# Risk of hepatitis C virus infection from tattooing and other skin piercing services

GAYLE H SHIMOKURA BS, PAUL R GULLY MB CHB FRCPC FFCM

THE EPIDEMIOLOGY OF HEPATITIS C IN CANADA IS NOT WELL described. Reported cases of newly diagnosed hepatitis C virus (HCV) infections continue to rise (1321 cases in 1992, 1634 in 1993 and 2588 in 1994 [provisional]) (1, personal communication), and there are good indications that the major risk factors of prevalent infections are injection drug use followed distantly by past blood transfusion (2). The proportion of acute HCV infections attributable to unexplained exposures is often quoted as being in the order of 40% (3). This figure appears to be an overestimate for Canada. However, in reviewing the risk of transmission of other blood-borne infections, in particular hepatitis B, it is clear that procedures involving the piercing of skin, eg, tattooing, must be considered as a possible means of infection.

The National Meeting on the Prevention and Control of Hepatitis C, held in December 1994 and coordinated by the Laboratory Centre for Disease Control (LCDC), recommended that "since hepatitis C and other blood-borne infections are transmissible through personal services such as tattooing, body piercing and electrolysis, national guidelines and a national strategy should be developed for the prevention of blood-borne infections in these settings" (4).

To aid the process of developing infection control guidelines for 'personal services' and to review existing guidelines, the medical literature on the epidemiology of hepatitis C was searched and assessed. Tattooing is emphasized in this review because an abundance of information on that subject was available. However, literature search summaries of other services involving skin piercing, ie, acupuncture, electrolysis and body/ ear piercing are included, because conclusions from the tattooing studies may possibly be extrapolated to these services.

*Blood-borne Pathogens Group, Bureau of Communicable Disease Epidemiology, Laboratory Centre for Disease Control, Ottawa, Ontario*

*Correspondence: Dr Paul R Gully, Blood-borne Pathogens Group, Bureau of Communicable Disease Epidemiology, Laboratory Centre for Disease Control, Health Canada, Jeanne Mance Building, Room 1704, Tunney's Pasture, Ottawa, Ontario K1A 0K9. Telephone 613-957-1789, fax 613-952-6668, e-mail pgully@isdtcp3.hwc.ca*

## WHAT IS TATTOOING?

Tattooing is the process of puncturing the skin with a cluster of fine needles containing indelible dyes to achieve a permanent design or mark. The needles are soldered on to a moveable shaft called the 'needle bar', inserted into stainless steel tubes and sterilized. The bar, which may contain anywhere from one to 14 needles, is dipped in different pigments to outline a design and to fill in the areas with colour. The needle, bar and tube assembly are mounted onto a DC-powered machine that vibrates the needle bar, causing the needle to protrude out of the base of the tube (personal communication). Other skin piercing services are related to tattooing in that they involve needles piercing the skin.

## EVIDENCE OF HCV TRANSMISSION

In 1991, Abildgaard and Peterslund (5) reported an incident of HCV transmission by a tattooing needle. The patient had no other risk factor, such as history of blood transfusion, injection use or multiple sexual partners. However, two months before onset of symptoms, he had been tattooed by a wandering merchant. Though he had no previous medical history, he was repeatedly positive for antibodies to HCV, and negative for hepatitis B virus, hepatitis A virus, and human immunodeficiency virus.

## EPIDEMIOLOGICAL STUDIES

Several HCV studies have included questions about tattooing. However, in the majority of these studies tattooing played a minor role, and consequently their designs do not adequately address tattooing as a potential risk factor. The three studies discussed below represent those studies that best addressed the association between tattooing and HCV.

In 1992, Ko et al (6) conducted a cross-sectional study of Taiwanese military recruits sampled on tattoo status. Nontattooed persons were matched to tattooed persons by sex, age, education, occupation and geographic origin of their parents.

Confounding was additionally controlled by exclusion of participants with multiple sexual partners and injection drug use.

All eligible tattooed persons and their matched controls who had sufficient amount of serum sample for anti-HCV testing (87 tattooed, 126 nontattooed) were included in the study. An odds ratio (OR) of 5.9 (95% CI 1.6 to 22) was found among tattooed persons compared with nontattooed persons. $\chi^2$ tests for trend were performed for variables that were ranked, and these included variables further describing tattooing practices: persons with multiple-site tattoos were at greater risk of infection than those with single-site tattoos or their nontattooed controls ($\chi^2$ test for trend P=0.002); and persons with tattoos done by nonprofessionals were at a higher risk of infection than persons with professional tattoos or their nontattooed controls ($\chi^2$ test for trend P=0.002).

One limitation of the cross-sectional study design is that temporality cannot be established. However, due to the nature of the exposure in question, the cross-sectional design has its merits. Having a tattoo is an exposure that is memorable and that does not vary over time, thereby avoiding any bias stemming from citing current exposure practices rather than the more etiologically important historical ones.

