G. van Panhuis et al., *Contagious Diseases in the United States from 1888 to the Present*, 369 NEW ENG. J. MED. 2152, 2152 (2013).

56 Susan van den Hof et al., *supra* note 34, at 1485.

57 Paul A. Gastañaduy et al., *Gastroenteritis Hospitalizations in Older Children and Adults in the United States Before and After Implementation of Infant Rotavirus Vaccination*, 310 JAMA 851, 852 (2013); Mark Loeb et al., *Effect of Influenza Vaccination of Children on Infection Rates in Hutterite Communities: A Randomized Trial*, 303 JAMA 943, 949 (2010); Pedro A. Piedra et al., *Herd Immunity in Adults Against Influenza-Related Illnesses with Use of the Trivalent–Live Attenuated Influenza Vaccine (CAIV-T) in Children*, 23 VACCINE 1540, 1546 (2005); Thomas A. Reichert, *The Japanese Experience with Vaccinating Schoolchildren Against Influenza*, 344 NEW ENG. J. MED. 889, 895 (2001); Anna Roca et al., *Effects of Community-Wide Vaccination with PCV-7 on Pneumococcal Nasopharyngeal Carriage in The Gambia: A Cluster-Randomized Trial*, 8 PLOS MED. 1, 6 (2011), http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3196470/pdf/pmed.1001107.pdf.

58 Jessica E. Atwell et al., *Nonmedical Vaccine Exemptions and Pertussis in California, 2010*, 132 PEDIATRICS 624, 627 (2013); Saad B. Omer et al., *Geographic Clustering of Nonmedical Exemptions to School Immunization Requirements and Associations with Geographic Clustering of Pertussis*, 168 AM. J. EPIDEMIOLOGY 1389, 1394 (2008) (discussing the significant overlap between clusters of exemptions and clusters of pertussis cases); Jennifer L. Richards et al., *Nonmedical Exemptions to Immunization Requirements in California: A 16-Year Longitudinal Analysis of Trends and Associated Community Factors*, 31 VACCINE 3009, 3012 (2013) (geographic areas with high rates of nonmedical exemptions were also associated with high rates of pertussis in California in between 1994 and 2009); *see also* Fine et al., *supra* note 34, at 914 ("Social clustering among parents who decide not to vaccinate their children can result in groups of children in which

higher rates of pertussis.[59] All these studies support the point that higher rates of vaccination protect against vaccine preventable diseases, by means of herd immunity.

In other words, there is abundant evidence—contrary to Holland and Zachary's faultily premised assertion—that herd immunity does, in fact, work.

B. The Claim That Vaccine Immunity Wanes Quickly

Part of Holland and Zachary's construction is that, unlike disease-based immunity, vaccine-induced immunity wanes rapidly.[60] Their supposition is that since adults may not routinely keep up their boosters, most of the population is not immunized; this means that we are not up to the herd immunity threshold, and therefore vaccine-induced herd immunity is mostly not real, in their view.[61] Anti-vaccine sites certainly advance this argument.[62] It is true that immunity wanes for some vaccines, but the picture is more complex than presented in Holland and Zachary's article.

Certain vaccines do not provide immunity that is lifelong: the CDC recommends a booster for the tetanus and diphtheria vaccines every ten years.[63] The acellular pertussis vaccine, which replaced the

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vaccination levels are well below the herd immunity threshold. The same effect is found in religious communities that eschew vaccination . . . ."(footnote omitted)). This increased risk accords with the fact that unvaccinated children have greatly increased odds of contracting the disease. *E.g.*, Jason M. Glanz et al., *Parental Refusal of Pertussis Vaccination is Associated with an Increased Risk of Pertussis Infection in Children*, 123 PEDIATRICS 1446, 1447, 1449 (2009) (finding a twenty-three-fold increased risk among vaccine refusers in a large Colorado health maintenance organization).

59 Saad B. Omer et al., *Nonmedical Exemptions to School Immunization Requirements: Secular Trends and Association of State Policies with Pertussis Incidence*, 296 JAMA 1757, 1761–62 (2006).

60 Holland & Zachary, *supra* note 1, at 20.

61 *Id.* at 19–20.

