

Revisiting Orthopaedic Surgery Residents' Views of the CDC and AAOS Precautionary Guidelines for HIV

Garrett Schwarzman, MD, Dan Rybalko, MD, Richard Danilkowicz, BS, and Mark Hutchinson, MD

Investigation performed at the Department of Orthopaedic Surgery, University of Illinois at Chicago, Chicago, Illinois

Background: The purpose of the present study was to evaluate how orthopaedic residents' views and behaviors toward the human immunodeficiency virus (HIV) have changed over the past 25 years.

Methods: Between May 2017 and June 2017, an electronic survey was distributed to residents who were enrolled orthopaedic residency programs in the United States. The survey included questions based on the revised 2012 American Academy of Orthopaedic Surgeons (AAOS) and Centers for Disease Control and Prevention (CDC) guidelines for HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) transmission prevention. Every program in the United States was contacted to avoid selection bias. Categorical data were analyzed with use of the chi-square goodness-of-fit test for the comparison of current and historical results. The null hypothesis of no change between survey results in 1992 and 2016 was set at $p > 0.05$. Numerical data were analyzed with use of the chi-square goodness-of-fit test with subsequent p value calculations to determine deviation from expected values between the 2 study years.

Results: The present study demonstrated that there have been compelling changes in residents' attitudes and behaviors with respect to HIV. Current residents are more aware of and compliant with their institutional safety protocols. They are also more accepting of treating HIV-positive patients. However, current residents underestimate the risk of HIV transmission from needle-stick injury and are less aware of proper timing for post-exposure prophylactic medication administration.

Conclusions: The present study indicates that there has been a compelling positive change in perception and prevention of HIV transmission by orthopaedic residents in the past 25 years but that there is still room for improvement.

Human immunodeficiency virus (HIV) transmission and precautionary measures among health-care professionals have been important issues since the virus captured global attention 3 decades ago. Over time, advances in pharmaceutical therapies, prophylaxis¹, and social stigmas^{2,3} toward these blood-borne pathogens undoubtedly have affected the way physicians perceive the risk of transmission and deliver care to patients. In 1992, Hutchinson et al.⁴ conducted a national survey to evaluate orthopaedic residents' knowledge, attitudes, and behaviors with regard to HIV. The authors found that residents' overall knowledge about precautionary measures related to HIV was poor and that they were unlikely to follow universally recommended precautions. The purpose of the present study was to evaluate how orthopaedic resi-

dents' views and behaviors have changed over the past 25 years from when the original study was conducted. As this topic was revisited, we also took into account the increased cognizance of the risk of hepatitis-B and C virus (HBV and HCV) transmission, including the updated guidelines that have been recommended by the Centers for Disease Control and Prevention (CDC) and the American Academy of Orthopaedic Surgeons (AAOS). We were particularly interested in how adherence to these recommendations has changed given advances in treatment, changing social attitudes, and the enhanced emphasis on these diseases in medical school. Our hypothesis was that knowledge, adherence to protocol, and willingness to treat HIV-positive patients among residents have improved over the last 25 years.

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Materials and Methods

Between May 2017 and June 2017, an electronic survey was distributed to all 3,684 residents who were enrolled in orthopaedic residency programs the United States. The 55-question survey was generated with use of an online platform, esurveycreator.com (enuvo). The survey was modeled after the original survey but included questions based on the revised 2012 AAOS and CDC guidelines for HIV and HBV/HCV transmission prevention. Every program in the U.S. was contacted to avoid selection bias. Contact information in the form of the e-mail addresses of program directors and/or their representatives was obtained from the Fellowship and Residency Electronic Interactive Database (also known as FREIDA Online) as well as from our institution's program coordinator's contacts database. The survey was e-mailed to the program coordinators of each institution, who distributed the questionnaire to their residents. All responses were voluntary and anonymous. Hospital administrators were not informed of this survey.

Knowledge regarding HIV risks and precautions was assessed with use of a series of questions pertaining to the protocols at each resident's home institution, the resources available to the residents, and the residents' knowledge about current recommendations regarding transmission prevention and treatment.

