

# Enhancing Children against Unhealthy Behaviors—An Ethical and Policy Assessment of Using a Nicotine Vaccine

Ori Lev\*, Sapir Academic College, Israel

Benjamin S. Wilfond, Treuman Katz Center for Pediatric Bioethics, Seattle Children's Hospital and Department of Pediatrics, University of Washington School of Medicine

Colleen M. McBride, Social and Behavioral Research Branch, National Human Genome Research Institute, National Institutes of Health

\*Corresponding author: Ori Lev, Department of Public Policy and Administration, Sapir Academic College, D.N. Ashkelon, Israel 79165.  
Email: orilev22@mail.sapir.ac.il

Health behaviors such as tobacco use contribute significantly to poor health. It is widely recognized that efforts to prevent poor health outcomes should begin in early childhood. Biomedical enhancements, such as a nicotine vaccine, are now emerging and have potential to be used for primary prevention of common diseases. In anticipation of such enhancements, it is important that we begin to consider the ethical and policy appropriateness of their use with children. The main ethical concerns raised by enhancing children relate to their impact on children's well-being and autonomy. These concerns are significant, however they do not appear to apply in the case of the nicotine vaccine; indeed the vaccine could even further these goals for children. Nevertheless, concerns about broadly applying this enhancement may be more challenging. The vaccine may be less cost-effective than alternative public efforts to prevent tobacco use, utilizing it could distract from addressing the foundational causes of smoking and it might not be publically acceptable. Empirical research about these concerns is needed to ascertain their likelihood and impact as well as how they could be minimized. This research could help determine whether behavior-related enhancements hold promise for improving children's health.

## Introduction

Health behaviors such as tobacco use contribute significantly to common cancers, cardiovascular and pulmonary diseases as well as other medical conditions which together account for 443,000 premature deaths annually (CDC, 2011). Experimentation with tobacco starts young, with approximately 46.3 per cent of 9th through 12th graders reporting having ever tried tobacco (Eaton *et al.*, 2010). If trends in uptake of tobacco use persist, more than 6 million current child smokers will eventually die prematurely from a smoking-related disease (CDC, 2006). In the past 5 years, smoking cessation rates have stalled in the USA suggesting that for a sizeable number of child smokers, tobacco use will become an intractable habit (CDC, 2010). Accordingly, interventions to prevent uptake of tobacco use in childhood

could benefit children's health with substantial downstream benefits for reducing population disease burden.

Developments in biotechnology may move us closer to these goals. One example is a nicotine vaccine that scientific leaders suggest may prove to be a 'powerful tool in smoking prevention' (Media Newswire, 2009; Gartner *et al.*, 2012). The vaccine works by stimulating the production of antibodies that bind to nicotine molecules, blocking them from entering the brain and inhibiting their pleasurable reinforcing properties (Hall and Gartner, 2011). Proffering a nicotine vaccine in childhood before tobacco experimentation begins, as early as age 10 years, is attractive in concept as it could decrease the likelihood that a child's first experience with tobacco will lead to continued use.

The vaccine's potential to be a powerful public health intervention will depend initially on amassing sufficient

evidence of its safety and efficacy for Food and Drug Administration approval. It is important to note that the most current data show that the vaccine under investigation (NicVax) was found to be no more effective than a placebo in helping research subjects quit smoking, given these results the clinical trial was stopped (PharmaTimes Online, 2011). Moreover, a major review of several clinical trials of nicotine vaccines shows that there are serious scientific challenges to designing a vaccine that would have more than a modest effect as well as favorable cost–benefit ratio (Hall and Gartner, 2011). These results show the enormous challenge of developing a safe and effective nicotine vaccine.<sup>1</sup> It is a reasonable expectation, as has been the case for other vaccines (e.g. HPV), that these challenges can be overcome and a safe and effective vaccine could be approved for clinical use at some point. Accordingly, critical ethical and policy considerations will need to be addressed to ensure that such biotechnologies can be translated effectively to improve the health of children (Wilfond *et al.*, 2002). The aim of this article is to investigate these considerations, thereby helping to determine whether such a vaccine should be offered to children, and if so how.

The primary ethical concerns raised by such interventions have been well articulated in the pediatric bioethics literature and particularly, in the literature on enhancements (Archard, 1993; Juengst, 1998; Lev *et al.*, 2010). The debate over enhancing children is particularly relevant in this case as the nicotine vaccine can be regarded an ‘enhancement’. By examining this vaccine through the ‘lens’ of the enhancement debate, we aim to shed light not only on this particular intervention but also on other enhancements that are likely to be developed for children.

Drawing on the arguments in that literature, we consider in this article whether administering a nicotine vaccine to children would inherently undermine children’s well-being and infringe on the development of their capacity to be autonomous. We conclude that as far as developing autonomy is concerned using this intervention with children does not pose an intractable ethical concern. We also suggest that the vaccine is unlikely to harm children’s well-being, yet research to ascertain that observation would be needed.