62 *See, e.g.*, Russell Blaylock, *The Deadly Impossibility of Herd Immunity Through Vaccination*, INT'L MED. COUNCIL ON VACCINATION (Feb. 18, 2012), http://www.vaccinationcouncil.org/2012/02/18/the-deadly-impossibility-of-herd-immunity-through-vaccination-by-dr-russell-blaylock/; *Russell Blaylock, M.D.*, THE SKEPTIC'S DICTIONARY, http://www.skepdic.com/blaylock.html (last updated Feb. 12, 2015). Holland and Zachary themselves rely on anti-vaccine sites rather than peer-reviewed science to make this claim. *See* Holland & Zachary, *supra* note 1, at 19–20 nn.101–03 (citing sources such as *Principles and Findings*, INT'L MED. COUNCIL ON VACCINATION, http://www.vaccinationcouncil.org/about/ (last visited Mar. 9, 2014)).

63 PINK BOOK, *supra* note 15, at 113, 346. Another underlying question here is the extent to which "natural" immunity depends upon "natural boosting," i.e., the sickness of others in society, especially the natural reservoir of new children, to provide repeated exposure to the disease. In other words, naturally acquired immunity may only be lifelong

whole-cell version in the mid-1990s,[64] wanes faster than scientists expected, providing reasonable short-term immunity but requiring boosters.[65] Additionally, because the influenza virus changes from year to year, a new vaccine is needed annually (and these changes in the virus mean that natural immunity will not protect one against influenza for life either).[66]

But waning immunity is not true across the board. Take the MMR diseases, for example. For measles, "both serologic and epidemiologic evidence indicate that the vaccine induces long-term—probably lifelong—immunity, in most persons."[67] In the case of rubella, "[f]ollow-up studies indicate that one dose of vaccine confers long-term—probably lifelong—protection."[68] With mumps, the duration of immunity does appear to be shorter. Although the exact duration is not quite clear, it seems to be at least ten years.[69]

For hepatitis B, "[s]tudies indicate that immunologic memory remains intact for at least 20 years among healthy vaccinated individuals who initiated hepatitis B vaccination >6 months of age."[70]

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if there are enough people susceptible to the disease, with its concomitant risks, to offer boosters to revive immunity. This dependence on the sickness of others represents a potentially high price for them. *See, e.g.*, Artur Galazka, *The Changing Epidemiology of Diphtheria in the Vaccine Era*, 181 J. INFECTIOUS DISEASES S2, S7 (2000) ("Three to 4 years after the [1940s Norway] epidemic's peak, the proportion of immune persons was low, and data . . . suggest that the process of acquiring natural immunity through contact with C. diphtheriae was much less effective than immunization.").

64 *See* Dalya Guris et al., Ctrs. for Disease Control & Prevention, *Pertussis Vaccination: Use of Acellular Pertussis Vaccines Among Infants and Young Children: Recommendations of the Advisory Committee on Immunization Practices (ACIP)*, MORBIDITY & MORTALITY WKLY. REP., Mar. 28, 1997, at 1, 18 (recommending replacement).

65 *See* Sara Y. Tartof et al., *Waning Immunity to Pertussis Following 5 Doses of DTaP*, 131 PEDIATRICS e1047, e1049 (2013). Then again, disease-based immunity from pertussis is not lifelong either. *See* Aaron M. Wendelboe et al., *Duration of Immunity Against Pertussis After Natural Infection or Vaccination*, 24 PEDIATRIC INFECTIOUS DISEASE J. S58, S60 (2005).

66 *See* F. Carrat & A. Flahault, *Influenza Vaccine: The Challenge of Antigenic Drift*, 25 VACCINE 6852, 6853 (2007).

67 John C. Watson et al., Ctrs. for Disease Control & Prevention, *Measles, Mumps, and Rubella—Vaccine Use and Strategies for Elimination of Measles, Rubella, and Congenital Rubella Syndrome and Control of Mumps: Recommendations of the Advisory Committee on Immunization Practices (ACIP)*, MORBIDITY & MORTALITY WKLY. REP., May 22, 1998, at 1, 7.

68 *Id.* at 8.

69 *See* Rubin & Plotkin, *supra* note 54, at 433.

