

Guidance on the investigation and management of occupational exposure to hepatitis C

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* This guidance was written by Dr Mary Ramsay and endorsed by the PHLS Advisory Committee on Blood Borne Viruses on 2 February 1999 (membership list Appendix 1)

Summary: *This document updates previous PHLS guidance on the risks and management of occupational exposure to hepatitis C. In line with recent guidance from the UK Health Departments, the PHLS now recommends that all source patients, subject to appropriate consent, should be tested for evidence of hepatitis C infection. A baseline serum should be obtained from the exposed health care worker and stored for at least two years. Health care workers exposed to known infected sources should be followed up at six, 12, and 24 weeks after exposure. Serum taken at six and 12 weeks should be tested for hepatitis C virus (HCV) RNA and serum taken at 12 and 24 weeks for anti-HCV. Health care workers exposed to a source believed not to be infected do not require active follow up for hepatitis C unless requested or if they develop symptoms or signs of liver disease. Management of personnel exposed to a source whose hepatitis C status is unknown or a source unavailable for testing will depend upon a risk assessment by a designated doctor. Health care workers who are found to be positive for HCV RNA or antibody to hepatitis C should be referred to an appropriate consultant for consideration of early treatment.*

Key Words:
disease transmission,
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Introduction

Guidance on the risks and management of occupational exposure to hepatitis C was last issued in 1993 by the PHLS Hepatitis Subcommittee¹. Since then, knowledge has increased about the prevalence of hepatitis C virus (HCV) infection in the United Kingdom (UK), the risks of occupational transmission, and the benefits of treatment. Guidance on the management of potential exposures to HCV was issued recently in the United States (US)² and Canada³ and recommendations in these documents differ from those in the previous PHLS guidance¹. In addition, the UK Health Departments have issued recommendations on the management of significant exposures with regard to the potential risks of HIV,

hepatitis B virus, and HCV infection⁴. These developments provided an opportunity for the PHLS Advisory Committee on Blood Borne Virus Infections to reconsider and revise the recommendations of the PHLS group. This guidance is intended to supplement the detailed guidance on the management of blood exposure incidents produced by the UK Health Departments⁴.

The evidence base

Risks of exposure to hepatitis C

Population based studies suggest that the prevalence of HCV infection in western Europe and North America is below 2.5%, lower than in many other parts of the world⁵. Studies of low risk groups in the UK suggest that the prevalence of anti-HCV in the general population is below 1%⁶⁻⁸. The prevalence among new blood donors is currently 0.06%⁶ but a seroprevalence of 0.72% was found in UK organ donors⁷. The prevalence in the West Midlands of anti-HCV among pregnant women was 0.14%⁸ but in a more recent PHLS study of pregnant women the prevalence was 0.33% in Greater London and 0.22% in Yorkshire (J Parry, personal communication).

Patients receiving health care in the UK are likely to have a higher prevalence of HCV infection than the general population. Known high risk exposures for HCV infection in the UK include injecting drug use, receipt of blood transfusion or blood products,

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tattooing, and having been born abroad^{9,10}. The prevalence of HCV among injecting drug users (IDUs) in studies in England and Wales was 46% in South Wales¹¹, 59% in one area of rural England¹², 59% among IDUs undergoing voluntary HIV testing in north west England (J Craske, personal communication), and 67% in IDUs attending a regional drug clinic in the north east¹³. In Scotland, studies of IDUs have found prevalences of anti-HCV between 77% and 90%^{14,15}. People with haemophilia who received untreated clotting factors¹⁶⁻¹⁸ and patients on renal dialysis in some units¹⁹ are also known to have a high prevalence, although the prevalence has been low in some renal units^{16,20}. In some specialties and geographical locations, therefore, the risk of exposure to an HCV infected source may be high. Exposure to HCV positive sources in the UK is likely to be commoner than exposure to sources positive either for HIV or for hepatitis B surface antigen²¹.

