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# Laboratory surveillance of hepatitis C virus infection in England and Wales: 1992 to 1996

ME Ramsay, MA Balogun, M Collins, V Balraj

**Summary:** Screening assays for antibody to hepatitis C virus (HCV) became available late in 1990 and their use has subsequently become widespread. Laboratories in England and Wales reported 5232 confirmed HCV infections to the PHLS Communicable Disease Surveillance Centre (CDSC) between 1992 and 1996. Fifty-seven per cent (2976) of reports included risk factor information, 80% of which (2382) identified injecting drug use as the main route of transmission. Thirty-one per cent of reports (1640) included clinical information: 41% (665) were asymptomatic, 57% (938) had symptoms, signs, or biochemical abnormalities of hepatic origin, and 2.2% (37) had non-hepatic conditions. To enhance these data two additional surveys have been undertaken to collect data on all anti-HCV tests performed in public health laboratories. In 1993, a retrospective survey of people tested between 1990 and 1993 revealed that the prevalence of antibody was highest (222/331 [67%]) among injecting drug users and recipients of blood or blood products (189/548 [34%]) and lower among other groups. In a prospective survey of HCV tests performed in transfusion recipients in early 1995, the prevalence of antibody was higher in those transfused before 1985 (11/418 [2.6%]) than in those transfused after 1985 (14/1441 [1.0%]). Reports of confirmed infections are a useful method of monitoring hepatitis C infection but additional data on testing are needed to interpret trends overall and in specific risk groups.

**Key words:**

blood donors

epidemiological methods

hepatitis C

risk factors

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## Introduction

Population based studies show that hepatitis C virus (HCV) infection occurs worldwide but that the prevalence of infection varies between countries<sup>1,2,3</sup>. Seroprevalence data from different countries are difficult to compare because different generations of screening assays are used. Seroprevalence data indicate that Egypt and other parts of Africa and some parts of South America have a high population prevalence (>10%)<sup>4</sup>. Intermediate prevalence areas (2% to 10%) include Japan and parts of South East Asia, and low prevalence countries (<2%) include the United Kingdom (UK) and the United States<sup>4</sup>. Smaller studies in certain groups have established regional and ethnic variations in prevalence within individual countries<sup>5,6,7,8</sup>. Three studies of blood donors in the UK (reported between 1990 and 1992) estimated a prevalence of infection of 0.08% to 0.55%<sup>9,10,11</sup>, whereas a prevalence of 0.72% was found among organ donors in the UK<sup>12</sup>. Low prevalences have been reported in women attending antenatal clinics<sup>6</sup> and among people who undergo renal dialysis in the UK<sup>13,14</sup>. These findings contrast with the prevalence of 10% estimated in a study at a single renal dialysis centre in London<sup>15</sup>. Fifty-nine per cent of injecting drug users (IDUs) in a

rural area of England were found to have antibody to HCV (anti-HCV)<sup>16</sup> in keeping with overseas studies that show high prevalences in IDUs<sup>17,18</sup>.

Hepatitis C is the major cause of parenterally transmitted non-A non-B hepatitis<sup>19</sup>. Since 1990, hepatitis C virus (HCV) screening and confirmatory tests have been performed in some public health laboratories (PHLs) in England and Wales and positive test results have been reported to the PHLS Communicable Disease Surveillance Centre (CDSC). Screening tests were introduced gradually in laboratories around the country. In 1993, a questionnaire was sent to all PHLs in England and Wales to determine which laboratories were offering tests for HCV and the proportions of positive tests identified in particular risk groups. In January 1995, following media interest in the risk of HCV infection associated with blood transfusion and the announcement of a "lookback" exercise among transfusion recipients<sup>20</sup>, the number of requests for anti-HCV assays in PHLs rose sharply. To collect information about people being tested at this time, PHLs were asked to report the results of all tests performed over a four week period and to send a simple form to all requesting clinicians. This paper

includes the results from these two surveys of anti-HCV testing conducted in 1993 and 1995 and describes the features of confirmed HCV infections reported between 1992 and 1996.