70 *Hepatitis B FAQs for Health Professionals*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/hepatitis/hbv/hbvfaq.htm (last updated May 31, 2015). *See also* Elke Leuridan & Pierre Van Damme, *Hepatitis B and the Need for a Booster*

Completion of the live oral polio vaccine series probably confers lifelong immunity, and while we do not know the duration of immunity from the inactivated polio vaccine currently in use in the United States and Europe, it is estimated to be long-term.[71] Although the varicella vaccine is relatively new, a recent study found no waning immunity at the end of its fourteen-year analysis period.[72]

In addition, since Holland and Zachary address school mandates,[73] it is important to remember that schools are potentially places of high transmission, with children concentrated together,[74] and that some diseases are more dangerous in younger children. Even for vaccines that provide a shorter duration of immunity, requiring immunization for school attendance can be objectively justified for those reasons.

C. Vaccine Failure Does Not Undermine Herd Immunity

Holland and Zachary criticize herd immunity on the basis that among children, and later among adults, "the vaccine failure rate exceeds the herd immunity threshold."[75] They use two examples to this end: measles and varicella.[76] Neither example supports the claim that herd immunity is unattainable.

1. Measles and Herd Immunity in the United States

Ironically, the authors chose measles as an example, claiming the vaccine has low rates of effectiveness. It is true that measles is extremely contagious and requires high levels of immunization to achieve herd immunity, but, contrary to what Holland and Zachary claim, the measles vaccine is extremely effective. Indeed, their own source demonstrates that two doses offer long-term protection to

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Dose, 53 CLINICAL INFECTIOUS DISEASES 68, 69 (2011) (finding no booster needed twenty years after vaccination).

71 PINK BOOK, *supra* note 15, at 302–03.

72 Roger Baxter et al., *Long-Term Effectiveness of Varicella Vaccine: A 14-Year, Prospective Cohort Study*, 131 PEDIATRICS e1389, e1389 (2013) ("Vaccine effectiveness at the end of the study period was 90%, with no indication of waning over time.").

73 *See* Holland & Zachary, *supra* note 1, at 6.

74 *See* Muireann Brennan et al., *Evidence for Transmission of Pertussis in Schools, Massachusetts, 1996: Epidemiologic Data Supported by Pulsed-Field Gel Electrophoresis Studies*, 181 J. INFECTIOUS DISEASES 210, 214 (2000); Dieter Schenzle, *An Age-Structured Model of Pre- and Post-Vaccination Measles Transmission*, 1 MATHEMATICAL MED. & BIOLOGY 169, 169 (1984).

75 Holland & Zachary, *supra* note 1, at 39.

76 *See generally id.* at 21–28.

almost all recipients.[77] There is good reason why measles is today mostly a disease brought (or brought back) to the United States by the unvaccinated and affecting primarily the unvaccinated or undervaccinated.[78] When two-dose vaccination rates are high, achieving herd immunity against measles in a community is very possible.

Holland and Zachary rely on papers from the 1980s to suggest that "even these policies have not been enough to create herd immunity."[79] The policy they are referring to was the move to two doses of the MMR vaccine.[80] However, in both outbreaks they describe, the regimen in place for most students was a single dose of MMR—which protects a lower percentage of recipients than a two-dose regime.[81] Their inability to provide evidence of measles outbreaks in vaccinated populations after the adoption of a two-dose regime shows that the move to two doses did, in fact, contain and prevent outbreaks, as long as vaccination rates are high enough.

They also discuss, as another putative example of the breakdown of herd immunity, an outbreak in a Hasidic community in New York that involved fifty-eight cases.[82] The cases were mainly confined to three

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77 In their discussion of MMR, Holland and Zachary cite numbers (perhaps the lowest they could find) of eighty-five percent to ninety-five percent in ninety-nine percent of previously seronegative children. *Id.* at 17 n.89 (citing *Canadian Immunization Guide: Measles Vaccine*, PUB. HEALTH AGENCY CAN., http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-meas-roug-eng .php (last modified Apr. 21, 2015)). Their source also highlights that "[w]ith a second dose, efficacy in children approaches 100%," *Canadian Immunization Guide: Measles Vaccine*, *supra*, something that the authors omit, *see* Holland & Zachary, *supra* note 1, at 17. According to the CDC, "[m]easles antibodies develop in approximately 95% of children vaccinated at 12 months of age and 98% of children vaccinated at 15 months of age." PINK BOOK, *supra* note 15, at 218.