Risk of transmission to health care workers

Health care workers may be at greater risk of hepatitis C than the general UK population^{9,10}, but the prevalence of anti-HCV in such staff is lower than among health care workers in the US²², and western Europe^{22,24}. In the UK, the overall prevalence of infection was estimated to be 0.23% among all health care workers and 0.28% in those at risk of occupational contact with blood and body fluids^{25,26}.

In the US, a review of published studies in health care workers who received a needlestick injury from an anti-HCV positive source estimated the risk of transmission to be 1.8% (range 0%-7%)². In a recent meta-analysis, the risk of transmission was shown to be greater if the source patient was known to be positive for HCV RNA; no transmission occurred from HCV RNA negative sources²⁷.

Risk of transmission from health care workers

Only two episodes of transmission from an HCV infected surgeon to patients have been described to date^{28,29}. In the UK, transmission from an HCV infected

surgeon was implicated in a single case of acute hepatitis C detected after cardiothoracic surgery²⁸. In the lookback investigation that followed, 277 patients were tested but no other infected individuals were identified³⁰. This suggests that the risk of transmission from health care worker to patient is much lower than the risk of transmission from surgeons positive for hepatitis B e antigen³⁰.

Based on this evidence, health care workers with HCV infection in the UK are not restricted from performing exposure prone procedures unless they have been shown to transmit hepatitis C to a patient²⁸. Nevertheless, health care workers with HCV infection should be seen in occupational health departments to be advised on scrupulous adherence to the optimal precautions for control of bloodborne virus infections in order to reduce the potential risk of transmission during exposure prone procedures⁴. In addition, infected health care workers should be advised about the local arrangements for the reporting, assessment, and management of any incidents in which patients appear to have been exposed to a health care worker's blood. Patients who sustain a significant exposure to blood (box 1) should be managed in the same way as exposed health care staff.

Management of hepatitis C infection

The UK Health Departments have concluded that there is no effective post exposure prophylaxis for hepatitis C⁴. The use of immunoglobulin has been suggested, but a US review in 1998 concluded that it did not prevent HCV infection³¹. Prophylaxis with alpha-interferon did not prevent transmission of hepatitis C after a needlestick injury in Japan³². No formal assessments of antiviral agents for post exposure prophylaxis have been performed, but their use has not been recommended in the US².

Alpha-interferon is now commonly used to treat chronic hepatitis C infection^{33,34}. Better response rates are likely to be seen with combination therapies that include ribavirin³⁵⁻³⁷. A recent European consensus statement recommended that combination therapy should be offered to all previously untreated infected individuals without contraindications³⁸. Evidence based guidance on the management of patients with hepatitis C currently being developed by professional groups in the UK may involve the selection of patients on the basis of abnormal liver function, HCV RNA positivity, and grade of abnormality on a liver biopsy³³. A decision about whether to continue treatment may depend upon demonstration of a virological response as assessed by genome detection.

Evidence on the optimal timing of treatment for acute and chronic hepatitis C infection is unclear. The use of interferon for acute hepatitis in a small number of patients suggested that early treatment might prevent chronic carriage³². A subsequent meta-analysis of the use of alpha- and beta-interferon in acute hepatitis C infection concluded that short term early treatment produced better response rates than treatment of chronic infections³⁹. Control data on

BOX 1

Definitions of occupational exposure¹

Percutaneous exposure:

the skin of the health care worker is cut or penetrated by a needle or other sharp object (for example, scalpel blade, trochar, bone fragment, or tooth), which is contaminated with blood or other body fluid

Mucocutaneous exposure:

the eye(s), the inside of the nose or mouth, or an area of non-intact skin of the health care worker is contaminated by blood or other body fluid

Significant exposure:

includes all percutaneous exposures and any mucocutaneous exposure to blood or bloody body fluids (but not mucocutaneous exposure to other body fluids).

untreated infections were limited, however, so the difference in response could reflect the natural clearing of acute infection. More recently, workers in Italy reported the results of a randomised controlled trial of beta-interferon in acute hepatitis C, in which the rates of chronic infection in treated (15/20) and untreated groups (16/20) were similar⁴⁰.

