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Risk of Infection From Needle Reuse at a Phlebotomy Center

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A B S T R A C T

Objectives. This study determined infection risk for HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) from needle reuse at a phlebotomy center that possibly exposed 3810 patients to infection.

Methods. We used a model for the risk of infection per blood draw, supplemented by subsequent testing results from 1699 patients.

Results. The highest risk of transmission was for HBV infection: 1.1×10^{-6} in the best case and 1.2×10^{-3} in the (unlikely) worst case. Subsequent testing yielded prevalence rates of 0.12%, 0.41%, and 0.88% for HIV, HBV, and HCV, respectively, lower than National Health and Nutrition Examination Survey III prevalence estimates.

Conclusions. The infection risk was very low; few, if any, transmissions are likely to have occurred. (*Am J Public Health.* 2001;91:636–638)

In March 1999, a phlebotomist in Palo Alto, Calif, admitted to reusing needles 5 to 10 times to draw blood (E. A. Kaufman, oral communication, April 1999), contrary to accepted standards.[1,2] The company that operated the phlebotomy center initiated a notification, counseling, and testing program for concerned patients; this program ultimately involved approximately 15 300 patients, including those at other service centers (E. A. Kaufman, oral communication, August 1999).

We performed a quantitative risk assessment[3] as part of the investigation. For HIV, hepatitis B virus (HBV), or hepatitis C virus (HCV), we calculated best- and worst-case scenarios for (1) the probability that a patient would have become infected after a single blood draw, (2) the expected number of individuals who might have become infected owing to needle reuse, and (3) the fraction of subsequently detected infections that could be attributable to needle reuse. We then compared these calculations with results of subsequent testing of patients.

Methods

If needles are reused only once, the probability of infection per draw is the product of the baseline prevalence, the needle reuse rate (number of reused needles divided by the total number of draws), and the transmission probability from a contaminated needle.[3–5] The expected number of new (reuse-related) infections was found by multiplying the number of people uninfected at baseline by this risk per draw and by the number of draws per individual; the fraction of infections attributable to needle reuse was found by dividing the expected number of new (reuse-related) infections by the total number of infections (baseline infections and new reuse-related infections). Models of multiple needle reuse and sensitivity analysis are available elsewhere.[3]

The implicated health care worker (HCW1) was the sole phlebotomist during most of the time she worked at the center (June 1, 1997–March 23, 1999); during this time, there were 6272 blood draws on 3810 patients. HCW1 said that 5 to 10 23-gauge butterfly needles were reused once[6]; statements from another health care worker (HCW2) alleged that HCW1 used butterfly needles more often than straight needles and reused butterfly needles more often than she used sterile butterfly needles; HCW2 also alleged that HCW1 claimed that needles could be reused

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more than once.[6] HCW1 reported rinsing these needles with dilute hydrogen peroxide, which may have some effect against HIV[7] in addition to diluting the blood; some needle rinsing is believed likely, since otherwise the formation of blood clots in the small-bore needles would likely have prevented reuse. Between January 1998 and March 1999, 900 butterfly needles are known to have been ordered at the site. The probability of HIV,[8–14] HBV,[15–17] and HCV[18–22] infection following needlestick injury with contaminated blood was used as an estimate of the unknown transmission probability from needle reuse[4,5] (Table 1).

We calculated a lower-bound estimate for the prevalence of each infection in the largely suburban clinic population by using National Health and Nutrition Examination Survey III (NHANES III) estimates[23–25] (Table 1). Upper-bound estimates were obtained from the 95% upper confidence limit from those center patients tested for 1 of the 3 infections at the time of their phlebotomy (between June 1997 and March 1999). In addition to those patients who were tested, an additional 17, 0, and 3 patients were apparently being monitored for treatment of HIV, HBV, and HCV, respectively (E. A. Kaufman, oral communication, August 1999).

TABLE 1—Parameter Estimates for the Mathematical Model of Blood-Borne Pathogen Transmission During Phlebotomy Needle Reuse: Palo Alto, Calif, 1999

Parameter	Lower	Upper
Transmission probability, %		
HIV	0.25	0.50
HBV	19.00	30.00
HCV	1.80	7.40
Baseline prevalence, %		
HIV	0.50	1.20
HBV	0.50	3.50
HCV	1.80	5.80
No. of reused needles	7	700

Note. HBV = hepatitis B virus; HCV = hepatitis C virus. For the lower-bound prevalence estimate of HIV, 0.5% was used, for the sake of caution, instead of the National Health and Nutrition Examination Survey III (NHANES III) estimate[23] of 0.32%; the estimates derived from NHANES III for HBV24 and HCV25 also were used. The numbers (E. A. Kaufman, oral communication, 1999) of positive screening tests for HIV, HBV, and HCV between June 1997 and March 1999 were 0 of 245 (95% upper confidence interval [CI] = 1.22%) for HIV enzyme-linked immunosorbent assay (ELISA), 3 of 247 (95% CI = 0.25%, 3.5%) for hepatitis B surface antigen, and 3 of 148 (95% CI = 0.42%, 5.8%) for HCV. We assumed that no needle was reused more than once.