## Methods

### Reports of positive anti-HCV tests received at CDSC from 1 January 1992 to 31 December 1996

Some laboratories in England and Wales have reported confirmed HCV infections to CDSC since the second half of 1990 using a surveillance form designed for reports of acute hepatitis or an on-line electronic reporting system. The form prompts reporters to indicate why the test was performed, risk factors for infection, clinical features (including liver function tests), and whether cases have travelled overseas. Reports received on-line include little information about risk factors.

### Survey of anti-HCV testing in public health laboratories

In 1993, a questionnaire was sent to the directors of the 53 PHLs in England and Wales, asking for details of anti-HCV tests being provided, laboratories used for confirmatory testing and, if possible, for the numbers of tests performed and the number of positive results in people from six risk groups (IDUs, blood or blood product recipients, patients with chronic liver disease, acute hepatitis, homosexual men, renal unit patients). Non-respondents were sent reminders after three and six months.

### Survey of anti-HCV tests performed on transfusion recipients early in 1995

In January 1995, directors of all public health laboratories were asked to complete a simple form with details of all anti-HCV tests performed between 16 January and 10 February 1995. They were also asked to send questionnaires to the clinicians who had requested the tests. These questionnaires - which were to be returned directly to CDSC - asked whether patients had a history of prior transfusion, the year and region where they had been transfused, and about other risk factors for HCV infection. PHL directors were also asked, where appropriate, to pass the forms and questionnaires on to colleagues in NHS laboratories. Data from the questionnaires were matched with data sent from the survey laboratories at CDSC. Reports of anti-HCV positive patients with a history of transfusion were sent to the appropriate regional Blood Transfusion Centre and reporting laboratories were asked to provide information about follow up serological tests.

## Results

### Positive anti-HCV tests reported in England and Wales from 1 January 1992 to 31 December 1996

CDSC received a total of 5232 reports between 1992 and 1996 (only 27 reports were received in 1991). The number of reports received increased each year from 1992 to 1996 (241, 435, 769, 1463, 2324). The majority

**TABLE 1 Confirmed hepatitis C infections in England and Wales: 1992-1996**

Age group (years)	Sex			Total (%)
	Females	Males	Not stated	
<15	21	51	4	76 (1.5)
15-24	151	345	12	508 (9.7)
25-34	498	1431	45	1974 (38)
35-44	386	999	32	1417 (27)
45-54	122	350	9	481 (9.2)
≥55	163	276	11	450 (8.6)
Not stated	92	205	29	326 (6.2)
Total	1433 (27%)	3657 (70%)	142 (2.7%)	5232

of infections were detected in young adults aged 25 to 44 years. More than twice as many infections were reported in males as in females (table 1). Infections were reported from laboratories in all English regions and Wales, with the largest number from South Thames (table 2).

Thirty-one per cent (1640) of the reports included information about clinical features, in 41% (665) of which the patients were said to be asymptomatic. Of the remaining 59% (975), 938 had signs or symptoms of hepatic origin and 37 of non-hepatic conditions. Twenty-one per cent (201) of those with hepatic conditions had acute hepatitis, 29% (274) had chronic liver disease, 0.3% (3) had hepatocellular carcinoma, and 49% (460) had other liver abnormalities. These other abnormalities were described in 428; 47 had hepatomegaly, 74 jaundice, and 307 abnormal liver function tests.