The US Centers for Disease Control and Prevention has concluded that there is insufficient evidence to suggest that treatment of acute hepatitis is more successful than early treatment of chronic hepatitis². In Canada, however, early treatment of health care workers who seroconvert following percutaneous exposures is now recommended³. A recent consensus conference in Europe also stated that most experts now favour treating patients with acute hepatitis C infection³⁸.

Recommendations

The recommendations of the committee for the management of a significant exposure (box 1)¹ are as follows:

Investigation of source patients

In most settings, most source patients are likely to be anti-HCV negative. The exclusion of HCV infection in the patient should reassure the exposed health care worker. Identification of a source patient who is positive for anti-HCV should prompt appropriate assessment of the patient and follow up of the health care worker. The advisory committee therefore recommends that, where possible, a baseline serum from the source patient should be obtained and tested for anti-HCV. Patients who are anti-HCV positive should be further investigated for HCV RNA (an EDTA plasma may be required by the local laboratory). In immunocompromised patients (including those on renal dialysis)⁴¹ or in patients with features suggestive of acute hepatitis C infection, the use of genome detection should be considered even if the source patient is found to be anti-HCV negative. These investigations will normally entail pre-test discussion and obtaining fully informed consent from the source patient⁴. Specimens from the source patient must be stored in a secure archive at a temperature at or below 20°C for at least two years after the incident.

Source patients found to be anti-HCV and/or HCV RNA positive should be referred to an appropriate consultant with an interest in hepatitis C infection.

In the event that the source patient cannot be identified or if the patient refuses to be tested or is unavailable for testing, management should be based upon a risk assessment. This risk assessment should be conducted by one of the doctors designated to offer advice on the management of exposures to bloodborne viruses within the health authority or NHS Trust⁴. Epidemiological and clinical information about the incident and/or the source patient should be obtained and reviewed. If the source patient is considered to be 'high risk' then the health care worker may be managed as if exposed to a source known to be positive. Such high risk exposures would normally

be limited to sharps injuries contaminated with fresh blood from a member of a known high risk group (for example, an IDU). Because the risk of transmission of bloodborne viruses from dried blood is likely to be lower than from fresh blood, the advisory committee does not consider community needlestick injuries from discarded needles to be 'high risk' exposures.

Investigation of the exposed health care worker

Baseline serum should be obtained from the exposed person and stored in a secure archive at -20°C or below for at least two years (box 2). If the source patient is not infected with HCV, no further follow up with respect to HCV is required unless the health care worker develops liver disease. Information, counselling, and psychological support should be available for any employee who reports an exposure and a potential risk of any bloodborne viral infection⁴. If, after the provision of information, the exposed person requests follow up, additional testing may be offered. At a minimum, this follow up should include testing for anti-HCV at six months.

For health care workers exposed to a source known to be positive for anti-HCV or HCV RNA (or a source whose hepatitis C status is unknown but who is assessed to be at 'high risk'), serum should be obtained from the health care worker at baseline, six weeks, 12 weeks, and 24 weeks after exposure (box 2). Serum should be tested for HCV RNA at six and 12 weeks and for anti-HCV at 12 weeks and 24 weeks.

Early testing of the serum of the health care worker for HCV RNA will, if negative, give some reassurance at this stage. In a follow up study of individuals who sustained needlestick exposures to patients with non-A, non-B hepatitis, both of the health care workers who developed anti-HCV were HCV RNA positive one

BOX 2 Summary of investigation and follow up of health care workers

Known HCV infected source

- obtain baseline serum for storage from health care worker
- obtain serum/EDTA for genome detection at six and 12 weeks
- obtain serum for anti-HCV at 12 and 24 weeks

Source known not to be infected with HCV

- obtain baseline serum for storage from health care worker
- obtain follow up serum if symptoms or signs of liver disease develop

HCV status of source unknown

- obtain baseline serum for storage from health care worker
- designated doctor to perform risk assessment:

High risk

- manage as known infected source

Low risk

- obtain serum for anti-HCV at 24 weeks

BOX 3

National surveillance of occupational exposure to bloodborne virus surveillance scheme**Copies of the report forms are available from**

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In Scotland, report forms are available from

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month after exposure⁴⁵; early genome detection was not performed on health care workers who did not seroconvert. The negative predictive value of genome detection at six weeks is therefore not documented, but it seems likely that this would correlate with a lower risk of transmission.