Misclassification bias of disease and confounding factors cannot be avoided or quantified, however. Specifically, current injection drug use or multiple sexual partners may be underreported. Since this misclassification is nondifferential – meaning that the rates of misclassification between exposed and nonexposed are comparable – the bias reduces the relative risk estimate (7). In contrast, misclassification of disease caused by relatively nonspecific laboratory tests only (duplicate enzyme immunosorbent assay) resulted in an overestimate.

Another issue is the external validity of the results. Tattooing practices in Taiwan may not mirror Canadian tattooing practices, but they probably do overlap. Tattooing is legal in Canada, and there is no reason to think that every tattoo done in Canada is done under hygienic conditions. Consequently, the tattooed men in this Taiwanese study population are probably comparable with many Canadians who got tattooed in various situations, ranging from the local tattoo parlour to the tattoo parlour in a foreign country while on military service, or to the fellow prison inmate who offered his or her tattooing services. Differences in prevalence rates of infection, however, may be an important difference between the two populations, since baseline prevalence rates affect the relative risk of tattooing and HCV infection.

Though the results should represent a good estimate of the true effect, since the study design and analysis minimized potential biases, the wide confidence intervals of the resultant relative risks limit their credibility. Nevertheless, because the association between tattooing and HCV infection was significant, and because the lower boundaries of the confidence intervals are appreciably above one, these results show on a qualitative level that tattooing is a risk factor for HCV infection.

In the second study, Kaldor et al (8) carried out a case-control study of Australian blood donors. Potential cases comprised anti-HCV positive persons who gave blood between February 1990 and April 1991. Prospective controls were all HCV-negative donors identified in the last four months of the study period (January to April 1991). Risk factor information was obtained by oral questionnaire; anti-HCV status was determined by ELISA and confirmed by recombinant immunoblot assay (RIBA) -1. Two-hundred and twenty cases and 210 controls were recruited, with 74% and 67% response rates, respectively.

Overall risk of HCV infection and among specific subgroups were analyzed. Here, only the analysis excluding potential confounders is of interest: when the analysis was restricted to noninjection drug users and/or nonblood transfusion recipients and stratified by age and sex, a significant association between HCV infection and presence of a tattoo was found (Mantel-Haenszel adjusted OR=27; 95% CI 8.4 to 87; P<0.00001).

The following study design issues should be noted. First, confounding was adequately controlled for by restriction. Second, there may have been a selection bias: participation rates were low – 74% for the cases and 67% for the controls – which may have compromised the internal validity of the study. In fact, the authors found that more of the nonresponders were male and that they were younger than the participants. Third, recall bias is a concern in case-control studies. However, since in this study the questionnaire did not inquire about the details of the exposure (which would normally be the area where the cases would give better information than the controls), the cases had little opportunity to give more accurate information than the controls. Fourth, exposure misclassification bias is a much greater concern here, since the cases and controls could easily give misleading answers about their injection drug use without the study coordinators being able to confirm or deny it. Fifth, the degree of disease misclassification depends on the type of laboratory test used to determine HCV infection. In this case, because they used a screening test as well as a supplementary test, disease misclassification was probably minimal. The sixth concern is external validity: exposures of blood donors may not reflect those of the general population. However, conducting a study from blood donor samples is cost effective and generates information somewhat indicative of the low risk segment of the general population.

The results show that tattooing is a significant risk factor for HCV infection. Since the univariate analysis excluding injection drug users and blood transfusion recipients is significant, and because the study was not severely biased, it is safe to say that in this study HCV-infected persons were more likely to be tattooed than controls.

The final study is a matched case-control study of English blood donors by Goodrick et al (9). Cases were recruited in a nonrandom, convenient manner, and controls were the first or second donor that matched the cases' age, sex and time of blood donation. Anti-HCV status was determined by duplicate ELISA, supplemented RIBA-2, and where results were indeterminate, HCV RNA polymerase chain reaction was used.

The results were as follows: when analysis was re-

stricted to noninjection drug users, HCV-infected persons had a sevenfold greater likelihood of having a tattoo than noninfected persons (OR=7, 95% CI 0.9 to 100). This was not significant at the 0.05 level.

This study was designed to examine the association between injection drug use and HCV infection rather than tattooing. While a sample size of 50 matched pairs was sufficient to address injection drug use as a risk factor, it was not sufficient to address tattooing in noninjection drug users. Nonetheless, though an OR of 7 (95% CI 0.9 to 100) of infected persons having a tattoo was not significant, it probably would have been if the sample size had been larger.

## SUMMARY OF TATTOOING AND HCV STUDIES

Two of the three studies demonstrated a statistically significant association, with the nonsignificant study likely to be significant given a larger sample size. The primary strength of the studies is that they controlled for injection drug use.

The important limitations of these studies are that, first, only in one study was tattooing the focus of the study; second, only self-reporting of tattooing, injection drug use and other risk factor information was available; third, none of the studies were conducted on Canadian populations; and fourth, in none of the studies could temporality be established, ie, that the tattoo came before the infection. However, the solution to that problem, conducting a cohort study, is not logistically feasible for this research question.