Given that on closer scrutiny the ethical concerns about this intervention do not appear insurmountable, some might suggest that broad application of this vaccine should be promoted. However, broad application should be carefully considered and approached cautiously. For example, such applications might raise particular social issues and might not present the best

use of limited public resources. In this article, we discuss the following issues: (i) the need to compare the effectiveness and costs of the vaccine to other public health efforts, (ii) the concern that using such interventions to redress public health problems would distract from addressing the foundational causes of such behaviors and (iii) the potential, that for various reasons, such interventions would not be publically acceptable.

We also discuss concerns that might arise if this intervention was paired with emerging screening technologies, including genetic screening. Such pairing might improve the cost–benefit analysis of using this intervention, because only those at highest risk of nicotine dependence would be targeted. However, this strategy could raise a concern that those deemed to be at ‘high risk’ would be stigmatized and thus harmed.

These issues must be assessed before any decision about broad application is made. Specific empirical research would be warranted, such research could provide crucial data about the likelihood and consequences of these concerns as well as on whether they could be resolved or minimized. Such information would help policy makers decide whether and how broad application of this enhancement should be designed.

While the issues noted above are important for the translation of many new interventions to improve population health, the current example draws on the context of enhancements, vaccines, adolescence and social contested behaviors and these contexts make the issues even more salient and complex. The nicotine vaccine and vaccines such as the widely debated HPV vaccine are aimed at reducing the substantial disease burden associated with risk behaviors that begin in adolescence (Colgrove, 2006; Field and Caplan, 2008; Balog, 2009). These vaccines have the common goal to prevent negative health outcomes, yet they have considerable difference in their effect on behavior. The nicotine vaccine reduces the probability that one will engage in a particular behavior (tobacco use), whereas the HPV vaccine confers protection from an infectious agent without interfering with any behavior. Additionally, the prevalence of risky health behaviors such as tobacco use and poor nutrition is disproportionately concentrated in geographic areas associated with low socio-economic characteristics, whereas HPV infection is highly prevalent and thus risk is more evenly distributed (Eaton *et al.*, 2010; Tabrizi *et al.*, 2012). Accordingly, at least *prima facie*, the nicotine vaccine and other behavior-directed enhancements raise concerns about autonomy and social impact that the HPV vaccine does not,

making the nicotine vaccine ethically distinct from and arguably more problematic than the HPV vaccine.

The future portends the development of additional enhancements that, for example, could address overeating and sedentary behaviors. An analysis of the ethical and social issues brought up by the prospect of a nicotine vaccine will be germane for these enhancements as well. It is crucial to consider these issues when such technologies are in the early stages of development, as this can provide guidance about what translational research questions must be answered before broadly applying such enhancements.

## Enhancing Children

The debate over biomedical enhancements in general and about enhancing children in particular has been going on for some time now. But as Allen Buchanan has recently argued, this debate has reached an impasse, two positions have emerged: the pro-enhancement and the anti-enhancement (Buchanan, 2011). This division is unhelpful; arguments from both sides are too broad and are thus likely to miss critical differences between particular enhancements. To avoid this impasse he suggests a more productive approach which is to examine each enhancement in its own lights. Such examination could draw on the arguments from this debate, yet the arguments need to be carefully applied to each case. This is the approach we have undertaken in this paper, arguments opponents of enhancing children have proposed will be applied to the nicotine vaccine case.

Before turning to the analysis, a few clarifications are needed. We should first consider whether the nicotine vaccine is indeed a biomedical enhancement. There remains ongoing debate over how to distinguish medical treatment from enhancements, an issue that cannot be resolved here. Instead, for the purposes of this article, we adopt the view that an intervention operates as a ‘treatment’ when it is aimed at improving biological functioning that is considered by current medical knowledge as outside the normal range (Juengst, 1998; Buchanan, 2011). Conversely, ‘enhancements’ are interventions used to improve functioning that is considered to be within the normal range (Chan and Harris, 2007; Buchanan, 2009).

It could then be argued that medical interventions such as the nicotine vaccine ought to be considered ‘enhancements’ because they do not treat an existing medical condition, but instead aim to improve normal functioning of biological mechanisms in healthy children. In the same way that a flu vaccine ought to be

considered an enhancement because it improves a normally functioning immune system, so would be a vaccine that addresses a behavior when the underlying mechanism is in most cases considered normal. In general, the uptake of tobacco use is not associated with abnormal functioning or with an underlying health deficit. Accordingly, measures that would make children ‘immune’ to nicotine use would be considered enhancements.<sup>2</sup>

One might object to the view that the nicotine vaccine should be regarded an enhancement. It could be argued that such a vaccine is not an enhancement and neither are infectious diseases vaccines; they are preventive measures and as such occupy a distinct category. This, however, seems implausible because the nicotine vaccine, like a flu vaccine, is a medical intervention that triggers a biological response that would not otherwise take place; it makes a normally functioning biological makeup less vulnerable than it otherwise would have been. This, we would argue, is an enhancement. We do not suggest that all preventive measures ought to be regarded enhancements and surely not all enhancements are preventive. Yet, in the case of the nicotine vaccine and many infectious disease vaccines, these interventions are both preventive and enhancing.