Fifty-seven per cent of the reports (2976/5232) specified one or more risk factors for HCV infection. The commonest risk factor was injecting drug use, which was specified in 80% of the 2976 reports (table 3). Among 192 patients who had received blood products, 173 had received clotting factors, nine had received a batch of intravenous immunoglobulin subsequently found to be contaminated, and the remaining ten had received unspecified blood

**TABLE 2 Regional distribution of confirmed HCV infections in England and Wales: 1992-1996**

Region	1992	1993	1994	1995	1996	Total
Northern and Yorkshire	9	26	31	41	46	153
Trent	4	8	13	43	46	114
Oxford and Anglia	7	25	48	123	383	586
North Thames	78	77	43	73	246	517
South Thames	78	172	344	462	453	1509
South and West	23	55	140	339	458	1015
West Midlands	7	17	36	41	108	209
North West	22	30	71	169	172	464
Wales	13	25	43	172	412	665
Total	241	435	769	1463	2324	5232



**TABLE 3 Risk factors associated with HCV infection described on laboratory reports in England and Wales: 1992-1996**

Risk factor	Number (%)
Injecting drug use	2382 (80)
Blood product recipient	192 (6.5)
Transfusion	128 (4.3)
Sexual exposure	85 (2.9)
Renal failure	56 (1.9)
Vertical/household	22 (0.7)
Drug use unspecified	21 (0.7)
Other known	90 (3.0)
Total	2976

products. Fifty-one of the 85 cases thought to have been acquired by sexual exposure were sexual contacts of known HCV positive individuals and nine had partners who were IDUs. A further 11 were thought to have been exposed heterosexually, five cases reported were men who had sex with men, and for nine cases the nature of the sexual exposure was unspecified. Other potential risk factors reported included being in prison, tattooing, invasive surgical treatment, and occupational exposure. A total of 68 infections were reported to have been acquired abroad.

#### Childhood infections

Twenty-two infants (under 1 year of age) were reported who were anti-HCV positive, but in only six cases was evidence suggesting infection during infancy available (one was polymerase chain reaction (PCR) positive, five were anti-HCV positive at 6 months of age). Fifteen infants were reported to have acquired the infection by vertical transmission. No risk factors were reported for the other seven. Among 54 children aged 1 to 15 years who were reported anti-HCV positive, 19 had received blood products (17 had received clotting factors, one intravenous immunoglobulin, and one an unspecified blood product), nine had received multiple transfusions, three were IDUs, three had acquired infection vertically, one had renal failure, one had undergone major surgery overseas, and two were adopted from overseas. No risk factor was reported in the 16 remaining childhood cases.

**TABLE 4 Anti-HCV tests performed in public health laboratories by risk group: 1990-1993**

Risk factor	Number of tests	Number positive (%)
Injecting drug use	331	222 (67.1)
Blood or blood product recipient	548	189 (34.4)
Chronic liver disease	602	67 (11.1)
Acute hepatitis	1079	48 (4.4)
Homosexual men	14	2 (14.3)
Renal unit	741	14 (1.9)
Total	3315	542 (16.3)

#### Survey of anti-HCV testing in public health laboratories in 1993

Questionnaires were returned from 33 of the 41 area and nine of the 12 regional laboratories of the PHLS. Twenty-one laboratories (13 area and 8 regional) were offering tests for HCV infection. Twelve laboratories sent specimens to other PHLS for confirmation. Fourteen of the 21 laboratories that performed tests provided the numbers of tests performed as well as of positive results for each risk category, three were able to provide numbers of positive results only, and the remaining four could provide no data. Among the laboratories able to provide denominators for specific risk groups, 16% (542) of the 3315 specimens tested between 1990 and 1993 were positive for anti-HCV (table 4). The number of specimens tested increased in the latter half of the period, and the proportion positive fell from 22% (101/449) in 1990 and 1991 to 16% (441/2816) in 1992 and 1993. The proportion of tests performed on specimens from patients in renal units increased dramatically, from 1.3% (6/449) in 1990 and 1991 to 26% (735/2816) in 1992 and 1993. The proportion of tests performed for the investigation of liver disease (acute hepatitis or chronic liver disease) fell from 67% (335/499) in 1990 and 1991 to 48% (1346/2816) in 1992 and 1993.