Statistical analysis was performed with use of Excel (Microsoft) and StatPlus (AnalystSoft). Categorical data were analyzed with use of the chi-square goodness-of-fit test for the comparison of current and historical results. The null hypothesis of no change between survey results in 1992 and 2016 was evaluated with the level of significance set at a p value of 0.05. Numerical data were analyzed with use of the chi-square goodness-of-fit test, with subsequent calculation of p values to determine deviation from expected values between the 2 study years. On the basis of the responses that were obtained, the study populations were similar in terms of age, demographic characteristics, and region.

Results

A total of 198 completed surveys were collected, for a response rate of 5.37%. With regard to demographic characteristics, 95.5% of the participants were between the ages of 26 and 35 years; 83.8% were male and 16.2% were female; 84.3% were white/Caucasian; 53.3% were married, 46.2% had never married, and 0.5% were widowed or divorced; and 76.1% reported having no children. Demographic data are represented in Table I.

The findings of the current study are presented in 3 categories: (1) orthopaedic surgery residents' knowledge about HIV infection risks and precautions, (2) orthopaedic surgery residents' attitudes about HIV-related issues, and (3) orthopaedic surgery residents' behavior with regard to CDC and AAOS precautionary measures.

Orthopaedic Surgery Residents' Knowledge About HIV Infection Risks and Precautions

Data on the orthopaedic surgery residents' knowledge about the availability of HIV precautionary measures are presented in

TABLE I Demographic Data on Respondents

Age	
≤29 yr	51.8%
30-35 yr	43.7%
>35 yr	4.6%
Sex	
Male	83.8%
Female	16.2%
Race	
White	84.3%
African-American	3.0%
Hispanic-American	5.1%
Asian-American	7.1%
Other	0.5%
No. of children	
0	76.1%
1-2	19.3%
3-4	4.5%
Marital status	
Married	53.3%
Never married	46.2%
Widowed/divorced	0.5%
Hospital size	
100-299	9.1%
300-599	43.1%
≥600	47.7%
Population of city served	
<50,000	0.5%
50,000-99,999	2.0%
100,000-249,999	13.2%
250,000-499,999	12.2%
500,000-1,000,000	22.3%
>1,000,000	49.7%
Geographic stratification of sample distribution by time zone	
Eastern	50.5%
Central	35.4%
Mountain	3.0%
Pacific	11.1%

Table II. The percentage of respondents who reported that they knew that their institution provided eye-protection goggles on request was slightly lower in 2016 than in 1992 (82.8% compared with 92.6%; $p = 0.5385$). The percentage of respondents who reported availability of impermeable gowns was higher in 2016 than in 1992 (90.4% compared with 61.5%; $p < 0.001$). Despite recommendations that multidisciplinary teams should address issues related to HIV and acquired immune deficiency syndrome (AIDS), the percentage of respondents who were aware that their hospital had such a team was only slightly higher in 2016 than in 1992 (50.0% compared with 46.3%;

$p = 0.136$). In contrast, the percentage of respondents who reported availability of foot and leg covers extending to the knee was higher in 2016 than in 1992 (97.9% compared with 44.2%; $p < 0.001$). Resident responses were significantly different for 3 of 5 repeated questions and appeared to reflect a better understanding regarding the availability of precautionary supplies and services at their institutions.

Orthopaedic Surgery Residents' Attitudes About HIV Issues
 Orthopaedic surgery residents' attitudes toward HIV issues have significantly changed over the past 2 decades. The percentage of respondents who believed that mandatory HIV testing was necessary for all patients undergoing elective surgical cases was lower in 2016 than in 1992 (23.74% compared with 64.3%; $p < 0.001$). The percentage of respondents

TABLE II Comparison of Residents' Knowledge of HIV Recommended Precautions Between 1992 and 2016

Precaution*†	Yes		No		Uncertain		P Value
	1992	2016	1992	2016	1992	2016	
OR provides goggles on request	92.6%	82.8%	5.6%	5.6%	1.3%	11.1%	0.5385
OR provides impermeable gowns on request	61.5%	90.4%	18.6%	1.0%	19.5%	8.1%	<0.001
Hospital has a multidisciplinary team for AIDS issues	46.3%	50.0%	10.8%	3.5%	42.9%	45.9%	0.1362
OR provides leg or footwear to the knee on request	44.2%	97.9%	43.7%	1.0%	11.3%	0.5%	<0.001
Institution has a policy for HIV+ patients in OR	27.3%	52.5%	50.2%	8.1%	22.5%	38.9%	<0.001

*OR = operating room. †Not all surveys had answers for every question.