Whether one agrees with this analysis might not be too important, as Buchanan and others have argued, what is crucial is whether the intervention undermines important values (Buchanan, 2011; Lev, 2011). The mere fact that an intervention is labeled an ‘enhancement’, a ‘treatment’ or ‘prevention’ is not crucial for the moral analysis.<sup>3</sup>

To illustrate this point, we could compare the nicotine vaccine with a flu vaccine. We suggested that both are enhancements and thus one might conclude that as the latter is permissible, the former should be too, and no further analysis is needed. However, this conclusion would be too quick. This is because the nicotine vaccine is in important respects different from a flu vaccine; the latter does not intervene in behavioral aspects while the former does. Intervening in behavior could potentially be ethically problematic. For example, if the nicotine vaccine blocks certain valuable options, autonomy and well-being could be harmed. In contrast, a flu vaccine does not generate such concerns. Thus, the fact that both interventions are enhancements does not imply that either is permissible or impermissible. To render such judgments, we must go beyond the label and examine the intervention’s specific effects and how they might impact important values and ideals.

With this analysis in mind, we now turn to assess the claims that Michael Sandel and Jurgen Habermas—two

of the most important critics of enhancements—have made about enhancing children. We consider their arguments with the nicotine vaccine case.

### Concerns about Undermining Children's Autonomy

Concerns have been raised that enhancement interventions, such as those that would improve intelligence, memory, height or athletic abilities, may undermine children's development of autonomy. The argument here is that by modifying children for certain traits, parents may over-determine their children's preferences, attitudes and values, thereby restricting autonomy (Habermas, 2003; Coady, 2009). These cautions have been directed most vociferously toward genetic enhancements; however, they apply to the nicotine vaccine as well because the vaccine could have lasting effects on children's preferences,

'...genetically programmed persons might no longer regard themselves as the sole authors of their own life history;' (Habermas, 2003: 79)

This claim could be applied to a whole host of discretionary parenting practices (Harris, 2007: 140). Parents exercise authority over their children in deciding which activities to encourage, which to discourage or even ban. While these actions have a powerful influence on their children's values and preferences, effects that cannot be entirely reversed, they do not necessarily undermine children's future autonomy (Fenton, 2006; Harris, 2007). Indeed, they hardly ever do. As long as a sufficient number of options remain available, children's development of autonomy is not threatened. Importantly, while the nicotine vaccine does limit certain options, it could promote children's autonomy by enabling children to pursue a wider set of activities. For example, the nicotine vaccine could expand children's options for activities by virtue of improved health and physical capacity. Thus, the claim that the nicotine vaccine would undermine the conditions needed for the development of autonomy is implausible. The contrary is likely to be the case; the vaccine would ensure that valuable options are not eliminated, thereby maintaining the conditions needed for the development of autonomy.<sup>4</sup>

It could also be argued that the nicotine vaccine and others like it could undermine children's capacity to become autonomous agents, that is, to develop the mental abilities needed to render independent judgments. For example, consider that children who have received this enhancement would have a diminished experience and thus are unlikely to engage in tobacco use,

under these conditions one could argue that the enhancement essentially takes away the opportunity to decide whether to experiment with tobacco or to defer. This concern too is lessened as one considers that children have numerous opportunities to exercise their decision-making abilities (e.g. what sport to play, who to befriend). Such opportunities could be sufficient to nurture the competencies needed for independent decision-making.

In addition, permitting parents to decide to administer this novel intervention to their children could be argued to be well within the scope of parental authority (Wilfond and Ross, 2009). Interventions aimed at keeping children from smoking may be no less acceptable than parents influencing their children's diet, education and other recreational activities. To be sure, parental authority is not without restrictions. There are limits as the role of the state in suspected child abuse or neglect demonstrates (Archard, 1993, 2004). Social service agencies can intervene when it is clear that parental behavior is imminently and seriously harmful to children and the intervention can address the harm. Yet, as conceptualized here, emerging enhancements with the objective to reduce risky health behaviors do not exceed the threshold for parental authority. While arguably it would be better to motivate children to refrain from smoking tobacco by reasoned discussion and deliberation, as some parents will attest this is not always sufficient. Parents may look to biomedical enhancements as well as social influences to shape their children's future. To be clear, parents may choose not to take any step to discourage the uptake of tobacco use by their children; such an approach is within their rights. Importantly, turning to the nicotine vaccine would also be consistent with their parental rights.