Collation of information on such exposures will contribute towards the prospective estimation of transmission risks and the likely predictive value of laboratory investigations. All exposures to known anti-HCV or HCV RNA positive sources should therefore be reported to the PHLS national surveillance scheme for health care workers occupationally exposed to bloodborne viruses (box 3). An equivalent scheme for Scotland is coordinated by the Scottish Centre for Infection and Environmental Health. If the health care worker is found to be positive for anti-HCV or HCV RNA at any stage, retrospective investigation of baseline specimens from the health care worker and source patient for HCV RNA, if not already available, can then be performed. Additional studies that may be useful at this stage include genotyping and viral load. Genotyping of source and health care worker will help to confirm whether transmission from patient to health care worker has occurred⁴³, and specimens for genotyping can then be referred to the PHLS Hepatitis and Retrovirus Laboratory in Colindale. Estimates of viral load in the source patient may also help to inform the management of such incidents in the future.

Advice to exposed health care workers during follow up

It is difficult to offer advice on the appropriate management of health care workers exposed to a known HCV infected source during follow up. The risk of transmission is small², and there is insufficient evidence to advise mandatory restriction of work practices. Occupational health departments may wish, however, to suggest additional precautions during certain procedures⁴. In line with the Blood Transfusion Service recommendations⁴⁴, before donating blood,

health care workers who have been exposed to an individual infected with hepatitis should be referred to the medical officer for assessment. We advise similar caution with respect to donations of other tissues. In studies of chronic HCV infection, the transmission of infection from mother to child is believed to occur in less than 10% of cases⁴⁵. Sexual transmission from chronically infected individuals occurs, but the risk appears to be low⁴⁶⁻⁴⁸. The risk of transmission to infants and sexual partners may be higher in acute than chronic infections, but the magnitude of this increased risk is unknown. Discussion of the possible benefits of adopting safer sexual practices and the avoidance of pregnancy during follow up is therefore recommended.

Health care workers found to be anti-HCV and/or HCV RNA positive at any stage during follow-up should be referred to an appropriate consultant with an interest in hepatitis C infection. The evidence for the effectiveness of early treatment is limited, but referral will allow early assessment and a consideration of the potential role of treatment. As treatment options are likely to change over the next few years, early detection will enable recruitment into clinical trials and the early implementation of any treatment shown to improve outcome. Health care workers found to be anti-HCV and/or HCV RNA positive should also be referred to occupational health for advice.

References

1. PHLS Hepatitis Subcommittee. Hepatitis C virus: guidance on the risks and current management of occupational exposure. *Commun Dis Rep CDR Rev* 1993; **3**: R135-9.
2. CDC. Recommendations for follow-up of health-care workers after occupational exposure to hepatitis C virus. *MMWR Morb Mortal Wkly Rep* 1997; **46**: 603-6.
3. Sherman M. Management of viral hepatitis: clinical and public health perspectives – a consensus statement. CASL Hepatitis Consensus Group. Canadian Association for the Study of the Liver. *Can J Gastroenterol* 1997; **11**: 407-16.
4. UK Health Departments. *Guidance for clinical health care workers: protection against infection with bloodborne viruses. Recommendations of the Expert Advisory Group on AIDS and the Advisory Group on Hepatitis. 3rd edition.* London: Department of Health, 1998.
5. WHO. Hepatitis C: global prevalence. *Wkly Epidemiol Rec* 1997; **72**: 341-8.
6. CDSC. Surveillance of viral infections in donated blood. *Commun Dis Rep CDR Wkly* 1997; **7**: 256.
7. 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**: 768-72.
8. 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.
9. 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.
10. 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.
11. McBride AJ, Ali IM, Clee W. Hepatitis C and injecting drug use in prisons. *BMJ* 1994; **309**: 876.
12. Majid A, Holmes R, Desselberger U, Simmonds P, McKee