78 Ctrs. for Disease Control & Prevention, *Measles—United States, January–May 20, 2011*, 60 MORBIDITY & MORTALITY WKLY. REP. 666, 666 (2011); Amy Parker Fiebelkorn et al., *Measles in the United States During the Postelimination Era*, 202 J. INFECTIOUS DISEASES 1520, 1524 (2010); Gregory Wallace et al., Ctrs. for Disease Control & Prevention, *Measles—United States, January 1–August 24, 2013*, 62 MORBIDITY & MORTALITY WKLY. REP. 741, 741 (2013).

79 Holland & Zachary, *supra* note 1, at 21.

80 *See id.*

81 *See generally* Ctrs. for Disease Control & Prevention, *Measles Outbreak Among Vaccinated High School Students—Illinois*, 33 MORBIDITY & MORTALITY WKLY. REP. 349 (1984), http://www.cdc.gov/mmwr/preview/mmwrhtml/00000359.htm (discussing the outbreak in Sangamon County, Illinois, in 1983 to 1984); Tracy L. Gustafson et al., *Measles Outbreak in a Fully Immunized Secondary-School Population*, 316 NEW ENG. J. MED. 771 (1987) (discussing the outbreak in Corpus Christi, Texas, in 1985).

82 Robert J. Arciuolo et al., Ctrs. for Disease Control & Prevention, *Notes from the Field: Measles Outbreak Among Members of a Religious Community—Brooklyn, New*

extended families within a community whose members rejected MMR vaccination and to children with delayed MMR.[83] The fact that no one outside the community became infected is actually evidence that herd immunity works when rates are sufficiently high. It is unlikely no one who is contagious travelled outside the affected community, but enough people outside its borders were immune to prevent the disease from taking hold in those better protected areas.[84] Holland and Zachary also misrepresent the case in claiming that "many of those who became ill had in fact been vaccinated."[85] The source they refer to points out that "[n]o case was identified in a person who had documented measles vaccination at the time of exposure; 12 (21%) of the cases were in infants too young (aged <12 months) for routine immunization with measles, mumps, and rubella (MMR) vaccine."[86]

In other words, rather than showing failure of herd immunity, as Holland and Zachary suggest, this outbreak demonstrates the importance—and effectiveness—of herd immunity in protecting against preventable disease.

Accordingly, the authors fail to document their claim that measles is an example of a failure of herd immunity. In fact, since the move to the two-dose schedule, measles cases have declined in the United States to the point where the disease was declared eliminated in 2000, although a small number of cases are still imported each year.[87] Recently, however, numbers have been increasing—something directly connected to nonvaccination.[88] In Europe, too, the continuing prevalence of measles is connected to the failure to vaccinate.[89]

York, March–June 2013, 62 MORBIDITY & MORTALITY WKLY. REP. 752, 752 (2013); Holland & Zachary, *supra* note 1, at 23.

83 Arciuolo et al., *supra* note 82, at 752; Holland & Zachary, *supra* note 1, at 23.

84 A similar phenomenon was described in relation to the December 2014–March 2015 measles outbreak that started in Disneyland, California, where communities with low rates were more vulnerable, again showing the importance of maintaining herd immunity rates. Majumder et al., *supra* note 53, at 494.

85 Holland & Zachary, *supra* note 1, at 23.

86 Arciuolo et al., *supra* note 82, at 752.

87 Papania et al., *supra* note 35, at 149.

88 *Measles Cases in the United States Reach 20-Year High*, CTRS. FOR DISEASE CONTROL & PREVENTION (May 29, 2014), http://www.cdc.gov/media/releases/2014/p0529-measles.html; *see also Measles (Rubeola): For Healthcare Professionals*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/measles/hcp/ (last updated Aug. 4, 2015).

