



Elsevier has created a [Monkeypox Information Center](#) in response to the declared public health emergency of international concern, with free information in English on the monkeypox virus. The Monkeypox Information Center is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its monkeypox related research that is available on the Monkeypox Information Center - including this research content - immediately available in publicly funded repositories, with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the Monkeypox Information Center remains active.

What Dermatologists Do Not Know about Smallpox Vaccination: Results from a Worldwide Electronic Survey

Robert P. Dellavalle^{1,2}, Lauren F. Heilig^{2,3}, Shayla O. Francis², Kathryn R. Johnson², Eric J. Hester², Kristie M. McNealy², Lisa M. Schilling^{3,4} and William L. Weston²

The risk of a bioterrorist attack with smallpox has increased owing to breakthroughs in the *de novo* synthesis of long-chain DNA molecules. Although the leading roles of dermatologists in diagnosing recent outbreaks of cutaneous anthrax and monkeypox demonstrate the importance of dermatologist preparedness for bioterrorism, dermatologist knowledge regarding smallpox vaccination has not been extensively examined. We conducted a cross-sectional worldwide electronic survey of all members of the American Academy of Dermatology with available e-mail addresses. The response rate was 23% (1,303/5,723): 34% of respondents were women, 52% were age 50 or older, 85% practiced in the US, and 90% reported English as their primary language. Less than 37% indicated the Centers for Disease Control and Prevention estimated rate of death owing to smallpox vaccination (1 in 1,000,000), and many failed to identify vaccination contraindications: previous myocardial infarction (83%), angina (83%), congestive heart failure (78%), steroid eye drop use (65%), and the non-emergency vaccination of those younger than age 18 (95%). Widespread dermatologist smallpox vaccination knowledge deficits pinpoint opportunities for educational efforts.

Journal of Investigative Dermatology (2006) **126**, 986–989. doi:10.1038/sj.jid.5700235; published online 9 March 2006

INTRODUCTION

US smallpox vaccination policy has generated heated debate (Beane, 2004; Kaiser, 2005). Although US physicians and patients are increasingly unwilling to volunteer for smallpox vaccination (Blendon *et al.*, 2003; Everett *et al.*, 2003, 2004; Kuhles and Ackman, 2003; Benin *et al.*, 2004; Centers for Disease Control and Prevention, 2005a), advances in long molecule DNA synthesis that facilitate *in vitro* synthesis of viral genomes have recently heightened concerns about smallpox bioterrorism attacks (Tian *et al.*, 2004).

This study assessed dermatologist knowledge regarding smallpox vaccination.

RESULTS

The response rate for the electronic survey (Online Appendix A) was 23% (1,303/5,723). Thirty-four percent of respondents were women, 52% were age 50 or older, 85% practiced in the USA, and 90% reported English as their primary language. Respondents reflected American Academy of Dermatology (AAD) fellow sex and age distributions, and over-represented fellows in the USA (Online Appendix B).

Questions regarding smallpox vaccination adverse events and contraindications were imbedded among 29 questions addressing the practices and attitudes of dermatologists regarding smallpox vaccination and responder demographics. Owing to skip patterns determined by the answers provided, all responders completing the full survey viewed at least 21 of the 29 questions. Response rates per question for these 21 questions ranged from 99% for the first question regarding types of media exposure through which smallpox educational information had been obtained to 90% for the fill-in question requesting country of practice. Except for one nurse, all respondents were physicians. Most respondents (71%) saw patients in a town of 100,000 or more people, and 46% practiced in a group setting.

Few respondents (17%) reported recent vaccination for smallpox in the preceding 5 years (16.8% US vs 27.3% outside the US) (relative risk for smallpox vaccination among US respondents = 0.6; 95% confidence interval = 0.3, 1.3). Eighty-three percent of those who had been given

¹Department of Veterans Affairs Medical Center, Denver, Colorado, USA;

²Department of Dermatology, University of Colorado at Denver and Health Sciences Center, Aurora, Colorado, USA; ³Department of Preventive Medicine and Biometrics, University of Colorado at Denver and Health Sciences Center, Aurora, Colorado, USA and ⁴Department of Medicine, University of Colorado at Denver and Health Sciences Center, Aurora, Colorado, USA

Correspondence: Dr Robert P. Dellavalle, Department of Veterans Affairs Medical Center, Denver, Colorado 80220, USA.