- TA. Molecular epidemiology of hepatitis C virus infection amongst intravenous drug users in rural communities. *J Med Virol* 1995; **46**: 48-51.
13. Serfaty MA, Lawrie A, Smith B, Brind AM, Watson JP, Gilvarry E, et al. Risk factors and medical follow-up of drug users tested for hepatitis C - can the risk of transmission be reduced? *Drug and Alcohol Review* 1997; **16**: 339-47.
 14. McCrudden EA, Hillan KJ, McKay IC, Cassidy MT, Clark JC. Hepatitis virus infection and liver disease in injecting drug users who died suddenly. *J Clin Pathol* 1996; **49**: 552-5.
 15. Goldberg D, Cameron S, McMenamin J. Hepatitis C virus antibody prevalence among injecting drug users in Glasgow has fallen but remains high. *Commun Dis Public Health* 1998; **1**: 95-7.
 16. Jacyna MR, O'Neil K, Brown J, Drobner R, Karayiannis P, Thomas HC. Hepatitis C virus antibodies in subjects with and without liver disease in the United Kingdom. *Q J Med* 1990; **77**: 1009-12.
 17. Brettler DB, Alter HJ, Dienstag JL, Forsberg AD, Levine PH. Prevalence of hepatitis C virus antibody in a cohort of hemophilia patients. *Blood* 1990; **76**: 254-6.
 18. Laurian Y, Blanc A, Delaney SR, Allain JP. All exposed haemophiliacs have markers of HCV. *Vox Sang* 1992; **62**: 55-6.
 19. Conway M, Catterall AP, Brown EA, Tibbs C, Gower PE, Curtis JR, 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.
 20. Brind AM, Codd AA, Cohen BJ, Gabriel FG, Collins JD, James OF, et al. Low prevalence of antibody to hepatitis C virus in North East England. *J Med Virol* 1990; **32**: 243-8.
 21. Cummins AJ, Tedder RS. Inadequate information on needlestick accidents. *Lancet* 1992; **339**: 1178-9.
 22. Miller-Tereskerz P, Petrosillo N, Puro V, Jagger J. Hepatitis C virus in health care workers. *Advances in Exposure Prevention* 1995; **2**: 1,7-9.
 23. Jochen AB. Occupationally acquired hepatitis C virus infection. *Lancet* 1992; **339**: 304.
 24. Struve J, Aronsson B, Frenning B, Forsgren M, Weiland O. Prevalence of antibodies against hepatitis C virus infection among health care workers in Stockholm. *Scand J Gastroenterol* 1994; **29**: 360-2.
 25. Zuckerman J, Clewley G, Griffiths P, Cockcroft A. Prevalence of hepatitis C antibodies in clinical health-care workers. *Lancet* 1994; **343**: 1618-20.
 26. Neal KR, Dornan J, Irving WL. Prevalence of hepatitis C antibodies among health care workers of two teaching hospitals. Who is at risk? *BMJ* 1997; **314**: 179-80.
 27. Dore GJ, Kaldor JM, McCaughan GW. Systematic review of role of polymerase chain reaction in defining infectiousness among people infected with hepatitis C virus. *BMJ* 1997; **315**: 333-7.
 28. CDSC. Hepatitis C virus transmission from health care worker to patient. *Commun Dis Rep CDR Wkly* 1995; **5**: 121.
 29. Esteban JL, Gomez J, Martell M, Cabot B, Quer J, Camps J, et al. Transmission of hepatitis C virus by a cardiac surgeon. *N Engl J Med* 1996; **334**: 555-60.
 30. Duckworth GJ, Heptonstall J, Aitken C, for the Incident Control Team and others. Transmission of hepatitis C from a surgeon to a patient. *Commun Dis Public Health* 1999; **2**: 188-92.
 31. Bolyard EA, Tablan OC, Williams WW, Pearson ML, Shapiro CN, Deitchmann SD. Guideline for infection control in healthcare personnel, 1998. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1998; **19**: 407-63.