Some might argue that the nicotine vaccine is ethically problematic because it could constrain the choices that children should have available to them as adults (Hasman and Holm, 2004). While as a society we might be comfortable allowing parents to limit children from pursuing certain options to preserve their health, many would consider it unacceptable to limit adults' freedom to engage in legal activities such as cigarette smoking. One way to address this concern is to design the nicotine vaccine in a way that restricts its effects to a specific time period, for instance to a year. This will ensure that when children reach the age of majority they would be able to decide whether or not to engage in tobacco use. However, even if the nicotine vaccine's effect is lasting—which is not the case with the vaccines currently under development—it might still be

permissible to administer it. Many child-rearing decisions, such as education, religion and geography, profoundly influence options and opportunities in adulthood. Indeed, some of these decisions effectively limit legally permissible options. Adults can make further choices to modify their life as they grow older, but these are built on the foundation of their childhood that was, in part, shaped by their parents' decisions.

Finally, one could argue that adolescents should be able to make their own choices, provided they have the required maturity and sufficient knowledge. However, when children adopt this risky behavior, they are usually ill-informed and unable to assess the risks involved. In other words, they commonly do not, indeed cannot, exercise autonomy when making this decision. A nicotine vaccine, by eliminating the pleasurable effects of tobacco, could make it more likely that such non-autonomous decisions are not taken (McMahon-Parkes, 2011).

Enhancing children with the nicotine vaccine is unlikely to harm the development of autonomy; indeed it might even promote that goal. This, however, does not mean that every biomedical enhancement is likely to promote or have no detrimental effect on autonomy. Some enhancements could undermine it, enhancing children in order to inculcate a risk averse behavior, depending on the magnitude of the effect of the enhancement, could harm autonomy. If children are made strongly averse to a whole host of high-risk activities, such as horse-riding, rock-climbing, becoming a policeman or a pilot as well as other risky activities, autonomy could be negatively affected. In other words, if the enhancement effectively closes a range of options and not just one choice, the development of autonomy would be affected. This, however, does not appear to be the case with the nicotine vaccine because only one option is curtailed, thereby rendering Habermas' argument inapplicable.

### Concerns about Children's Well-Being

A second concern about enhancements is that efforts to shape children's abilities and capacities might undermine other important values and attitudes (Sandel, 2009). This concern would be that using behaviorally targeted enhancements might engender instrumental attitudes toward children and negatively influence parental affection thereby harming children's well-being. Michael Sandel has raised this concern suggesting that children not be treated as objects of design.

To appreciate children as gifts is to accept them as they come, not as objects of our design or products of our will or instruments of our ambitions. Parental love is not contingent on the talents and attributes a child happens to have (Sandel, 2009: 79).

Underlying this assertion is the deeply held belief that parents should accept and love their children regardless of their 'talents and attributes'. However, as a society we accept that parents enhance their children via educational and biomedical means. Indeed, it is incumbent on parents to nurture children and take actions to protect them from harm, to wit a nicotine vaccine might be pursued out of love and care for one's child. While not every enhancement would be acceptable, infectious diseases vaccinations and a nutritious diet, for example, would be considered by most to be ethically acceptable (Lewens, 2009).

However, it would be naive to suggest that these enhancements have no potential for misuse. For example, it might be ethically problematic if parents pursued the vaccine based on their own ambitions and dissatisfaction with the child. Parental encouragement for athletic prowess could raise this concern. While undesirable, such motivations would not render such interventions impermissible. Preserving a child's welfare is central to determining ethical permissibility (Kamm, 2009). Thus, parents' motivation for applying any enhancement to their child is not relevant unless the enhancement is harmful to the child or undermines the child's rights. The nicotine vaccine as we saw earlier does not undermine autonomy, by extension children's rights are not threatened. The question of harm would depend on extensive testing; we assume that the vaccine would not be available unless it is reasonably safe.

Moreover, using an enhancement to reduce the likelihood that a child would smoke, which is a risk factor for countless negative health outcomes, is arguably consistent with parents' obligation to show concern for a child's health and welfare. Indeed, one could argue that this intervention expresses parental love and is likely to promote children's well-being. Accordingly, the worries Sandel raises do not seem to apply in this case.

However, Sandel's claim should not be dismissed entirely; there could be circumstances under which his argument might have purchase. For example, if parents used, in addition to the nicotine vaccine, a large number of enhancements, ones that have substantial impact on children's identity and preferences, under such circumstances children's well-being might be affected. The child might feel that his parents are treating him instrumentally and this might lead to a diminished sense of

well-being. This is, of course, merely a potential outcome. It is difficult to predict what children would feel if their parents enhanced them with more than just the nicotine vaccine. Other scenarios could be illustrated, for instance, if the nicotine vaccine is effective but has a negative side effect on children's sense of taste such that overall their well-being is diminished, administering the vaccine could be problematic. Many other scenarios can and should be described; anticipating future scenarios will help us assess how enhancing children with various interventions would affect their well-being.