TABLE III Comparison of Residents' Attitudes Toward Routine HIV Testing of Physicians and Patients Between 1992 and 2016*

	Mandatory HIV Testing of Elective Surgery Patients Is Necessary							
	Yes		No		Uncertain		Total	
	1992	2016	1992	2016	1992	2016	1992	2016
Mandatory HIV Testing of Physicians Is Necessary								
Yes	17.9%	12.63%	2.5%	6.56%	0.00%	0.50%	20.4%	19.69%
No	38.7%	10.10%	24.3%	60.10%	4.7%	2.02%	67.7%	72.22%
Uncertain	7.7%	1.01%	2.6%	2.02%	1.7%	4.54%	11.9%	7.57%
Total	64.3%	23.74%	29.4%	68.68%	6.4%	7.06%		

*Chi-square = 90.4 and $p < 0.0001$ when comparing all 1992 values to 2016 values.

TABLE IV Comparison of Orthopaedic Residents' Attitudes Concerning Willingness and Intention to Treat HIV-Positive Patients Between 1992 and 2016*

	It Is a Physician's Responsibility to Treat HIV+ Patients											
	Strongly Agree		Agree		Uncertain		Disagree		Strongly Disagree		Total	
	1992	2016	1992	2016	1992	2016	1992	2016	1992	2016	1992	2016
I intend to care for HIV+ patients when I am in private practice												
Yes (strongly agree or agree)	13.1%	46.97%	44.1%	39.89%	2.5%	1.52%	2.5%	4.04%	0.4%	1.70%	62.6%	94.12%
Uncertain	0.8%	0.51%	8.9%	1.01%	8.9%	2.52%	3.8%	0.50%	1.7%	0%	24.1%	4.54%

*Chi-square = 29.9 and $p < 0.001$ when comparing all 1992 values to 2016 values.

TABLE V Comparison of Residents' Adherence to Recommended HIV Precautionary Measures Between 1992 and 2016

CDC/AAOS Recommendation	Congruent Findings		Z Score	P Value
	1992	2016		
All contaminated dressing and other materials should be placed directly in disposable bags and sealed	7%	45.9%	-6.4556	<0.001
Needles should not be recapped	10%	50%	-6.3528	<0.001
Surgical masks should be changed immediately if splattered or moist	10.9%	32.8%	-7.7296	<0.001
Hands should be washed immediately after gloves are removed	23.4%	35.4%	-2.453	0.01428
Gloves should be worn when changing dressings	23.4%	73.2%	-6.8255	<0.001
Exposed ends of orthopaedic pins should be protected with caps or other devices	37.4%	69.2%	-4.678	<0.001
Protective eyewear, not substituted by eyeglasses, should be worn during procedures that are likely to generate droplets of blood or bodily fluids	62.2%	71.2%	-2.2146	0.0271
Sutures should not be tied with the same suture needle in hand. Instrument ties should be used instead	69.3%	33.8%	2.8929	0.00386
Mouthpieces or other ventilation devices should be used in place of mouth-to-mouth resuscitation	76.7%	70.7%	-0.7697	0.4413
Double gloves should be worn for all surgical procedures	99.6%	87.9%	-0.5982	0.5485

who believed that mandatory HIV testing was necessary for physicians was similar in 2016 and 1992 (19.69% compared with 20.4%; $p = 0.66$). The percentage of respondents who believed that mandatory testing was not necessary for either physicians or patients undergoing elective surgeries was higher in 2016 than in 1992 (60.10% compared with 24.3%; $p < 0.001$).

The percentage of respondents who believed (i.e., agreed or strongly agreed) that it is a physician's responsibility to treat HIV-positive patients was higher in 2016 than in 1992 (86.86% compared with 57.2%; $p < 0.001$). The percentage of respondents who stated that they intended to take care of HIV-positive patients in their practice was higher in 2016 than in 1992 (94.12% compared with 62.7%; $p < 0.001$).