E-mail: Robert.dellavalle@uchsc.edu

Abbreviations: AAD, American Academy of Dermatology; CDC, Centers for Disease Control and Prevention

Received 21 November 2005; revised 22 December 2005; accepted 8 January 2006; published online 9 March 2006

a choice regarding whether or not to be vaccinated stated that vaccine safety had influenced their decision (Table 1). Most reported receiving recent information on smallpox from journal articles (91%), medical mailings (85%), Internet information (72%), medical lectures (71%), or newspaper articles (70%).

Dermatologists were frequently not in agreement (15% overestimated, 22% underestimated, 26% unsure) with the CDC estimate of death owing to smallpox vaccination (1 in 1,000,000) (Table 2). Most identified immunosuppression (97%), eczema (93%), breastfeeding (58%), and a household member with a history of eczema (57%) as contraindications to smallpox vaccination, but few identified myocardial infarction (17%), angina (17%), congestive heart failure (22%), use of steroid eye drops (35%), and non-emergency vaccination of those under age 18 (5%).

Table 1. Smallpox vaccination status

	Yes	No	Not sure
Has smallpox vaccination been available in your country in the past 5 years?	618 (52)	415 (35)	165 (14)
Has smallpox vaccination been available to you in the past 5 years?	526 (44)	479 (40)	205 (17)
Were you able to freely choose whether or not to receive smallpox vaccination?	448 (87)	51 (10)	15 (3)
<i>What factors influenced your smallpox vaccination decision?</i>			
Level of risk of a smallpox outbreak	370 (83)	77 (17)	
Vaccination safety	367 (83)	76 (17)	
Recommendations by healthcare organizations	267 (61)	168 (39)	
Recommendations by healthcare providers	256 (59)	178 (41)	
Vaccination convenience	125 (29)	305 (71)	
Patriotism	88 (20)	347 (80)	
Planned travel to other countries	71 (16)	364 (84)	
Recommendations by employer	62 (14)	371 (86)	
Incentives for vaccination	20 (5)	414 (95)	
<i>Have you recently been vaccinated (within 5 years) for smallpox?</i>			
Year			
2004	2 (2)		
2003	64 (74)		
2002	20 (23)		
2001	1 (1)		
2000	0 (0)		

Table 2. Smallpox vaccination knowledge

	Number (%)		
<i>Approximately, what is the current estimate of the rate of non-lethal serious side effects from smallpox vaccination, including blindness and hospitalization?</i>			
1 in 1,000,000 or more rare	128 (11)		
1 in 100,000 ¹	379 (31)		
1 in 10,000	249 (20)		
1 in 1,000	140 (12)		
Not sure	323 (27)		
<i>Approximately, what is the current estimate of the rate of death from smallpox vaccination?</i>			
1 in 10,000,000 or more rare	270 (22)		
1 in 1,000,000 ¹	448 (37)		
1 in 100,000	139 (11)		
1 in 10,000	46 (4)		
Not sure	313 (26)		
	Yes	No	Not sure
<i>Which of the following do you believe to be contraindications to smallpox vaccination?²</i>			
Immunosuppression	1184 (97)	11 (1)	26 (2)
Eczema	1133 (93)	47 (4)	38 (3)
Breastfeeding mother	698 (58)	211 (17)	298 (25)
Household member with a history of eczema	690 (57)	354 (29)	166 (14)
Use of steroid eye drops	420 (35)	441 (37)	344 (29)
Congestive heart failure	267 (22)	642 (54)	290 (24)
Previous myocardial infarction	206 (17)	759 (64)	228 (19)
Angina	198 (17)	761 (64)	239 (20)
Under the age of 18 years	63 (5)	1044 (88)	84 (7)

¹Best answer based on current CDC information.
²All conditions listed are contraindications to vaccination. A complete list of contraindications is available at: <http://www.bt.cdc.gov/agent/smallpox/vaccination/contraindications-clinic.asp>.

The answers of those who responded before the third e-mail invitation on October 8, 2004 ($n=877$) were compared with the answers of those responding after October 8, 2004 ($n=426$). No significant differences between the two groups were found with regard to sex, age, vaccination status, or agreement that a smallpox attack was likely in the next 12 months.