#### Survey of anti-HCV tests performed on transfusion recipients early in 1995

From 16 January to 10 February 1995, 3219 tests were performed in 48 PHLS and four NHS laboratories (range 7 to 252), 92 (2.9%) of which yielded positive or equivocal results on an enzyme linked immunosorbent assay (ELISA) for anti-HCV. Questionnaires were returned from the requesting clinicians about 2414 (75%) of those tested. A lower proportion of those tested with a history of transfusion were anti-HCV positive or had equivocal results than those without such a history, who were probably tested for other reasons (table 5). Infections in 29 of the 32 patients with a history of transfusion who were anti-HCV positive or equivocal were confirmed by other assays (20 were positive on recombinant immunoblot assay (RIBA) or PCR tests and nine were confirmed by a second ELISA). Another high risk exposure was identified in five of the 29 confirmed infections; four were IDUs, and one had a husband who was anti-HCV positive. Reports specified the year when

**TABLE 5 Anti-HCV tests performed by public health and NHS laboratories between 16 January and 10 February 1995**

Result	Test performed n (%)	Replies received		
		Total n (%)	History of transfusion n (%)	Not transfused n (%)
ELISA positive/equivocal	92 (2.9)	75 (3.1)	32 (1.6)	43 (10.1)
ELISA negative	3127	2339	1955	384
Total	3219	2414	1987	427



98% (1955/1987) of recipients were first transfused (including 25 of the 29 confirmed positives). The proportion of recipients confirmed as anti-HCV positive was lower among those first transfused from 1991 to 1995 (2/389 [0.5%]) than among those first transfused from 1986 to 1990 (12/1052 [1.1%]), 1981 to 1985 (7/255 [2.7%]), and up to 1980 (4/163 [2.5%]). From 1991 to 1995, one patient received a transfusion from an anti-HCV positive donor before screening was introduced, and the other had several other risk factors associated with HCV infection.

## Discussion

Hepatitis C is a major global public health concern. Data from PHLS in England and Wales indicated that, by 1993, almost half of the area and virtually all of the regional laboratories were performing anti-HCV ELISA tests. Although some laboratories could not provide earlier data the results suggest that the numbers of tests requested increased between 1990 and 1993 and the proportion of positive tests fell. This probably reflects increased screening of patients thought to be at high risk (including patients on dialysis), and a reduction in the number of patients with chronic liver disease of unknown aetiology (as such patients were tested soon after the test became available). As previously described<sup>21-23</sup>, IDUs yielded the highest proportion of positive anti-HCV tests.

A similar pattern was seen in the positive tests reported by laboratories to CDSC. Their numbers rose each year from 1992 to 1996. Clinical data were provided on fewer than half of the cases reported: few patients had acute or chronic liver disease, but many had mild abnormalities (such as abnormal liver function tests). Chronic asymptomatic carriers of anti-HCV<sup>24</sup> can transmit the infection to others and are at risk of chronic liver disease, such as with chronic hepatitis, cirrhosis of the liver, and hepatocellular carcinoma<sup>25,26</sup>. Up to 80% of anti-HCV positive individuals develop ongoing liver damage and it is believed that 10% to 20% of individuals with chronic hepatitis will develop cirrhosis over the next 20 to 40 years<sup>27</sup>. Many of the infections reported to CDSC are likely to have been acquired many years ago. The costs of increased use of alpha-interferon to treat complications of HCV infection make data on the number of such infections important for health care planning. The commonest route of transmission reported was injecting drug use, and a large proportion of anti-HCV positive blood donors in the UK are known to have injected drugs in the past<sup>28,29</sup>. The high prevalence of anti-HCV in IDUs means that this group will be the main focus of preventive activity. Needle exchange programmes, designed to prevent transmission of HIV infection, were introduced in the UK during the late 1980s. Such schemes should also prevent the transmission of other bloodborne infections, such as hepatitis B and C infections<sup>30,31</sup>. As dates of acquisition of infection (or even dates of drug use) were not obtainable from the laboratory reporting

system we have been unable to assess the impact of needle exchange on transmission of HCV infection.