To be sure, different enhancements are likely to affect children's well-being differently; the nicotine vaccine's effect on well-being is likely to be quite different from the effects of memory or athletic abilities enhancements. Some enhancements are likely to improve well-being more than others; this will depend on the actual effects of the enhancement on children and also on how third parties, such as parents and teachers, treat enhanced children. These differences could make a moral difference and thus require an independent assessment of each enhancement.

With these considerations in mind, it is reasonable to conclude that targeting children with a nicotine vaccine that is safe and effective would be ethically permissible as it would not undermine children's autonomy and is unlikely to harm their well-being. Indeed, it could be argued that this intervention is likely to further these values.<sup>5</sup> However, the fact that it would be permissible does not mean that it should be pursued broadly, that is, as a matter of public policy. We thus turn to assess some of the main issues that need to be resolved in order to determine whether broad application of the nicotine vaccine would be desirable.

## Societal Implications of Using a Nicotine Vaccine

Children with low socio-economic status are more likely to engage in tobacco use as well as poor eating habits and physical inactivity than their counterparts from higher income households (Bethell *et al.*, 2010). Should the nicotine vaccine be deemed safe and effective, this vaccine could have the potential to reduce as yet intractable health disparities. Indeed, by improving the health of economically disadvantaged children, the nicotine vaccine has the potential to move society closer to the ideal of equality of opportunity.

However, there are other ways in which as a society we could improve children's health and their range of

opportunities. Thus, in order to decide whether broad application of the nicotine vaccine should be pursued, research comparing the effectiveness and costs of the vaccine with other public health efforts should be undertaken. It might be the case that simpler steps, such as adjusted pricing and creating an environment in which adolescents' access to tobacco products is much more difficult than it is currently, would be more cost-effective. Indeed, Carol Gartner has recently argued that broad application of the nicotine vaccine is unlikely to be cost-effective and that other strategies should be sought to address the issue of adolescents' tobacco use (Gartner *et al.*, 2012). It is important to note that even if the vaccine proves to be more cost-effective than other alternatives, additional considerations ought to be assessed. In other words, comparative effectiveness research is necessary but not sufficient for deciding on broad application; there are a few other concerns that warrant investigation.

One concern is that use of this vaccine could distract from addressing the foundational causes of such behaviors. It is well established that risky health habits such as smoking tobacco often result from deeply rooted social disparities in income and education that create stressful life circumstances where tobacco use can be an important coping strategy. It would be important that such vaccines be considered in the broader socio-ecological context to ensure that potential unintended consequences such as masking of deeper social issues are assessed. It would be important to ensure that the use of such a vaccine would not divert resources and efforts to address the underlying social contexts that make smoking attractive.

A related issue that would need to be assessed is the social acceptability of such a vaccine. A few concerns about the likelihood of uptake could be raised. Some might be concerned that smoking might be better dealt with in a non-medical way, because of a worry that using this biomedical intervention would 'medicalize' behaviors, thereby labeling as 'ill' those targeted by the intervention. Others might be concerned about the safety of using vaccines on children. These concerns, if widespread, could hinder uptake.

Specific social and behavioral research would be needed to assess the likelihood and magnitude of these concerns. Such research would be important as it can provide policy makers with the necessary information to decide whether to promote broad application of the vaccine and if so, how to implement such program.

One potential way to investigate these concerns, especially those related to social acceptability and uptake, could be through directly engaging with communities in

which this measure is to be implemented. Community engagement can serve multiple purposes; it could inform on ways to reduce the likelihood of misperceptions about the vaccine and enable objections to be aired and addressed (Ross, 2010). It could also be instrumental in identifying optimal strategies for implementing vaccine programs and help determine the resources needed.

## Concerns about Pairing Screening Technologies with the Nicotine Vaccine

Some might argue that widespread vaccine programs would be unnecessary as tobacco dependence is confined to a relatively small proportion of the population. Many children who experiment with tobacco do not go on to become dependent. Optimally, vaccines should be targeted at those who are most susceptible to tobacco dependence (Hall, 2005). Genome-based susceptibility testing is increasingly being offered to characterize those at increased risk for a variety of health outcomes including addictive behaviors and obesity (Frayling *et al.*, 2007). While such uses of genomics remain highly contested, such testing could eventually lend insight into which individuals may be most likely to benefit from vaccinations (Hall *et al.*, 2010; Evans *et al.*, 2011). For example, in the case of tobacco use, genetic susceptibility assessment might be combined with social and behavioral susceptibility assessments (Wilfond *et al.*, 2002; Kaprio, 2009) to identify and target ‘high-risk’ youth who could benefit most from novel interventions and where public health benefit could be maximized (Pierce *et al.*, 1996; Collins, 2010). Additionally, should the nicotine vaccine be associated with any risk of adverse events, genetic testing could be used to minimize these occurrences by better targeting its application. Combining genetic testing and the emerging interventions might seem like an attractive public health strategy.