89 Mark Muscat et al., *Measles in Europe: An Epidemiological Assessment*, 373 LANCET 383, 387 (2009).

It is difficult to achieve herd immunity when a vaccine is not used. But that is not because herd immunity is unattainable with vaccines. If anything, school mandates can help counter this and help achieve herd immunity by leading to greater vaccine uptake.

2. Varicella and Herd Immunity

Holland and Zachary's critique of the varicella program relies entirely on a comment to a peer-reviewed paper by G.S. Goldman and P.G. King,[90] whose claims have been strongly criticized by Martin G. Myers.[91]

Goldman and King criticize the addition of a booster dose and the increase in price of the vaccine as making it not cost-effective.[92] Putting aside the fact that cost effectiveness does not actually reflect on the ability to achieve herd immunity, Myers highlights that:

> [I]t is important to factor into programmatic assessments the facts that since universal varicella immunization of children was introduced in 1995, there have been substantial declines in both varicella morbidity and mortality in the United States. Prior to 1995, the United States experienced about 4 million cases of varicella annually, with 10-15,000 hospitalizations and 105 deaths, largely among immunocompetent individuals. Very severe varicella disease among the immunocompromised has largely been prevented by [varicella] immunity of those around them, a consequence of the universal [varicella] vaccination program.[93]

In other words, the evidence suggests that the vaccine has dramatically reduced the incidence of varicella—supporting the effectiveness of the program[94]—and even a calculation of cost-effectiveness should include the costs of hospitalization and lost work days. And herd immunity following vaccination has protected those most vulnerable—the immunocompromised —from severe versions of the disease. Moreover, another study has demonstrated that the varicella program has benefitted infants too young to vaccinate: since the introduction of the vaccine, disease incidence among this

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90 G.S. Goldman & P.G. King, *Review of the United States Universal Varicella Vaccination Program: Herpes Zoster Incidence Rates, Cost-Effectiveness, and Vaccine Efficacy Based Primarily on the Antelope Valley Varicella Active Surveillance Project Data*, 31 VACCINE 1680 (2013). For Holland and Zachary's discussion of the Goldman and King paper, see Holland & Zachary, *supra* note 1, at 25–28.

91 Martin G. Myers, *Vaccination to Prevent Varicella*, 31 VACCINE 1695, 1695 (2013).

92 Goldman & King, *supra* note 90, at 1689.

93 Myers, *supra* note 91, at 1695 (footnote omitted).

94 *See* Roush et al., *supra* note 55, at 2158 tbl.2.

population has decreased almost 90 percent.[95] Since these infants are not, themselves, vaccinated, they are directly benefiting from herd immunity created as a result of the vaccination program.

Goldman and King also claim that the vaccine leads to a high level of adverse events.[96] This, too, is not relevant to the discussion of herd immunity: herd immunity focuses on vaccine effectiveness, while adverse events are part of an assessment of vaccine safety. Further, it is badly supported. In part, they base this conclusion on entries in the Vaccine Adverse Event Reporting System (VAERS).[97] Yet, as the program itself plainly explains, it is a passive reporting system, which can be used, at best, for hypothesis generation: the reports do not show causation.[98] Goldman and King bolster it with three other not-necessarily VAERS cases that appear to be the result of informal contacts—without much verification.[99] Such data does not support the claim that the vaccine is harmful. The CDC's *Pink Book* mentions no serious problems from the vaccine.[100]

Finally, Goldman and King claim that the program has increased the risk of shingles in children.[101] However, as Myers points out, the

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95 Sandra S. Chaves et al., *Varicella in Infants After Implementation of the US Varicella Vaccination Program*, 128 PEDIATRICS 1071, 1075 (2011).

96 Goldman & King, *supra* note 90, at 1690.

97 *See id.* at 1690 & 1693 n.117.

98 It is, nominally, a precondition to database access that one acknowledge having read and understood, inter alia, the following:

> VAERS is a passive reporting system, meaning that reports about adverse events are not automatically collected, but require a report to be filed to VAERS. VAERS reports can be submitted voluntarily by anyone, including healthcare providers, patients, or family members. Reports vary in quality and completeness. They often lack details and sometimes can have information that contains errors.
>
> . . . .
>
> A report to VAERS generally does not prove that the identified vaccine(s) caused the adverse event described. It only confirms that the reported event occurred sometime after vaccine was given. No proof that the event was caused by the vaccine is required in order for VAERS to accept the report. VAERS accepts all reports without judging whether the event was caused by the vaccine.