Other common risk factors include receipt of blood products, usually clotting factors, and blood transfusion. Heat treatment of factor VIII was introduced in 1986, and current virus inactivation procedures reduce HCV-RNA to undetectable levels in factor VIII concentrates<sup>32</sup>. New infections in blood product recipients may therefore be expected to be reported less often in the future. Blood donations in the UK have been screened for anti-HCV since 1991. Screening for anti-HCV has been shown to interrupt HCV transmission through blood transfusion<sup>33</sup>, and a recent study from the United States concluded that the risk of transmitting infection by the transfusion of screened blood is very small<sup>34</sup>. Current estimates for England suggest that the risk of an HCV infectious donation entering the blood supply is one in more than 200 000 (K Soldan, J Barbara, personal communication). Increased awareness of the risk of HCV infection through transfusion led to extensive testing early in 1995 of people who had been transfused, but few positive recipients were identified. Some of these infections may have been acquired by other routes, and people at greatest risk (such as those who had received multiple transfusions) may have been more likely to have been tested. These data suggest, therefore, that the risk of transfusion acquired infection is small, and has fallen since the early 1980s. The fall preceded the introduction of donor anti-HCV screening and probably reflects self-exclusion of donors at risk of HIV, including IDUs, since the late 1980s<sup>35</sup>. As part of the National Blood Authority's lookback, people transfused before 1991, who received blood from donors subsequently found to be anti-HCV positive, have been identified and tested since 1995. A large proportion of these recipients are expected to be anti-HCV positive, so the number of infections acquired by transfusion may have a continuing impact on health service planning.

Confirmed infections were reported from all English regions and Wales and the number of reports increased each year in all regions. Differences between regions are difficult to interpret as they may reflect different levels of testing and/or reporting or the distribution of specialist liver units. The largest numbers of reports were from South Thames region. This region covers part of inner London, which may be the main focus for HCV infection, consistent with the higher prevalence of injecting drug use observed in the capital<sup>36</sup>.

Laboratory reports of confirmed HCV infections are only one source of data with which to monitor HCV infections. The numbers of reports will be influenced by the prevalence of infection and the numbers of tests performed, both overall and in specific risk groups. Laboratory surveillance can be enhanced by collecting the number of anti-HCV tests performed as well as the number of positive test results. The long interval between infection and the development of chronic



disease makes it difficult to obtain reliable information about potential routes of transmission, particularly from patients who have developed chronic liver disease. This fact is reflected in the large proportion of infections reported without clinical or risk factor information. It is best if information about risk factors is obtained directly from clinicians. CDSC is therefore piloting a system for eliciting this information, which will be used to strengthen laboratory based surveillance of HCV infection. Additional problems have been identified in the surveillance of infections in children, as many 'infected' infants may have maternally derived anti-HCV. The Institute of Child Health and the PHLS are to monitor HCV infection in children through the British Paediatric Surveillance Unit's reporting scheme.

Continued surveillance of HCV infection and knowledge of the incidence and prevalence of infection in the population are vital components in any future HCV control programme. Despite reservations about the current laboratory reporting system, our findings are consistent with published work in the UK and elsewhere, which indicate that the main burden of infection is in IDUs and that they should be the main focus of prevention<sup>26,37,38</sup>. Laboratory surveillance in the future will be enhanced by estimates of seroprevalence in key groups. An improved laboratory reporting system will act as a foundation for studies to determine the natural history of HCV infection in cases whose dates of acquisition are known, the risk of vertical and sexual transmission, and the impact of infection in childhood.