However, the layering of biotechnologies such as genetic testing onto other emerging biotechnical interventions raises concerns that must be considered thoughtfully. First, genetic testing might help in targeting the interventions but the costs of genetic tests might outweigh their benefits. If the new interventions are as safe as influenza vaccines, administering them regardless of genotype or risk stratification might turn out to be as or even more cost-effective than an alternative that includes testing (Hall, 2005).

If the analysis indicates that pairing genetic testing with the vaccine is as or more cost-effective than other alternatives, such an approach should be considered. However, this strategy ought to be scrutinized as it might lead to unintended consequences. A major concern with strategies intended to stratify populations on disease risk is the potential to expose identified ‘high-risk’ children to the risk of being socially excluded or stigmatized (Wilfond *et al.*, 2002). The available data suggest that such fears have been exaggerated. However, the evidence base is quite limited and focused primarily on children affected by rare diseases (Wade *et al.*, 2010). Determining the potential of social stigma would help policy makers assess the desirability of different risk-screening approaches and inform ways in which harms could be minimized.

When technologies, such as genetic testing and enhancements to influence behavior are considered in tandem, even if that approach makes the most rational sense from a public health perspective, including cost, the social complexities of community acceptability will need to be examined carefully.

## Conclusions

Tobacco use and other health behaviors are the leading risk factors for developing major chronic diseases that account for high rates of morbidity and mortality worldwide. It is widely recognized that efforts to prevent these health outcomes should begin in early childhood. Emerging biomedical enhancements such as the nicotine vaccine are likely to continue to be developed. It is critical that we begin to consider the ethical and policy implications of targeting children for such biomedical enhancements.

The ethical concerns raised by critics of biomedical enhancements about child well-being and autonomy are not compelling in this particular case and thus the vaccine should be considered ethically permissible. However, ethical permissibility does not imply that the vaccine should be broadly promoted as a matter of public policy. We have highlighted several important issues that should be assessed in order to decide whether broad application of this vaccine should be promoted. These included the following: comparing the effectiveness and costs of the vaccine with other public health efforts aimed at improving children’s health, examining whether broad application of the vaccine would distract from efforts to address the foundational issues that cause disparities in children’s health and opportunities and exploring the social acceptability of such vaccines.

We have also suggested that pairing the vaccine with emerging genetic screening technologies, despite being attractive in concept, need to be carefully assessed.

Social and behavioral research, including comparative effectiveness research and community engaged research related to the use of nicotine vaccines is thus necessary. Such research could help determine which strategies are most promising to improving children's health and well-being in a complex social context. Ultimately, further ethical and policy analysis will be needed as more data emerge from such research.

## Acknowledgements

The authors would like to thank Dr Richard Street, Dr Carla Saenz, Dr Christopher Wade, Dr Shlomi Segall, Dr Benjamin Sachs, Mr Vence Bonham, Dr Dirk de Heer and the participants in the Public Health Genomics section at SBRB for their helpful suggestions. The opinions expressed are those of the authors and do not reflect any position or policy of the National Institutes of Health, United States Public Health Service or Department of Health and Human Services.

## Funding

The Intramural Research Program of the National Human Genome Research Institute, National Institutes of Health (grants to O.L. and C.M.); National Center for Advancing Translational Sciences (grant no. UL1TR000423 to B.W.); the Center for Genomics and Health Care Equality, National Human Genome Research Institute (grant no. P50HG003374 to B.W.).

## Conflicts of Interest

None declared.

## Notes

1. A nicotine vaccine is not the only approach being investigated to address tobacco use. A recent study points to gene transfer as an alternative method. There are likely to be critical ethical as well as policy differences between these approaches, ones that deserve careful consideration. In this article, we focus on the vaccine. See Hicks *et al.* (2012) on the potential for using gene transfer to produce

anti-nicotine antibodies that will block nicotine from binding to brain receptors.

2. It is important to clarify that the distinction between 'treatment' and 'enhancement' upon which we base our argument is grounded in the notion of 'normal functioning'. Accordingly, it could be the case that an intervention is labeled 'treatment' for some and an 'enhancement' for others. Human growth hormone is used as a treatment for those with abnormal stature; it is an enhancement for those whose height is considered to be within the normal range. The case of risky health behaviors, including tobacco use has similar features; most people are within the normal range while others are not. Assuming that is the case, the nicotine vaccine would be enhancement for most people and a treatment for some.
3. Given this statement, one might wonder about the alleged merits of the 'enhancement' debate and why a vast literature has been devoted to it. The debate over the ethical permissibility of enhancing people has, in our opinion clarified many important questions about what values are important to protect and even promote given this biomedical development. This literature has contributed significantly to our understanding of what is at stake if biomedical enhancements are pursued. One of the many outcomes that this debate has yielded is the insight that we should go beyond labels, indeed we should examine the impact of each intervention in its own lights.
4. One might argue that the 'real' ethical difference between the nicotine vaccine and other decision parents make about their children's lifestyle emanates from the fact that the vaccine is invasive, while the other choices are not. However, this would imply that flu vaccines are also somewhat problematic, that's an implausible position. Moreover, parents make choices about education and diet that might not violate bodily integrity but could be morally very problematic. Invasiveness by itself is not sufficient to make the vaccine problematic.
5. As children who will receive this vaccine are likely to be around the age of 9–16 years, it is crucial that they be engaged in the decision-making process. Their level of engagement will depend, among other things, on the age in which the vaccine will be offered.

