Introduction
Used appropriately, reliance on science distinguishes public health from policymaking driven more by theory and opinion and enhances trust in public health interventions. Evidence-based vaccine policymaking aims to control communicable disease by urging decision makers to base policies on the best available evidence rather than politics or personal views. The results of this approach, such as smallpox eradication, have been dramatic. Historically, mandatory childhood vaccination has been perhaps the most successful evidence-based tool in combating many epidemics. Philosophically, vaccination mandates correspond to the legal system’s dual role in codifying what society deems undesirable behavior (non-vaccination) and declaring beneficial social norms and values consistent with understandings of the social contract. Despite their effectiveness and philosophical grounding, vaccination mandates present serious legal and ethical questions. Public health policymakers have a continuing responsibility to rely on evidence not only as a basis for generating policy, but also for evaluating and improving elements of its legal design.

All 50 states and the District of Columbia require a slate of childhood vaccinations as a condition for school attendance. Additions and alterations to required vaccinations commonly arise as new vaccines are developed and evaluated. Existing laws also vary considerably, particularly regarding the availability and process for obtaining exemptions on the basis of religious or philosophical objection. Many states require little more than a signature on a preprinted form, while others require notarization, demonstration of sincerity, or other elements. Since the U.S. Supreme Court’s seminal Jacobson v. Massachusetts decision upholding mandatory adult smallpox vaccination, public health has relied on this authority as sacrosanct in developing increasingly comprehensive vaccination mandates. But Jacobson is not a blank check. Vaccination policy authority is predicated on using the best available evidence and minimizing intrusion on individual freedoms. This balance must continue to inform policymaking from development of vaccine recommendations to establishment and evaluation of mandates.

Coercion, Persuasion, and Herd Immunity
The goal of vaccination programs is disease eradication. Mass vaccination programs serve this goal in part through the “herd immunity” effect of vaccinating a large proportion of the population, reducing the likelihood that remaining non-immunized individuals will come into contact with infected persons. Governments generally take one of two approaches to mass vaccination: coercion or persuasion. Persuasive approaches are time-consuming, relying on public uptake and subsequent action. Nevertheless, persuasive approaches may lead to more durable, long-lasting positive effects. Many countries with the highest vaccination levels — Sweden, Norway, Denmark, the Netherlands, and the United Kingdom — have no legal mandates. However, health care access directly impacts the effectiveness of persuasive approaches,
and may be the most dominant factor in vaccination program effectiveness.\textsuperscript{7} Deficient health care infrastructure also leads to a lack of information that severely hinders analysis of policy effectiveness.\textsuperscript{7} The nations noted above all have national health insurance or health care programs, while in the U.S. the continuing lack of population-wide health care access, even after implementation of the Patient Protection and Affordable Care Act (ACA), remains a major roadblock to reliance on persuasion.

Persuasive approaches also generally lead to higher costs, which can further reduce access. The federal government can impact vaccination costs indirectly through the Advisory Committee on Immunization Practices (ACIP). The ACIP develops vaccination recommendations that health plans use to determine coverage and states use to craft mandates. The ACA requires most health plans to cover ACIP-recommended vaccines, but previously non-mandatory vaccines were targets for health plan cost-cutting as employers opted for increasingly restrictive plans.\textsuperscript{9}

Vaccination recommendations are evidence-based, and the policies that implement them must be so, as well. This is not to say that legislatures cannot act in the absence of perfect data. To the contrary, acting on the best available evidence, police power authority to protect public health is entitled to appropriate deference. Moreover, reasonable state variation can help demonstrate effectiveness of various approaches in the best traditions of the “laboratories of democracy.” However, as evidence further develops, legislatures must continue to evaluate existing policies. Mandatory vaccination prioritizes public health considerations over individual choice and must always be firmly grounded in evidence to justify this balance.

Evidence and Mandates
The U.S. Constitution generally protects competent adults’ right to control or refuse medical treatment and make such choices for minor children under most circumstances. Mandatory vaccination is a significant counterexample where public health benefits overcome strong individual rights protections.\textsuperscript{10} Largely this exception derives from battles against earlier threats like smallpox that caused extensive fatalities and impairments. In 1905 in \textit{Jacobson v. Massachusetts}, the U.S. Supreme Court held it is within state police power authority to require vaccination so long as such measures are “for the common good, for the protection, safety, prosperity, and happiness of the people” and do not lead to an “absurd consequence,” such as a serious and demonstrable individual health risk.\textsuperscript{11} \textit{Jacobson} still dominates public health law, supporting deference to state discretion in using the police powers to protect public health. As additional vaccines have been developed and evaluated as safe, they have been established as prerequisites for school attendance following \textit{Jacobson} and subsequent precedent.