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## References

- Chan GCB, Lim W, Yeoh EK. Prevalence of hepatitis C infection in Hong Kong. *J Gastroenterol Hepatol* 1992; 7: 117-20.
- Alter HJ. Transfusion - associated non-A, non-B post-transfusion hepatitis: the first decade. In: Zuckerman AJ, editor. *Viral hepatitis and liver disease*. New York: Alan R Liss, 1988: 537-42.
- Koshy A, Gopalakrishnan G, Al-Mufti S, Hira PR, Al-Wadi K, Al-Nakib B. Urinary schistosomiasis associated with hepatitis C virus infection. *J Urol* 1995; 153: 698-700.
- WHO. Hepatitis C: global update. *Wkly Epidemiol Rec* 1997; 72: 341-4.
- Aussel L, Denis F, Ranger S, Martin P, Caillaud M, Alain J, et al. Recherche des anticorps contre le virus de l'hépatite C chez les femmes enceintes d'origine étrangère vivant en France. *Pathol Biol (Paris)* 1991; 39: 991-6.
- Boxall E, Skidmore S, Evans C, Nightingale S. The prevalence of hepatitis B and C in an antenatal population of various ethnic origins. *Epidemiol Infect* 1994; 113: 523-8.
- Roudot-Thoraval F, Deforges L, Girollet PP, Maria B, Milliez J, Pathier D, et al. Prévalence des anticorps dirigés contre le virus de l'hépatite C dans une population de femme enceintes en France. *Gastroenterol Clin Biol* 1992; 16: 255-9.
- Ellis LA, Brown D, Conradie J D, Paterson A, Sher R, Mollo J, et al. Prevalence of hepatitis C in South Africa: detection of anti-HCV in recent and stored serum. *J Med Virol* 1990; 32: 249-51.
- Goodrick MJ, Anderson NAB, Fraser ID, Rouse A, Pearson V. History of previous drug misuse in HCV-positive blood donors. *Lancet* 1992; 339: 502.
- Garson JA, Tedder RS, Briggs M, Tuke P, Glazebrook JA, Trute A, et al. Detection of hepatitis C viral sequences in blood donations by 'nested' polymerase chain reaction and prediction of infectivity. *Lancet* 1990; 335: 1419-2.
- Follett EAC, Dow BC, McOmish F, Yap LP, Hughes W, Mitchell R, et al. HCV confirmatory testing of blood donors. *Lancet* 1991; 338: 1024.
- Wreghitt TG, Gray JJ, Allain JP, Poulain J, Garson JA, Deaville R, et al. Transmission of hepatitis C virus by organ transplantation in the United Kingdom. *J Hepatol* 1994; 20: 768-2.
- Brind AM, Codd AA, Cohen BJ, Gabriel FG, Collins JD, James OFW, et al. Low prevalence of antibody to hepatitis C virus in North East England. *J Med Virol* 1990; 32: 243-8.
- Jacyna M R, O'Neill K, Brown J, Drobner R, Karayiannis P, Thomas HC. Hepatitis C antibodies in subjects with and without liver disease in the United Kingdom. *Q J Med* 1990; 77: 1009-12.
- Conway M, Catterall A P, Brown E A, Tibbs C, Gower P E, Curtis J R, et al. Prevalence of antibodies to hepatitis C in dialysis patients and transplant recipients with possible routes of transmission. *Nephrol Dial Transplant* 1992; 7: 1226-9.
- Majid A, Holmes R, Desselberger U, Simmonds P, McKee A. Molecular epidemiology of hepatitis C virus infection amongst intravenous drug users in rural communities. *J Med Virol* 1995; 46: 48-51.
- Guadagnino V, Zimatore G, Rocca A, Montesano F, Masciari R, Caroleo B, et al. Anti-hepatitis C antibody prevalence among intravenous drug addicts in the Catanzaro area. *Arch Virol* 1992; 4 (suppl): 335-6.
- Cacopardo B, Fatuzzo F, Cosentino S, Celesia BM, Mughini MT, La Rosa R, et al. HCV and HIV infection among intravenous drug abusers in eastern Sicily. *Arch Virol* 1992; 4 (suppl): 333-4.
- Gish RG, Lau JYN. Hepatitis C virus: eight years old. *Viral Hepatitis Reviews* 1997; 3: 17-37.
- Chief Medical Officer. *Hepatitis C and blood transfusion lookback*. Heywood: Department of Health, 1995. (PL CMO(95)1). (In Wales: Cardiff: Health Professionals Support Unit, 1995 (CMO (95)1).
- Donahue JG, Nelson KE, Munoz A, Vlahov D, Rennie LL, Taylor EL, et al. Antibody to hepatitis C virus among cardiac surgery, homosexual men and intravenous drug users in Baltimore, Maryland. *Am J Epidemiol* 1991; 134: 1206-11.
- Zeldis JB, Jain S, Kuramoto IK, Richards C, Sazama K, Samuels S, et al. Seroepidemiology of viral infections amongst intravenous drug users in northern California. *West J Med* 1992; 156: 30-5.
- Anand CM, Fonseca K, Walle RP, Powell S, Williams M. Antibody to hepatitis C virus in selected groups of a Canadian urban population. *Int J Epidemiol* 1992; 21: 142-5.
- Esteban H, Gonzales A, Hernandez JM, Viladomiu L, Sanchez C, Juan C, et al. Evaluation of antibodies to hepatitis C virus in a study of transfusion associated hepatitis. *N Engl J Med* 1990; 323: 1107-12.
- van der Poel C, Cuypers HT, Reesink HW. Hepatitis C virus six years on. *Lancet* 1994; 344: 1475-9.
- Iwarson S, Norkrans G, Wejstal R. Hepatitis C: natural history of a unique infection. *Clin Infect Dis* 1995; 20: 1361-71.
- Alter H. Natural history and clinical aspects of hepatitis C virus infection. *Antiviral Therapy* 1996; 1 (suppl 3): 15-20.
- Goodrick MJ, Gray SF, Rouse AM, Waters AJ, Anderson NA. Hepatitis C (HCV) positive blood donors in south-west England: a case control study. *Transfus Med* 1994; 4: 113-9.
- 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.