DISCUSSION

In 2001, the CDC recommended smallpox vaccination for medical or laboratory personnel exposed to non-highly attenuated orthopoxviruses (Rotz LD *et al.*, 2001). In

December 2002, President George W. Bush announced that those “deployed or who may deploy to certain high threat areas be vaccinated” (CDC, 2005b). In 2003, the CDC recommended vaccination “for persons designated by public health authorities to conduct investigation and follow-up of initial smallpox cases that might necessitate direct patient contact.” Each state and territory has been advised to establish and maintain at least one smallpox response team consisting of members who have previously been vaccinated (Wharton *et al.*, 2003). Cardiac complications from smallpox vaccination precipitated a CDC press release recommending deferral for heart patients volunteering for smallpox vaccination in March 2003 (Casey *et al.*, 2005). Our survey occurred in late 2004. As of December 5, 2005, over 920,000 Department of Defense operational forces and healthcare workers have been vaccinated (CDC, 2005c; Office of the Assistant Secretary of Defense, 2005).

Dermatologists would likely be among the first consultants summoned to perform skin biopsies and help distinguish smallpox from chickenpox, monkeypox, orf, and other diagnoses. Although dermatologists in this survey indicated willingness to be vaccinated if a smallpox outbreak occurred, the current low rate of recent vaccination parallels that of other healthcare workers (Kuhles and Ackman, 2003; Benin *et al.*, 2004; CDC, 2005a).

Smallpox vaccination confers immunity to smallpox for 3–5 years with waning immunity thereafter (CDC, 2005d; Hatakeyama *et al.*, 2005). The CDC identifies the risk of serious side effects from vaccination, including the spread of the live virus used in the *vaccinia* inoculation to other sites of the body or to other people, to occur in 1 in 1,000 persons (CDC, 2005e). The CDC also reports that 14 to 52 in 1,000,000 vaccinees will experience life-threatening reactions including eczema vaccinatum, progressive *vaccinia*, and postvaccinal encephalitis, and one to two in 1,000,000 vaccinees may die as a result. The CDC’s contraindications to smallpox vaccination for persons unexposed to smallpox currently include having eczema or other skin conditions, immunosuppression, pregnancy or plans to become pregnant within 1 month of vaccination, an allergy to the vaccine or its components, age younger than 1 year in an emergency setting or younger than 18 years in a non-emergency setting, breastfeeding, use of steroid eye drops, history of a heart condition diagnosed by a physician, or three or more of the following cardiac risk factors diagnosed by a physician: high blood pressure; high blood cholesterol; diabetes; first-degree relative with a heart condition before age 50; and currently smoking cigarettes (CDC, 2005e).

Most responders’ answers did not reflect CDC guidelines for smallpox vaccination of persons with heart disease or under the age of 18 years, a finding consistent with nearly half of healthcare workers not feeling well informed about the risks and benefits of smallpox vaccination (Yih *et al.*, 2003). Physician advice has also deviated from widely publicized public health guidelines for other infectious agents (Chan *et al.*, 1997; Deng *et al.*, 2006), highlighting the need for new approaches for physicians learning of public health messages (Armstrong and Parsa-Parsi, 2005).

This study has strengths and weaknesses:

- (a) The response rate was 23% reflecting increasing limitations in obtaining high response rates to electronic surveys (Sheehan, 2001). We were, however, encouraged to achieve a response rate similar to those of many other published electronic surveys (Sheehan, 2001; Hester *et al.*, 2004) despite the decreased tendency of physicians to respond to surveys compared with other sample populations (Asch *et al.*, 1997).
- (b) The potential for response bias for e-mail surveys is greater than for mailed or telephone surveys (Braithwaite *et al.*, 2003). Voluntary response to an electronic survey likely selected for responses from physicians more interested in and knowledgeable about smallpox. The results therefore likely overestimate vaccination rates and underestimate knowledge deficits regarding smallpox vaccination.
- (c) Survey invitations were emailed directly by AAD administration in the hope of improving response rate as well as to ensure anonymity of respondents. However, as no e-mail addresses or other identifying variables for AAD members were provided to the authors, examination of non-responder bias was not possible. Late responders have been suggested to display biases that might be accentuated in non-responders (Armstrong and Overton, 1977). Comparison of early and late responders to this survey showed no significant differences.
- (d) The questionnaire was not available in languages other than English, deterring response from non-native English speakers and creating a possible language barrier for the 10% of respondents whose primary language was not English.
- (e) This study did not assess dermatologists’ smallpox diagnostic skill, an important parameter for successful response to a bioterrorist attack.