The percentage of respondents who believed (i.e., agreed or strongly agreed) that it is a physician's responsibility to treat HIV-positive patients was higher in 2016 than in 1992 (86.86% compared with 57.2%; $p < 0.001$). The percentage of respondents who stated that they intended to take care of HIV-

positive patients in their practice was higher in 2016 than in 1992 (94.12% compared with 62.7%; $p < 0.001$). Current residents appear to be more willing to take on that responsibility and planning to follow through with treatment in the future. Complete results for these questions can be found in Tables III and IV. There was a similar sentiment toward patients with HBV/HCV.

Orthopaedic Surgery Residents' Behavior with Regard to CDC and AAOS Precautionary Measures

Residents in 2016 were more adherent to 7 of the 10 precautionary measures recommended by the CDC and AAOS to protect against potential exposure to HIV. The largest changes were seen in the recommendations regarding properly disposing of contaminated materials (45.9% versus 7%), preventing needle sticks by avoiding recapping needles (50% versus 10%) and protecting the ends of pins with caps (69.2% versus 37.4%), and wearing gloves for dressing changes (73.2% versus 23.4%) ($p < 0.001$ for all). Complete response data and statistical analysis can be found in Table V.

TABLE VI Comparison of Residents' Collection of Pertinent History Between 1992 and 2016

Other Literature-Based Recommendations	Congruent Findings		Z Score	P Value
	1992	2016		
Patient history should include specific inquiries about: hepatitis history	75.7%	92.9%	-3.2	0.00132
Patient history should include specific inquiries about: intravenous drug abuse	74.8%	96.5%	-3.6	0.0003
Patient history should include specific inquiries about: transfusion history	65.4%	73.74%	-2.2	0.0251
Patient history should include specific inquiries about: sexual activity	22.7%	57.6%	-5.2	<0.001
Patient history should include specific inquiries about: contact with prostitutes	9.6%	47.9%	-6.1	<0.001
Physicians should not perform procedures with cut or chapped hands	1.7%	22.7%	-4.8	<0.001

Residents in 2016 showed an increased willingness to ask difficult questions regarding medical history. Complete data on these individual scenarios can be found in Table VI.

Discussion

The number of people living with HIV has been steadily climbing since the beginning of the "AIDS epidemic" in the 1980s⁵. At the time of the original study by Hutchinson et al., approximately 242,000 people had been diagnosed with HIV in the U.S. from a total population of 256.5 million, representing a prevalence of approximately 1 per 1,000⁴. According to a 2012 CDC report, there were 1.2 million people who were HIV-positive from a total population of approximately 314.1 million, or 1 in every 262 people⁶. A proportion of the staggering difference seen between 1992 and 2012 is attributed to HIV-positive patients living longer lives as a result of breakthroughs in treatment. A 20-year-old HIV-positive patient on antiretroviral therapy in the U.S. and Canada can expect to live into his or her 70s with proper treatment⁷. As a result, physicians in every specialty are treating an appreciably higher percentage of HIV-positive patients and must be aware of the associated risks and appropriate precautions. Given the multiple sharp objects and instruments used during orthopaedic procedures, the risk may be higher in orthopaedics than in other specialties. In 2007, Weiss et al. reported that almost 40% of patients who were tested for blood-borne pathogens at the time of presentation for surgical procedures at an urban university hospital were positive for HIV, HBV, or HCV⁸. However, as not all patients were tested, some selection bias may be present. While HCV is now >90% treatable with medication, adverse risks associated with treatment exists, including but not limited to mouth ulcers, fatigue, and gastrointestinal issues^{9,10}. In 2013, a single-institution study demonstrated

that 28% of medical students, 83% of orthopaedic residents/fellows, and 100% of orthopaedic faculty at Johns Hopkins University had experienced a sharps-related exposure during their medical career, with an additional 42% of the residents reporting an exposure within the prior calendar year¹¹. Even more alarmingly, only 12.5% of the medical students polled in the study followed the recommended sharps-exposure protocol after the incident. Additional studies have demonstrated similar institutional rates of exposure and lack of reporting^{12,13}. Despite an individual sharps exposure having a small risk of seroconversion (0.4%)¹⁴, the overall risk of seroconversion in surgeons over the course of a career may range from 1% to 4% based on repeated exposures^{14,15}. It is critical to identify potentially harmful behaviors or attitudes that may persist in orthopaedic resident training today in an attempt to further reduce potential serious exposures in the future.