Results

The results of 6 risk scenarios for HIV, HBV, and HCV transmission are shown in Table 2. In the best cases (A), we used NHANES III prevalence estimates, assumed that 7 needles were reused once each, and used the lower bounds for the transmission probabilities. For each of the other scenarios, the needle reuse rates, prevalence, or transmission probabilities were assumed to be larger. The F scenarios are worst-case scenarios.

For HIV, in the best-case scenario (A), we found that the infection risk per draw was 1.4×10^{-8}, rising to 6.8×10^{-6} in the worst case (F). For HBV, the risk per draw was 1.1×10^{-6} in the best case and 1.2×10^{-3} in the worst case, and for HCV the risks per draw were 3.6×10^{-7} and 4.8×10^{-4} in the best and worst cases, respectively. The expected number of infections and the attributable fraction are also shown in Table 2.

Results from the counseling and testing program for individuals who used the Palo Alto center were available for 1699 individuals who

TABLE 2—Transmission Risk Estimates for the Mathematical Model of Blood-Borne Pathogen Transmission During Phlebotomy Needle Reuse: Palo Alto, Calif, 1999

Scenario[a]	Baseline Prevalence	No. of Reused Needles	Transmission Probability	Risk per Draw	Expected New Infections	Fraction of Infections From Reuse
HIV						
A	0.005	7	0.0025	1.4×10^{-8}	8.7×10^{-5}	4.6×10^{-6}
B	0.005	70	0.0025	1.4×10^{-7}	8.7×10^{-4}	4.6×10^{-5}
C	0.005	700	0.0025	1.4×10^{-6}	8.7×10^{-3}	4.6×10^{-4}
D	0.012	7	0.0025	3.4×10^{-8}	2.1×10^{-4}	4.5×10^{-6}
E	0.005	7	0.005	2.8×10^{-8}	1.7×10^{-4}	9.1×10^{-6}
F	0.012	700	0.005	6.8×10^{-6}	0.042	9.1×10^{-4}
HBV						
A	0.005	7	0.19	1.1×10^{-6}	6.6×10^{-3}	3.5×10^{-4}
B	0.005	70	0.19	1.1×10^{-5}	0.066	3.5×10^{-3}
C	0.005	700	0.19	1.1×10^{-4}	0.66	0.034
D	0.035	7	0.19	7.4×10^{-6}	0.045	3.4×10^{-4}
E	0.005	7	0.3	1.7×10^{-6}	0.01	5.5×10^{-4}
F	0.035	700	0.3	1.2×10^{-3}	7.1	0.05
HCV						
A	0.018	7	0.018	3.6×10^{-7}	2.2×10^{-3}	3.2×10^{-5}
B	0.018	70	0.018	3.6×10^{-6}	0.022	3.2×10^{-4}
C	0.018	700	0.018	3.6×10^{-5}	0.22	3.2×10^{-3}
D	0.058	7	0.018	1.2×10^{-6}	6.9×10^{-3}	3.1×10^{-5}
E	0.018	7	0.074	1.5×10^{-6}	9.2×10^{-3}	1.3×10^{-4}
F	0.058	700	0.074	4.8×10^{-4}	2.8	0.013

Note. HBV = hepatitis B virus; HCV = hepatitis C virus.
[a]A, baseline; B, high reuse; C, very high reuse; D, high baseline prevalence; E, high transmission probability; F, worst case.

were tested (E. A. Kaufman, oral communication, August 1999); the prevalence was 0.12% for HIV, 0.41% for HBV, and 0.88% for HCV (see elsewhere for details[3] [also California Department of Health, unpublished data, 2001; report forthcoming]).

Discussion

These results suggest that needle reuse posed a very low infection risk for HIV, HBV, or HCV. In the best-case scenarios, the risk of acquiring any infection was 1 in 1 million or less for a single blood draw. Only in the worst-case scenarios, under the assumption that 100 times as many needles were used as reported and with the transmission probability and baseline prevalence levels at their upper bounds, did we find risks per draw on the order of 1 in 1000 (and then only for HBV). The total expected number of new infections is very small; even in the worst-case scenarios, only 7 HBV and 3 HCV infections would be expected. The attributable fraction of these infections due to reuse is 5% or less even in these scenarios.

These results were used by public health authorities and company representatives to predict the number of infections expected to be detected from the counseling and testing study, and to reassure the public that the infection risk was very low. This also aided company representatives in planning for clinical services and follow-up care and in counseling concerned patients that the infection risk had been very low. The preliminary prevalence estimates from the counseling and testing program (E. A. Kaufman, oral communication, August 1999) were lower than the NHANES III estimates, and they provide no evidence of transmission.

Finally, although no evidence suggested that the worst-case needle reuse rates occurred, these worst-case scenarios demonstrate that high levels of needle reuse in settings of high infection prevalence—unlike the Palo Alto site—could pose a substantial threat[4]; continued vigilance to prevent similar incidents is necessary. □

Contributors

All authors contributed to the design of the study, the selection of parameter values, and the writing of the paper.

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