Smallpox vaccination remains a topic of high importance and publicity. This study highlights the need to more effectively inform dermatologists about facts that may influence decisions regarding smallpox vaccination and provides descriptive information for improving public health smallpox communications with dermatologists and other potential first responders worldwide (Institute of Medicine, 2005). Future studies might investigate dermatologists’ smallpox diagnostic skill, how they view the importance of knowledge of smallpox, and how better knowledge might impact management of a bioterrorist attack.

MATERIALS AND METHODS

AAD fellows with active e-mail addresses (5,723 of 8,293) were emailed an introductory letter containing a link to the electronic-based questionnaire on August 9, 2004. Up to three further elicitations were emailed to non-responders on September 17, October 8, and December 9, 2004. The AAD mediated the emailing of members to protect member e-mail address confidentiality and prevent the authors from identifying responding and non-responding AAD members individually.

The survey (Online Appendix A) consisted of 29 questions addressing: (1) knowledge of efficacy, risks, and contraindications to smallpox vaccination, (2) perceived threat of a smallpox bioterrorism attack, (3) attitudes about vaccination, (4) personal vaccination history, and (5) demographic data. Information regarding contraindications to smallpox vaccination was obtained from the CDC (CDC, 2005e).

The questionnaire was designed and data collected using Survey Monkey, an Internet-based electronic survey resource (www.surveymonkey.com). Invitees were informed that all responses would remain anonymous and only be analyzed in aggregate. Data analysis, including relative risks with 95% confidence intervals, was performed using SAS Version 9 (Cary, NC). This study received Colorado Multiple Institutional Review Board approval (no. 03-677).

CONFLICT OF INTEREST

The authors state no conflict of interest.

ACKNOWLEDGMENTS

This study was presented at the International Dermatoepidemiology Association (IDEA) Americas Chapter meeting in St Louis, MO on May 5, 2005. We thank the members of the AAD who made this survey possible, especially 2004 President Boni Elewski, MD, Jon Hanifin, MD, and Jeffrey J. Meffert, MD, respectively, member and chair of the AAD Bioterrorism Task Force Committee, and AAD staff liaison Connie Tegeler. We thank Barbara Paez for providing AAD Fellowship demographics. We thank Kara Wallington, MRCP, for thoughtful discussion during the preliminary stages of the work. All authors helped design the project, draft, and pilot the survey, and comment upon the analysis of results and subsequent manuscript. Additionally, R.P.D. provided support for the study, wrote the first draft of the manuscript, and served as the principle investigator and corresponding author. L.F.H. conducted the analyses. This study was supported by National Institutes of Health (Bethesda, MD) Grants CA92550 (R.P.D.), 5 D14HP00153 (L.M.S.), and T32 AR07411 (K.R.J. and E.J.H.).

SUPPLEMENTARY MATERIAL

Online Appendix A. The survey.

Online Appendix B. Table reporting respondent and AAD fellow demographics.