VAERS Data, VACCINE ADVERSE EVENT REPORTING SYS., http://vaers.hhs.gov/data/index (last visited Aug. 22, 2015); *see also About the Vaccine Adverse Event Reporting System (VAERS)*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://wonder.cdc.gov/vaers.html (last visited Aug. 21, 2015) ("The Vaccine Adverse Event Reporting System . . . database contains information on <u>unverified</u> reports of adverse events (illnesses, health problems and/or symptoms) following immunization with US-licensed vaccines.").

99 *See* Goldman & King, *supra* note 90, at 1690–91.

100 *See* PINK BOOK, *supra* note 15, at 372.

101 *See* Goldman & King, *supra* note 90, at 1682–83.

data sets used are inconclusive and, in fact, the vaccine actually reduced that risk for children with leukemia, who are at high risk from shingles.[102] More recent studies also documented a lower risk of shingles in vaccinated children compared to children who got wild varicella.[103]

In short, Goldman and King's article does not in any way support the claim that the varicella vaccine shows herd immunity is unattainable, and is misleading and inaccurate in several ways. Therefore, Holland and Zachary's reliance on the Goldman and King article is highly problematic. Put simply, their claims that herd immunity is unattainable suffer from conceptual problems, do not fit the data, and rely on inaccurate information. This cannot stand.

III
ANALYTICAL PROBLEMS

In addition to these struggles with accuracy, Holland and Zachary's further attempt at analysis is problematic. For brevity, this Article focuses here on one glaring problem.

Holland and Zachary suggest a game theory model under which, they believe, vaccine mandates are shown unnecessary.[104] Game theory is "an extension of decision theory (to the case of two or more decision makers)."[105] In other words, it examines how people make decisions when they interact with others. The attempted application of game theory in this case does not support the authors' claim that voluntary vaccination policies will achieve sufficient immunization coverage to prevent outbreaks. The Holland and Zachary article itself suggests that an individual may decide not to vaccinate and that this would be more likely for a suboptimal vaccine.[106] However, this is not necessarily true. With an effective vaccine, the temptation to rely

[102] Myers, *supra* note 91, at 1695.

[103] Sheila Weinmann et al., *Incidence and Clinical Characteristics of Herpes Zoster Among Children in the Varicella Vaccine Era, 2005–2009*, 208 J. INFECTIOUS DISEASES 1859, 1859 (2013) ("HZ incidence in vaccinated children was 79% lower than in unvaccinated children. Among vaccinated children, half of HZ cases were due to wild-type [varicella]."); Su-Ying Wen & Wen-Liang Liu, *Epidemiology of Pediatric Herpes Zoster After Varicella Infection: A Population-Based Study*, 135 PEDIATRICS e565, e570 (2015).

[104] *See* Holland & Zachary, *supra* note 1, at 40–46.

[105] ROGER B. MYERSON, GAME THEORY: ANALYSIS OF CONFLICT loc. 217 (2013) (ebook).

[106] Holland & Zachary, *supra* note 1, at 44.

on herd immunity may be even higher.[107] With a less effective vaccine, the person deciding may conclude that the 80 percent effectiveness of the vaccine is important, since they cannot be as sure that herd immunity will protect them.

That apart, were one to take the analysis showing that rational individuals may decline to vaccinate absent mandates seriously, the result could be below what is required for herd immunity. The authors base their view on the problematic and inaccurate assumption that vaccine effectiveness for most modern vaccines is too low to achieve herd immunity.[108] But if they were correct on that issue, and if their so-called equilibrium is below the threshold for herd protection, then their claim that voluntarism will be sufficient is not well supported. If the equilibrium achieved with voluntary vaccination alone is below the threshold for herd immunity, the community is at risk of disease outbreaks. This is an excellent illustration of the tragedy of the commons highlighted in Holland and Zachary's article and suggests that voluntary vaccination policies may be insufficient on their own.[109]