The responses on our survey indicate that orthopaedic surgery residents' knowledge of and adherence to precautionary measures has improved markedly. In comparison with their peers from >20 years ago, today's residents appear to be more familiar with the safety materials at their disposal to limit exposure to HIV and other blood-borne pathogens. This increased familiarity may stem from a combination of increased knowledge of the infectious organisms and their mode of transmission as well as concerted efforts by individual institutions to have safe practices and associated training in place to protect their employees.

The survey responses also appeared to indicate that current orthopaedic surgery residents may be less knowledgeable regarding HIV transmission rates and the proper timing of post-exposure prophylaxis (PEP) than their peers in the previous study. According to multiple studies, the

TABLE VII Comparison of Residents' HIV Infection Transmission Risk and Recommended Prophylaxis Measures Between 1992 and 2016

	Year		Chi-Square	P Value
	1992	2016		
What is the risk of a single needle puncture from a known HIV+ patient turning seropositive in 6 months?			22	<0.0001
<0.1%	52.6%	76.7%		
0.4%*	40.0%	10.7%		
1.0%	6.1%	12.2%		
5.0%	1.3%	0.5%		
If a health-care worker is contaminated with the blood of a known HIV+ patient, within how long should zidovudine therapy be started?			23.9	<0.0001
The same day*	45.0%	73.1%		
The same week	17.3%	17.8%		
It does not matter or same month	2.6%	1%		
Uncertain	35.1%	8.1%		

*Correct answer.

individual risk of HIV seroconversion from needle-stick injury is calculated to be about 0.3%, with a confidence interval of 0.2% to 0.5%, which was the same figure cited in the previous study¹⁵. Forty percent of the residents who participated in the 1992 study chose the most accurate figure of 0.4%, as compared with only 10.7% of the residents in 2016 (Table VII). The residents who responded to the 2016 survey underestimated the risk, with a majority of respondents choosing a risk of $\leq 0.1\%$, despite the advanced understanding of the virus and its risk of transmission that is taught in current undergraduate medical education. Although the incorrect survey responses may not lead to a clinically evident rise in transmission rates, it is important to note the trend on resident attitudes that may reflect a relaxed outlook with regard to transmission. A similar trend is observed regarding the recommended timing of PEP measures following exposure. In 2016, the majority of residents chose "the same day," which is within acceptable limits based on the current guidelines from the CDC (Table VII)¹⁵. Although up to 72 hours may be acceptable for PEP, the CDC does stress that every hour counts. As prophylaxis itself carries a risk, such treatment is not routinely given if the patient's HIV, HCV, or HBV status is not known. However, when an HIV-negative physician does experience a needle stick during the treatment of a known HIV-positive patient with a detectable viral load, prophylaxis should be provided as soon as feasible. A possible explanation for why residents are more lax with precautions in 2016 as compared with 1992 is the improved ability to treat these viral illnesses now. Although we are aware of no data to this effect, it is a potential area of exploration in the future.

Arguably, the most dramatic shifts found in the present study concerned orthopaedic surgery residents' attitudes toward important HIV-related social issues. The results of the present study show a more accepting attitude of current residents with regard to treating HIV-positive patients. In 1992, only 62.7% of residents surveyed indicated definitively that they planned to treat HIV-positive patients, compared with 94.12% in 2016. This meaningful attitude change is most likely multifactorial and a combination of increased awareness of the disease, improved treatments for those inflicted, and, most notably, a reduction in the stigma attached to HIV-positive patients². Attitudes regarding mandatory HIV testing for both patients and provider also significantly changed; however, the shift was not as clear. The majority (60.10%) of residents in 2016 responded that neither party should require testing. In 1992, the highest percentage of residents (38.7%) responded that testing should be mandatory for patients but not for surgeons. This attitude change again reflects a greater cultural shift in how HIV-positive patients are viewed and the risks involved with operating on them². Finally, should a physician become HIV-positive, it is recommended by the American Medical Association (AMA) that he or she should disclose his/her serostatus to a state public health official or local review committee and should not perform exposure-prone procedures without permission from the local review committee and patient consent¹⁶.