REFERENCES

- Armstrong E, Parsa-Parsi R (2005) How can physicians' learning styles drive educational planning? *Acad Med* 80:680-4
- Armstrong JS, Overton TS (1977) Estimating nonresponse bias in mail surveys. *J Marketing Res* 14:396-402
- Asch DA, Jedrzejewski MK, Christakis NA (1997) Response rates to mail surveys published in medical journals. *J Clin Epidemiol* 50:1129-36
- Beane J (2004) A look behind the scenes: bioterrorism, smallpox, and public health policy. *J Biolaw Bus* 7:40-53
- Benin AL, Dembry L, Shapiro ED, Holmboe ES (2004) Reasons physicians accepted or declined smallpox vaccine, February through April, 2003. *J Gen Intern Med* 19:85-9
- Blendon RJ, DesRoches CM, Benson JM, Herrmann MJ, Taylor-Clark K, Weldon KJ (2003) The public and the smallpox threat. *N Engl J Med* 348:426-32
- Braithwaite D, Emery J, De Lusignan S, Sutton S (2003) Using the Internet to conduct surveys of health professionals: a valid alternative? *Fam Pract* 20:545-51
- Casey CG, Iskander JK, Roper MH, Mast EE, Wen XJ, Torok TJ et al. (2005) Adverse events associated with smallpox vaccination in the United States, January-October 2003. *JAMA* 294:2734-43
- Centers for Disease Control and Prevention (CDC) (2005a) Smallpox Vaccination Program Status by State. Available at: <http://www.cdc.gov/od/oc/media/spvaccin.htm> (accessed December 19, 2005)
- Centers for Disease Control and Prevention (CDC) (2005b) Protecting Americans: Smallpox Vaccination Program. Available at: <http://www.bt.cdc.gov/agent/smallpox/vaccination/vaccination-program-statement.asp> (accessed December 19, 2005)
- Centers for Disease Control and Prevention (CDC) (2005c) Smallpox Vaccination Program Report: Status and Adverse Events. Available at: <http://www.cdc.gov/od/oc/media/smpxrprt.htm> (accessed December 19, 2005)
- Centers for Disease Control and Prevention (CDC) (2005d) Frequently Asked Questions About Smallpox Vaccine. Available at: <http://www.bt.cdc.gov/agent/smallpox/vaccination/faq.asp> (accessed December 19, 2005)
- Centers for Disease Control and Prevention (CDC) (2005e) Smallpox Fact Sheet: People who Should not get the Smallpox Vaccine. Available at: <http://www.bt.cdc.gov/agent/smallpox/vaccination/contraindications-public.asp> (accessed December 19, 2005)
- Chan R, Khoo L, Goh CL, Lam MS (1997) A knowledge, attitudes, beliefs and practices (KABP) survey on HIV infection and AIDS among doctors and dental surgeons in Singapore. *Ann Acad Med Singapore* 26: 581-7
- Deng JF, Olowokure B, Kaydos-Daniels SC, Chang HJ, Barwick RS, Lee ML et al. (2006) The SARS International Field Team. Severe acute respiratory syndrome (SARS): Knowledge, attitudes, practices and sources of information among physicians answering a SARS fever hotline service. *Public Health* 120:15-9
- Everett WW, Coffin SE, Zaoutis T, Halpern SD, Strom BL (2003) Smallpox vaccination: a national survey of emergency health care providers. *Acad Emerg Med* 10:606-11
- Everett WW, Zaoutis TL, Halpern SD, Strom BL, Coffin SE (2004) Prevent vaccination against smallpox: a survey of pediatric emergency health care providers. *Pediatr Infect Dis J* 23:332-7
- Hatakeyama S, Moriya K, Saijo M, Morisawa Y, Kurane I, Koike K et al. (2005) Persisting humoral antiviral immunity within the Japanese Population after the discontinuation in 1976 of routine smallpox vaccinations. *Clin Diagn Lab Immunol* 12:520-4
- Hester EJ, Johnson KR, Crane LA, Schilling LM, Dellavalle RP (2004) Indoor UV tanning facility operator opinion regarding youth access: an electronic survey. *J Am Acad Derm* 51:814-6
- Institute of Medicine (2005) The Smallpox Vaccination Program: Public Health in an Age of Terrorism. Available at: <http://www.nap.edu/books/0309095921/html/> (accessed October 7, 2005)
- Kaiser J (2005) Report faults smallpox vaccination. *Science* 307:1540
- Kuhles DJ, Ackman DM (2003) The federal smallpox vaccination program: where do we go from here? *Health Aff (Millwood)*, Suppl Web Exclusives: W3-503-10
- Office of the Assistant Secretary of Defense-Public Affairs and the Military Vaccine Agency (2005) Smallpox vaccination program. Available at: <http://www.smallpox.mil/event/SPSafetySum.asp> (accessed December 22, 2005)
- Rotz LD, Dotson DA, Damon IK, Becker JA (2001) Vaccinia (smallpox) vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2001. *MMWR Recomm Rep* 50(RR-10):1-25
- Sheehan K (2001) Email survey response rates: A review. *J Computer Mediated Communication* 6 (<http://www.ascusc.org/jcmc/vol6/issue2/sheehan.html>) (accessed December 22, 2005)
- Tian J, Gong H, Sheng N, Zhou X, Gulari E, Gao X et al. (2004) Accurate multiplex gene synthesis from programmable DNA microchips. *Nature* 432:1050-4
- Wharton M, Strikas RA, Harpaz R, Rotz LD, Schwartz B, Casey CG et al. (2003) Recommendations for using smallpox vaccine in a pre-event vaccination program. Supplemental recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Healthcare Infection Control Practices Advisory Committee (HICPAC). *MMWR Recomm Rep* 52(RR-7):1-16
- Yih WK, Lieu TA, Rego VH, O'Brien MA, Shay DK, Yokoe DS et al. (2003) Attitudes of healthcare workers in US hospitals regarding smallpox vaccination. *BMC Public Health* 3:20