In fact, the European example that they refer to as evidence that such policies can be sufficient provides good evidence. It is true that Europe does not have school immunization mandates—and the rates of immunity for at least some vaccines are not high enough to achieve herd protection, predictably resulting in large outbreaks of measles.[110] In 2011 alone, Europe had over thirty thousand cases of measles, with at least eight deaths, twenty-seven cases of encephalitis, over one thousand cases of pneumonia, and other complications.[111] The vast

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[107] For example, pediatrician Bob Sears wrote: "I also warn them not to share their fears with their neighbors, because if too many people avoid the MMR, we'll likely see the diseases increase significantly." Renee DiResta, *Personal Exemptions from Reason*, SLATE (Apr. 8, 2015, 11:09 AM), http://www.slate.com/articles/health_and_science/medical_examiner/2015/04/california_anti_vaccine_movement_politics_wealth_bob_sears_and_robert_f.html.

[108] *See supra* Part II.

[109] *See* Holland & Zachary, *supra* note 1, at 42–43. The "tragedy of the commons" is a theory that suggests that in some situations, behavior that is rational and utility-maximizing from an individual's point of view ends up harming the group as a whole, ultimately to the detriment of its members. For example, if each fisherman in a group seeks to fish as much as possible, they can end up undermining the fish supply, harming everyone. In the vaccine context the idea is that it might be rational for an individual not to vaccinate (avoiding the risks of vaccines, however small) and count on herd immunity, but if enough people do it herd immunity is undermined and protects no one. *See id.*

[110] Muscat et al., *supra* note 89, at 387.

[111] *Surveillance Report: European Monthly Measles Monitoring*, EUR. CTR. FOR DISEASE PREVENTION & CONTROL, Feb. 21, 2012, at 2, 4 tbl.2, http://www.ecdc.europa

majority of the cases were in the unvaccinated.[112] Voluntary vaccination policies alone were clearly not enough to prevent these results. If anything, Europe has cause to eye with envy the United States' school immunization requirements.[113]

CONCLUSION

The question of whether vaccination rates should be managed through voluntary or mandatory policy tools is an important one, and reasonable people can differ on the appropriate answer. But any such discussion needs to be based on accurate, well-supported information. Holland and Zachary fail to do this and, hence, do not meaningfully advance the discussion.

.eu/en/publications/Publications/SUR_EMMO_European-monthly-measles-monitoring-February-2012.pdf.

112 *Id.* at 2.

113 Indeed, Germany has again seen calls for mandatory school vaccination. *E.g.*, Hannes Heine & Ingo Salmen, *Gesundheitssenator plädiert für Impfpflicht bei Masern* [*Health Senator Calls for Mandatory Vaccination for Measles*], DER TAGESSPIEGEL (Feb. 23, 2015, 5:51 PM), http://www.tagesspiegel.de/berlin/totes-kleinkind-in-berlin-gesundheitssenator-plaediert-fuer-impfpflicht-bei-masern/11410800.html (author's translation); *see also Berlin Measles Epidemic Reaches New High*, DEUTSCHE WELLE (Mar. 6, 2015), http://dw.de/p/1Emxp ("72 percent of Germans are in favor of compulsory vaccination").

The 2013 outbreak led the German Federal Minister of Health, Daniel Bahr, to remark, "In Skandinavien und in den USA sind Masern de facto ausgerottet. Wir in Deutschland haben sie immer noch, weil die Impfrate nicht hoch genug ist. Wenn das nicht besser wird, werden wir die Debatte über den Impfzwang bekommen." ["Measles was de facto eradicated in Scandinavia and in the United States. We still have them in Germany because the vaccination rate is not high enough. If that does not improve, we will have the debate on compulsory vaccination."] (author's translation). *Gesundheitsminister im Interview: "Verantwortungslos, wenn Eltern ihre Kinder Nicht Impfen Lassen,"* FOCUS ONLINE, http://www.focus.de/politik/deutschland/tid-31950/gesundheitsminister-im-interview-daniel-bahr-die-gruenen-betreiben-tugend-tyrannei-verantwortungslos-wenn-eltern-ihre-kinder-nicht-impfen-lassen_aid_1020928.html (last visited Oct. 11, 2015).