30. Hagan H, Des Jarlais DC, Friedman SR, Purchase D, Alter MJ. Reduced risk of hepatitis B and hepatitis C among injecting drug users in the Tacoma syringe exchange program. *Am J Public Health* 1995; **85**: 1531-7.
31. Des Jarlais DC, Stimson GV, Hagan H, Friedman SR. Injection drug use and emerging blood-borne diseases. *JAMA* 1996; **276**: 1034.
32. Guo ZP, Yu MW. Hepatitis C virus RNA in factor VIII concentrates. *Transfusion* 1995; **35**: 112-6.
33. Wang J T, Wang T H, Lin J T, Lee CH, Sheu JC, Chen DS. Effect of hepatitis C antibody screening in blood donors on post-transfusion hepatitis in Taiwan. *J Gastroenterol Hepatol* 1995; **10**: 454-8.
34. Schreiber GB, Busch MP, Kleinman SH, Korelitz JJ. The risk of transfusion-transmitted viral infections. *N Engl J Med* 1996; **334**: 1685-90.
35. Gunson HH, Rawlinson VI. Screening of blood donations for HIV-1 antibody: 1985-1991. *Commun Dis Rep CDR Rev* 1991; **1**: R144-6.
36. Wadsworth J, Hickman M, Johnson AM, Wellings K, Field J. Geographical variation in sexual behaviour in Britain: implications for sexually transmitted disease epidemiology and sexual health promotion. *AIDS* 1996; **10**: 193-9.
37. Wodak A. Hepatitis C: waiting for the Grim Reaper. *Med J Aust* 1997; **166**: 284-5.
38. Macdonald M, Crofts N, Kaldor J. Transmission of hepatitis C virus: rates, routes and cofactors. *Epidemiol Rev* 1997; **18**: 137-48.

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