Orthopaedic surgery residents' reported behaviors with regard to CDC, AAOS, and other literature-based HIV precautionary measures have changed significantly since 1992. While institutions may differ in their specific protocols and compliance efforts, it can be safely assumed that each program has a system in place that falls within the acceptable practices outlined by the CDC and AAOS. A significant difference was observed in 8 of 10 categories, with 6 of those categories representing a positive shift toward safer practices. The 2 categories in which current residents need to be more aware of their behavior involve suture-tying with needle in hand and double-gloving for procedures, relatively easy changes to make to further reduce transmission risk. As these 2 actions occur in essentially every operation, they serve as important starting points for residents seeking to improve their compliance.

One of the strengths of the present study is the 25-year follow-up on the knowledge and attitudes toward blood-borne pathogens among orthopaedic residents. By utilizing a questionnaire that was relatively unchanged compared with that used in the original study, we were able to accurately compare changes in responses over time. The present study provides information on the types of improvements that have been made over this period of time and also identifies what areas still need to be addressed. Furthermore, the present study reached out to all Accreditation Council for Graduate Medical Education (ACGME)-accredited orthopaedic programs in the U.S., thus attempting to minimize selection bias.

The potential limitations of the present study include small sample sizes, participant bias, and response bias. Despite the ease of transmitting and collecting data, we were only able to collect 198 participant responses from a potential 3,684 nationwide residents as of 2016, for a response rate of 5.37%¹⁷. Although this response rate was suboptimal and was lower than that in 1992 (37%, based on 238 total respondents), this figure is not far off from what can be expected from survey-based medical research, especially when using web-based surveys, which tend to garner a lower response rate than paper surveys (as used in the 1992 study)^{18,19}. In a similar sampling method, the self-reported 2014 National Physician Survey (NPS), available to all licensed physicians in Canada, had a response rate of just 14.4% for orthopaedic surgeons and just over 10% for other surgical specialties²⁰. In addition, the absolute numbers of respondents were very similar, with 238 residents responding to the 1992 survey and 198 residents responding to the 2016 survey. Despite the relatively low response rate, we do believe that the findings are representative of a broad range of residents within the country. Despite these limitations, it is likely that similar participant and response biases were present in both studies and should, therefore, not have a large effect on the overall implications drawn from the findings presented.

In conclusion, the present study demonstrated that there have been substantial changes in residents' attitudes and behaviors with respect to HIV. Current residents are more aware of and compliant with their institutional safety protocols. They are also more accepting of treating HIV-positive patients. In the past 25 years, there has been a statistically

significant positive change in perception and prevention of HIV transmission by orthopaedic residents, but the present study reveals that there is still room for improvement. ■

Garrett Schwarzman, MD¹
Dan Rybalko, MD¹
Richard Danilkowicz, BS¹
Mark Hutchinson, MD¹

¹Department of Orthopaedic Surgery, University of Illinois College of Medicine, Chicago, Illinois

E-mail address for G. Schwarzman: Gschwa2@uic.edu
E-mail address for D. Rybalko: drybalko@gmail.com
E-mail address for R. Danilkowicz: danilko1@uic.edu
E-mail address for M. Hutchinson: mhutchsportsmd@gmail.com

ORCID iD for G. Schwarzman: [0000-0003-0109-1007](https://orcid.org/0000-0003-0109-1007)
ORCID iD for D. Rybalko: [0000-0002-1578-6320](https://orcid.org/0000-0002-1578-6320)
ORCID iD for R. Danilkowicz: [0000-0003-3183-5310](https://orcid.org/0000-0003-3183-5310)
ORCID iD for M. Hutchinson: [0000-0002-7313-1736](https://orcid.org/0000-0002-7313-1736)

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