## References

- Archard, D. (1993, 2004). *Children—Rights and Childhood*. Oxford: Routledge.



- Balog, J. E. (2009). The Moral Justification for a Compulsory Human Papillomavirus Vaccination Program. *American Journal of Public Health*, **99**, 616–622.
- Bethell, C., Simpson, L., Stumbo, S., Carle, A. C. and Gombojav, N. (2010). National, State, and Local Disparities in Childhood Obesity. *Health Affairs*, **29**, 347–356.
- Buchanan, A. (2009). Moral Status and Human Enhancement. *Philosophy and Public Affairs*, **37**, 354.
- Buchanan, A. (2011). *Beyond Humanity?: The Ethics of Biomedical Enhancement*. New York: Oxford University Press.
- Centers of Disease Control and Prevention (CDC). (2006). *Sustaining State Programs for Tobacco Control Data Highlights 2006*. Available from: [http://www.cdc.gov/tobacco/data\\_statistics/state\\_data/data\\_highlights/2006/pdfs/dataHighlights06rev.pdf](http://www.cdc.gov/tobacco/data_statistics/state_data/data_highlights/2006/pdfs/dataHighlights06rev.pdf). [accessed 1 May 2012].
- Centers of Disease Control and Prevention (CDC). (2010). Vital Signs: Current Cigarette Smoking Among Adults Aged  $\geq 18$  Years — United States, 2009. *Morbidity and Mortality Weekly Report*, **59**, 1135–1140.
- Centers of Disease Control and Prevention (CDC). (2011). *Tobacco Use—Targeting the Nation’s Leading Killer: At a Glance 2011*. Available from: <http://www.cdc.gov/chronicdisease/resources/publications/AAG/osh.htm#aag> [accessed 1 May 2012].
- Chan, S. and Harris, J. (2007). In Support of Human Enhancement. *Studies in Ethics, Law and Technology* doi:10.2202/1941-6008.1007.
- Coady, C. A. J. (2009). Playing God. In Savulescu, J. and Bostrom, N. (eds), *Human Enhancement*. Oxford: Oxford University Press, pp. 155–180.
- Colgrove, J. (2006). The Ethics and Politics of Compulsory HPV Vaccination. *New England Journal of Medicine*, **355**, 2389–2391.
- Collins, F. (2010). Has the Revolution Arrived? *Nature*, **464**, 674–675.
- Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J., Harris, W. A., Lowry, R., McManus, T., Chyen, D., Lim, C., Whittle, L., Brener, N. D. and Wechsler, H. (2010). Youth Risk Behavior Surveillance — United States, 2009. *Morbidity and Mortality Weekly Report*, **59**, 1–142, Available from: <http://www.cdc.gov/mmwr/pdf/ss/ss5905.pdf> [accessed 4 February 2013].
- Evans, J. P., Meslin, E. M., Marteau, T. and Caulfield, T. (2011). Genomics: Deflating the Genomic Bubble. *Science*, **331**, 861–862.
- Fenton, E. (2006). Liberal Eugenics and Human Nature: Against Habermas. *Hastings Center Report*, **36**, 35–42.
- Field, R. I. and Caplan, A. L. (2008). A Proposed Ethical Framework for Vaccine Mandates: Competing Values and the Case of HPV. *Kennedy Institute of Ethics Journal*, **18**, 111–124.
- Frayling, T. M., Timpson, N. J., Weedon, M. N., Zeggini, E. et al. (2007). A Common Variant in the FTO Gene Is Associated with Body Mass Index and Predisposes to Childhood and Adult Obesity. *Science*, **316**, 889–894.
- Gartner, C., Barendregt, J., Wallace, A. and Hall, W. (2012). Would Vaccination Against Nicotine be a Cost Effective Way to Prevent Smoking Uptake in Adolescents? *Addiction*, **107**, 800–809.
- Habermas, J. (2003). *The Future of Human Nature*. Malden, MA: Polity.
- Hall, W. (2005). Will Nicotine Genetics and a Nicotine Vaccine Prevent Cigarette Smoking and Smoking-related Diseases? *PLoS Medicine*, **2**, e266.
- Hall, W. and Gartner, C. (2011). Ethical Issues in Using Drug Vaccines to Treat and Prevent Cocaine and Nicotine Dependence. *Current Opinion in Psychiatry*, **24**, 191–196.
- Hall, W., Mathews, R. and Morley, K. (2010). Being More Realistic About the Public Health Benefits of Preventive Genomic Medicine. *PLoS Medicine*, **7**, e1000347.
- Harris, J. (2007). *Enhancing Evolution*. Princeton, NJ: Princeton University Press.
- Hasman, A. and Holm, S. (2004). Nicotine Conjugate Vaccine: Is There a Right to a Smoking Future? *Journal of Medical Ethics*, **30**, 344–345.
- Hicks, M. J., Rosenberg, J. B., De, B. P., Pagovich, O. E., Young, C. N., Qiu, J. P., Kaminsky, S. M., Hackett, N. R., Worgall, S., Janda, K. D., Davisson, R. L. and Crystal, R. G. (2012). AAV-directed Persistent Expression of a Gene Encoding Anti-nicotine Antibody for Smoking Cessation. *Science Translational Medicine*, **4**, 140ra87.
- Juengst, E. T. (1998). What does Enhancement Mean?. In Parens, E. (ed.), *Enhancing Human Traits – Ethical and Social Implications*. Washington, DC: Georgetown University Press, pp. 29–47.
- Kamm, F. (2009). What is and is not Wrong with Enhancement?. In Savulescu, J. and Bostrom, N. (eds), *Human Enhancement*. Oxford: Oxford University Press, pp. 91–130.
- Kaprio, J. (2009). Genetic Epidemiology of Smoking Behavior and Nicotine Dependence. *Journal of Chronic Obstructive Pulmonary Disease*, **6**, 304–306.