States’ broad authority in this area increases the need for sound policy based on strong evidence to justify intrusion on personal choice.\textsuperscript{12} All 50 states and the District of Columbia have childhood vaccination requirements for diphtheria, tetanus, pertussis, poliomyelitis, measles, mumps, rubella, hepatitis B, and varicella.\textsuperscript{13} A recent major battle over expanding mandates has centered on human papillomavirus (HPV).

In 2006, the FDA approved Gardasil, a preventive HPV vaccine that must be administered before exposure, generally before sexual activity.\textsuperscript{14} Forty-two state legislatures have considered HPV mandates.\textsuperscript{15} Virginia and the District of Columbia adopted mandates in 2008, on the heels of a politically charged 2007 adoption and reversal in Texas.\textsuperscript{16} Evidence informing HPV vaccination policy includes the strong link between HPV and cancer, particularly cervical cancer in females.\textsuperscript{17} The ACIP recommended routine HPV vaccination for females ages 11-12 in 2007, adding males in 2011.\textsuperscript{18} Some argue that because HPV is generally transmitted through sexual contact, rather than casual contact in a school setting, HPV vaccination is inappropriate for school attendance mandates and should be addressed through persuasive approaches.\textsuperscript{19} Others note that despite modest recent increases, HPV vaccination coverage under existing approaches remains very low at 57.3% for girls and 34.6% for boys, but could be
as high as 91.3% if administered concurrently with other vaccinations already included in mandates, including hepatitis B, which is similarly transmitted through contact unlikely to occur in schools. While full analysis of HPV vaccination policy is beyond the scope of this article, it is illustrative of difficulties balancing individual rights and public health in immunization policy. While efficacy is not the sole factor upon which to base policy, this evidence is crucial in weighing competing ethical arguments regarding mandates. The persuasive approach utilized to date in most jurisdictions will require careful monitoring and analysis that should guide further consideration by state legislatures.

Exemption Policy and Potential Challenges
State policy variation has not been limited to contemplation of new mandates. States also diverge considerably in structuring existing mandates. All states allow some form of exemption on the basis of medical, religious, or philosophical objection. Recently, some states have tightened religious and philosophical objection requirements to counter increases in opt-out rates over the past 15 years. Washington, Oregon, and California now require persons seeking non-medical exemption to obtain the signature of a health care professional attesting to discussion of the benefits and risks of vaccination and non-vaccination. Oregon alternatively offers an online educational module, and Colorado considered but ultimately rejected a similar requirement, instead only creating an optional training.

Non-medical exemption policy differences appear to impact vaccination rates and may impact vaccine-preventable disease incidence. However, further study is needed to make improvements based on better understanding of the complex relationships between laws, surveillance reporting, vaccine uptake, and vaccine effectiveness. Vaccination recommendations are evidence-based, and the policies that implement them must be so, as well. This is not to say that legislatures cannot act in the absence of perfect data. To the contrary, acting on the best available evidence, police power authority to protect public health is entitled to appropriate deference. Moreover, reasonable state variation can help demonstrate effectiveness of various approaches in the best traditions of the "laboratories of democracy." However, as evidence further develops, legislatures must continue to evaluate existing policies. Mandatory vaccination prioritizes public health considerations over individual choice and must always be firmly grounded in evidence to justify this balance.

Failing to rely on the best available evidence could jeopardize public health authority. Jacobson remains a public health legal cornerstone, but acknowledged that vaccination mandates must be strongly supported by public health necessity. Modern challenges are not hypothetical, and they increasingly propose judicial review standards (e.g., strict scrutiny) more demanding than applied in Jacobson, which predated modern judicial frameworks and even incorporation of the First Amendment as to the states. The U.S. Supreme Court has not considered mandatory vaccination on the merits since Jacobson, though it has denied certiorari in some notable challenges, including Workman v. Mingo County Board of Education, which upheld West Virginia's school mandate in 2011.

Conclusion
Supported by over a century of post-Jacobson jurisprudence, mandatory school vaccination policies are not likely in any imminent danger. Yet caution is warranted. Recent U.S. Supreme Court decisions regarding religious objections to ACA provisions may signify an era of strong individual religious and philosophical liberty protections, and modern-day review may question mandates that fail to account for the best available evidence. Moreover, state mandate and exemption variation may be used to condemn some existing approaches as unduly restrictive. Proper legal caution enhances ethical obligations to monitor and evaluate vaccination policies to ensure that intrusions on individual rights are minimized while protecting the public's health to the highest possible degree. Reliance on evidence is engrained in public health policymaking and must continue to be the touchstone for the development and continuing refinement of vaccination policies.

References
5. 197 U.S. 11 (1905).
6. See Law, supra note 2.
7. Id.
9. See Law, supra note 2.
10. Id.
13. Id.
14. Law, supra note 2.