## OTHER SKIN PIERCING SERVICES

**Ear piercing:** Evidence for ear piercing as a risk factor is at present insufficient (9-13). Three of five epidemiological studies showed no association between ear piercing and HCV infection. Two of the studies that showed an association were not convincing, either because of small sample size or poor study design in regard to ear piercing. None of the studies specifically examined ear piercing as a primary exposure variable, with two studies combining ear piercing with other percutaneous exposures, diluting any potentially significant outcomes.

**Body piercing:** Up to now, no epidemiological studies have examined body piercing. However, due to the nature of body piercing, it is strongly suspected to be a rare, but possible, mode of transmission of HCV. Body piercing is likely to be carried out in the same situations as tattooing, but the procedures are simpler. It may be safe to assume that risks of body piercing could be similar to those of tattooing; however, this remains to be seen.

**Acupuncture:** Evidence for acupuncture as a risk factor for HCV infection is insufficient (10,11,13-15). Four of five studies found no association between acupuncture and HCV infection. The only study with positive results was based in a hepatitis C-endemic area in Japan, where acupuncture was also a highly prevalent practice. Thus, it is unclear whether the results of this study can be attributable to the practice of acupuncture itself or to a high baseline of HCV infection and acupuncture in the study population. In addition, the study population of one of the no-association studies comprised Japanese acupuncturists – persons who should be at high risk if acupuncture is risky – and their HCV prevalence was not different from that of controls.

**Electrolysis:** No evidence is available of transmission of HCV by electrolysis (10,11). Of two studies that addressed electrolysis, one looked at electrolysis specifically; the other study combined all percutaneous exposures together. Neither study showed a statistically significant association.

## CONCLUSIONS

Based on available epidemiological information, tattooing is the only skin piercing service with a documented risk of HCV infection, though the specific level of risk is undefined. According to studies, ear piercing, acupuncture and electrolysis pose little or no risk for infection, although published work does not adequately examine the risk. Not yet evaluated, body piercing may be a greater risk for infection than ear piercing.

Existing guidelines and regulations relating to personal services have been collected with the cooperation of provinces and territories. LCDC will be proposing to examine these documents in the near future in order to establish national guidelines on personal services that pierce the skin.

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## REFERENCES

1. Notifiable Diseases Annual Summary 1993. Can Commun Dis Rep 1995;21S1:32.
2. Holton D, Anderson C, Giglia L, SHUSS group. Sentinel Hepatitis Surveillance Study. Meeting of the Canadian Society for Epidemiology and Biostatistics, St John's, August 1995. (Abst)
3. Alter MJ, Hadler SC, Mores A, et al. Risk factors for acute non-A non-B hepatitis in the United States and association with hepatitis C virus infection. JAMA 1990;264:2231-5.
4. Prevention and Control of Hepatitis C, Guidelines and Recommendations. Can Commun Dis Rep 1995;21S1:9.
5. Abildgaard N, Peterslund NA. Hepatitis C virus transmitted by tattooing needle. Lancet 1991;338:460.
6. Ko YC, Mei-shang H, Tai-An C, Shun-Jen C, Change PY. Tattooing as a risk of hepatitis C virus infection. J Med Virol 1992;38:288-91.
7. Rothman KJ. Modern Epidemiology. Toronto: Little, Brown and Company, 1986:87.
8. Kaldor JM, Archer GT, Buring ML, et al. Risk factors for hepatitis C virus infection in blood donors: a case-control study. Med J Aust 1992;157:227-30.
9. Goodrick MJ, Gray SF, Rouse AM, Water AJ, Anderson NA. Hepatitis C (HCV)-positive blood donors in south-west England: a case control study. Transfus Med 1994;4:113-9.
10. MacLennan S, Moore MC, Hewitt PE, Nicholas S, Barbara JA. A study of anti-hepatitis C positive blood donors: the first year of screening. Transfus Med 1994;4:125-33.
11. Mele A, Sagliocca L, Manzillo G, et al. Risk factors for acute non-A, non-B hepatitis and their relationship to antibodies for hepatitis C virus: a case-control study. Am J Public Health 1994;84:1640-3.
12. Osmond DH, Charlebois E, Sheppard HW, et al. Comparison of risk factors for hepatitis C and hepatitis B virus infection in homosexual men. J Infect Dis 1993;167:66-71.
13. Neal KR, Jones DA, Killey D, James V. Risk factors for hepatitis

C virus infection. A case-control study of blood donors in the Trent Region (UK). Epidemiol Infect 1994;112:595-601.
14. Kiyosawa K, Tanaka E, Sodeyama T, et al. Transmission of hepatitis C in an isolated area in Japan: community- acquired infection. Gastroenterology 1994;106:1596-602.
15. Nakashima K, Kashiway S, Hayashi J, et al. Low prevalence of hepatitis C virus infection among hospital staff and acupuncturists in Kyushu, Japan. J Infect 1993;26:17-25.