- Lev, O. (2011). Will Biomedical Enhancements Undermine Solidarity, Responsibility, Equality and Autonomy? *Bioethics*, **25**, 177–184.
- Lev, O., Miller, F. G. and Emanuel, E. J. (2010). The Ethics of Research on Enhancement Interventions. *Kennedy Institute of Ethics Journal*, **20**, 101–113.
- Lewens, T. (2009). Enhancement and Human Nature: the Case of Sandel. *Journal of Medical Ethics*, **35**, 354–356.
- McMahon-Parkes, K. (2011). Is Prevention Better than Cure? A Re-evaluation of the Potential Use of Nicotine Conjugate Vaccine in Children. *Public Health Ethics*, **4**, 121–128.
- Media Newswire. (2009). *Federal Stimulus Grant Supports Crucial Study of Anti-Nicotine Vaccine*. Available from: [http://media-newswire.com/release\\_1104703.html](http://media-newswire.com/release_1104703.html) [accessed 05 March 2012].
- PharmaTimes Online. (2011). *Nabi Nicotine Vaccine Hopes go up in Smoke*. Available from: [http://www.pharmatimes.com/article/11-07-19/Nabi\\_nicotine\\_vaccine\\_hopes\\_go\\_up\\_in\\_smoke.aspx](http://www.pharmatimes.com/article/11-07-19/Nabi_nicotine_vaccine_hopes_go_up_in_smoke.aspx) [accessed 22 August 2012].
- Pierce, J. P., Choi, W. S., Gilpin, E. A., Farkas, A. J. and Merritt, R. K. (1996). Validation of Susceptibility as a Predictor of which Adolescents Take Up Smoking in the United States. *Health Psychology*, **15**, 355–361.
- Ross, L. F. (2010). 360 Degrees of Human Subjects Protections in Community-engaged Research. *Science Translational Medicine*, **2**, 45.
- Sandel, M. (2009). The Case Against Perfection: What's Wrong with Designer Children, Bionic Athletes, and Genetic Engineering. In Savulescu, J. and Bostrom, N. (eds), *Human Enhancement*. Oxford: Oxford University Press, pp. 71–90.
- Tabrizi, S. N., Brotherton, J. M. L., Kaldor, J. M., Skinner, S. R., Cummins, E., Liu, B., Bateson, D., McNamee, K., Garefalakis, M. and Garland, S. M. (2012). Fall in Human Papillomavirus Prevalence Following a National Vaccination Program. *Journal of Infectious Diseases*, **206**, 1645–1651.
- Wade, C. H., Wilfond, B. S. and McBride, C. M. (2010). Effects of Genetic Risk Information On Children's Psychosocial Wellbeing: A Systematic Review of the Literature. *Genetics in Medicine*, **12**, 317–326.
- Wilfond, B. S., Geller, G., Lerman, C., Audrain-McGovern, J. and Shields, A. E. (2002). Ethical Issues in Conducting Behavioral Genetics Research: the Case of Smoking Prevention Trials Among Adolescents. *Journal of Health Care Law and Policy*, **6**, 73–88.
- Wilfond, B. and Ross, L. F. (2009). From Genetics to Genomics: Ethics, Policy, and Parental Decision-making. *Journal of Pediatric Psychology*, **34**, 639–647.