 32. Nakano Y, Kiyosawa K, Sodeyama T, Tanaka E, Matsumoto A, Ichijo T, et al. Acute hepatitis C transmitted by needlestick accident despite short duration interferon treatment. *J Gastroenterol Hepatol* 1995; **10**: 609-11.
 33. Foster GR, Goldin RD, Main J, Murray-Lyon I, Hargreaves S, Thomas HC. Management of chronic hepatitis C: clinical audit of biopsy based management algorithm. *BMJ* 1997; **315**: 453-8.
 34. Poynard T, Leroy V, Cohard M, Thevenot T, Mathurin P, Opolon P, et al. Meta-analysis of interferon randomized trials in the treatment of viral hepatitis C: effects of dose and duration. *Hepatology* 1996; **24**: 778-89.
 35. McHutchinson JG, Poynard T. Combination therapy with interferon plus ribavirin for the initial treatment of chronic hepatitis C. *Semin Liver Dis* 1999; **19**: suppl-65.
 36. Poynard T, Marcellin P, Lee SS, Niederau C, Minuk GS, Ideo G, et al. Randomised trial of interferon alpha2b plus ribavirin for 48 weeks or for 24 weeks versus interferon alpha2b plus placebo for 48 weeks for treatment of chronic infection with hepatitis C virus. *Lancet* 1999; **352**: 1426-32.
 37. Davis GL, Esteban-Mur R, Rustgi V, Hoefs J, Gordon SC, Trepo C, et al. Interferon alfa-2b alone or in combination with ribavirin for the treatment of relapse of chronic hepatitis C. *N Engl J Med* 1998; **339**: 1493-9.
 38. Anon. EASL International Consensus Conference on Hepatitis C. Paris, 26-28 February 1999. Consensus statement. *J Hepatol* 1999; **30**: 956-61.
 39. Quin JW. Interferon therapy for acute hepatitis C viral infection - a review by meta-analysis. *Aust NZ J Med* 1997; **27**: 611-7.
 40. Calleri G, Colombatto P, Gozzelino M, Chieppa F, Romano P, Delmastro B, et al. Natural beta-interferon in acute type-C hepatitis patients: a randomized controlled trial. *Ital J Gastroenterol Hepatol* 1998; **30**: 181-4.
 41. Bukh J, Wantzin P, Krogsgaard K, Knudsen F, Purcell RH, Miller RH. High prevalence of hepatitis C virus (HVC) RNA in dialysis patients: failure of commercially available antibody tests to identify a significant number of patients with HCV infection. *J Infect Dis* 1993; **168**: 1343-8.
 42. Sodeyama T, Kiyosawa K, Urushihara A, Matsumoto A, Tanaka E, Furuta S, et al. Detection of hepatitis C virus markers and hepatitis C virus genomic-RNA after needlestick accidents. *Arch Intern Med* 1993; **153**: 1565-72.
 43. Harris KA, Gilham C, Mortimer PP, Teo CG. The most prevalent hepatitis C virus genotypes in England and Wales are 3a and 1a. *J Med Virol* 1999; **58**: 127-31.
 44. UK Blood Transfusion Service. *Guidelines for the Blood Transfusion Service in the United Kingdom (UKBTS/NIBSC)*, 3rd edition, 1996.
 45. Gillett P, Hallam N, Mok J. Vertical transmission of hepatitis C virus infection. *Scand J Infect Dis* 1996; **28**: 549-52.
 46. Brettler DB, Mannucci PM, Gringeri A, Rasko JE, Forsberg AD, Rumi MG, et al. The low risk of hepatitis C virus transmission among sexual partners of hepatitis C infected haemophilic males: an international multicenter study. *Blood* 1992; **80**: 540-3.
 47. Bresters D, Mauser-Bunschoten EP, Reesink HW, Roosendaal G, van der Poel CL, Chamuleau RA, et al. Sexual transmission of hepatitis C virus. *Lancet* 1993; **342**: 210-1.
 48. Ryan KE, MacLennan S, Barbara JA, Hewitt PE. Follow up of blood donors positive for antibodies to hepatitis C virus. *BMJ* 1994; **308**: 696-7.

Appendix I

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