Expert Report to the Infected Blood Inquiry: Statistics

Infected Blood Inquiry

September 2022

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Table of Contents

Communicating Uncertainty

Few of the quantities in this report are known with certainty. We use two main ways to express the uncertainty resulting from our analyses – numerical ranges and confidence statements.

Numerical ranges have two forms:

Confidence intervals (CI) are a standard statistical technique when estimating single quantities from individual data sources. They express a range of plausible values (usually 95%) that is compatible with the observed data.

Uncertainty intervals arise when building complex models based on a set of assumptions, some judgemental. Uncertainty about the inputs is propagated, using simulation methods, through the model to produce a range (usually 95%) of plausible values for the outputs.

Confidence statements summarise our judgement of the extent that the available data can answer the question of interest, on the following scale: Low, Low/Moderate, Moderate, Moderate/High, High.

Executive Summary

1: HIV infections in people with bleeding disorders

How many people with bleeding disorders were infected with HIV through blood products in the UK between 1970 and 1991?

How many have subsequently died; and of these deaths, how many were due to HIV/AIDS?

- Three independent data-sources lead to broadly similar conclusions.

Sources	HIV diagnoses	Infected in the UK	Died by 2020	Died by 2020 of HIV-related causes
Macfarlane Trust	1,243	1,243	890 (72%) by 2013	Unknown
UK Haemophilia Centre Doctors' Organisation (UKHCDO)	1,338	Unknown but likely to be the great majority	1,017 (76%)	639 (48%)
UK Health Security Agency (UKHSA)	'Haemophiliac' 1,061 'Haemophiliac' +'undetermined' 1,243	Unknown but likely to be the great majority	820 (77%) 963 (77%)	Unknown

Table ES1 HIV diagnoses in people with bleeding disorders reported from three different sources up to the end of 2020.

- We conclude that around 1,250 people with bleeding disorders were infected with HIV in the UK between 1970 and 1991. Around three-quarters of these have died, and around half have died of HIV-related causes.
- **Confidence that available evidence can answer the questions?** Moderate/High.

2: HCV infections in people with bleeding disorders

How many people with bleeding disorders were infected with HCV through blood products in the UK between 1970 and 1991?

How many have subsequently died; and of these deaths, how many were HCV-related?

- In spite of the efforts made by the UKHCDO, it is challenging to establish the number of HCV infections in people with bleeding disorders, due to the limited data on exposure and HCV status.

Source	HCV infections (without HIV)	Deaths
UKHCDO report	Confirmed ~ 2,400 Additional 'possible' at least 2,400	~700 [39% from HCV-related causes] ~1,400
NHD	Well documented (i.e. both born & NHD-registered before 1992 & with record-linkage follow-up): 2,055	Before 2020: 536
Skipton Fund	~ 2,760	~ 900

Table ES2 Number of HCV infections and deaths in people with bleeding disorders in the UK between 1970 and 1991: 'possible' infections include those known to have been exposed to at-risk blood products but with unknown HCV status. Additional infections will have occurred in those whose exposure history was unknown and who have not been tested for HCV.

- This table does not include those infected with HIV, who are covered in Chapter 1, though the Skipton Fund number will include some such persons. UKHCDO say it is reasonable to assume that all of those infected with HIV will also have been co-infected with HCV.
- We judge that between 2,400 – 5,000 people with bleeding disorders were infected with HCV, excluding those infected with HIV.
- **Confidence that available evidence can answer the questions?** Low/Moderate.

3: HIV infections in transfusion recipients

How many people were infected with HIV through blood transfusions in the UK between 1970 and 1991?

How many have subsequently died; and of these deaths, how many were due to HIV/AIDS?

- At least 79, and possibly up to ~100, people were infected with HIV through blood transfusions in the UK between 1970 and 1991, mostly pre-1986. Around 85% have subsequently died, but we do not know the causes of death. This assessment is based on a data set provided by the UK Health Security Agency (UKHSA).
- **Confidence that available evidence can answer the questions?** Moderate.

4: HCV infections in transfusion recipients

How many people were infected with HCV through blood transfusions in the UK between 1970 and 1991?

How many were chronically HCV-infected, and subsequently died; and, of these deaths, how many were due to their chronic HCV infection?

- Our analysis is based on a complex statistical model of the stages from HCV-infectious donors to recipients becoming chronically HCV-infected following transfusion, and then survival until the end of 2019, taking into account the increased risk associated with chronic HCV-infection. Our primary model was constructed for England, and then adapted for Scotland, Wales and Northern Ireland.
- Numerous sources of evidence have been used in constructing this model, but the many assumptions and inevitable limitations in the data mean that there is considerable uncertainty around our numerical conclusions. We provide central estimates and 95% uncertainty intervals for the results from our 'baseline scenario'. It is important to note the most likely value is near the central estimate, and that it is very unlikely that the true value is as high as the upper end of the interval, or as low as the lower end.
- Our summary estimates for the UK from our baseline scenario are:

Quantity of Interest	Estimate	95% uncertainty interval
Number of people infected with HCV through blood transfusion between 1970 and 1991	26,800	21,300 to 38,800
Number chronically infected (were they to survive 6 months post-transfusion)	22,000	17,300 to 31,900
Number chronically infected who survived to 10 years after transfusion	8,120	6,330 to 11,900
Number chronically infected, and survived to end of 2019 (assuming extra HCV risk)	2,700	2,050 to 3,910
Number chronically infected, and died by end of 2019	19,300	15,100 to 28,200
Number of deaths by end of 2019 related to HCV infection	1,820	650 to 3,320

Table ES4 Estimates and 95% uncertainty intervals of the main quantities of interest from the statistical model of HCV transmission from transfusions. Estimates are for the whole of the UK. Females accounted for 64% (95% uncertainty interval: 58% to 69%) of the people chronically infected with HCV by transfusion who survived to the end of 2019.

- Extensive sensitivity analyses identified that assumptions about the effect of both HIV antibody screening and changing guidance for potential blood donors were an important factor: assuming a more limited effect would reduce our estimates by around a quarter. There is essentially no direct evidence regarding this quantity, and so we are reliant on expert judgements.
- Our estimates for the number of infections are reasonably similar to previous estimates based on look-back exercises.
- **Confidence that available evidence can answer the questions?** Moderate.

5: Information from funds

- The funds will not be a complete record of those infected, but provide a useful 'calibration' of results derived from alternative sources.

6: vCJD infections from blood and blood products

How many people were infected with vCJD from blood and blood products in the UK?

- Out of 178 recorded cases of confirmed or probable vCJD in the UK, 5 were blood-borne infections: 3 symptomatic vCJD cases; one asymptomatic person (positive at autopsy for abnormal prion in her spleen) from transfusion-transmitted infection; and one asymptomatic infectee with severe haemophilia A who had been exposed to vCJD-implicated Factor VIII (positive at autopsy). All five have died.
- **Confidence that available evidence can answer the questions?** High.

7: HBV infections from blood and blood products

How many people were infected with HBV between 1970 and 1991 through blood and blood products, and what were the impacts?

- Due to the limitations in the data available, it is not possible to answer the questions set with any reasonable accuracy, when compared to other infections we investigated. There was a lack of an integrated public health approach at the onset of donor screening in 1971/72 to identify past recipients of transfusion from donors who were infectious HBV carriers. Furthermore, people infected with HBV have never received financial support and so funds are not a source of data.
- **Confidence that available evidence can answer the questions?** Low.

Introduction

0.1 The Inquiry's Letter of Instruction[1] to its Statistics Expert Group of 25th September 2019 contained an extensive list of questions concerning a wide range of uses of statistics about infections from blood and blood products. However, when the SARS-CoV-2 pandemic began in early 2020, this team of experts in infectious diseases immediately became very heavily engaged in statistical work on COVID-19, and this has continued until now.

0.2 Professor Stephen Evans, the Convenor of the Statistics Expert Group, wrote to Sir Brian Langstaff on 27th June 2022[2] suggesting a more restricted focus:

- We propose that the report we publish in September should set out, based on the most reliable data available and with clearly stated assumptions, the likely ranges for the numbers of people who have been infected through blood and blood products, and, where possible, their subsequent mortality. We will also publish the statistical models we have created.
- I understand from the Inquiry team that the evidence has touched on a number of statistical issues during the course of the Inquiry's hearings. We will explain any relevant statistical principles of interest in our report and when we give evidence at a hearing in early October.

This proposal was accepted by Sir Brian.

0.3 This report lays out the findings from our investigations into the number of infections from blood and blood products in the UK between 1970 and 1991 (later in the case of vCJD), and the subsequent survival of those infected. We cover HIV, HCV, vCJD and, to a limited extent, HBV. Despite their importance, we do not address how morbidity or quality of life has evolved during disease progression in the past 50 years of pharmaceutical and other advances in care.

0.4 It is important to be clear about the limitations of what we can conclude from this, and indeed any other, statistical investigation. In brief, any conclusions we draw from data will depend on:

- *Availability*: sometimes the information we want was not collected or not retained.
- *Definitions*: the numbers depend crucially on the criteria in use at the time, for example, what is meant by an antibody-positive HCV test has varied considerably over time.
- *Quality*: data may not be accurate, particularly when part of routine collections rather than a planned study.
- *Completeness*: data may be missing for a variety of reasons – and sometimes the fact that data are missing may itself be informative.

[1] Letter of Instruction: Statisticians Expert Group, 25 September 2019 [INQY0000369]
[2] Exchange of Letters, 27 June 2022 [INQY0000370; INQY0000371]

- *Context*: for example, we need to take into account why the data were collected (for example, by review of death certificates; or at autopsy), and what was known at the time.
- *Skill in Interpretation*: statistics are sometimes represented as hard 'facts', but the caveats listed above should make it clear that they can be much 'softer' than perhaps perceived. Drawing conclusions from data is not some automatic process, and judgement is always required – the data do not speak for themselves.

0.5 As explained previously, we try to be clear about these concerns by not only reporting numerical ranges expressing uncertainty about quantities, but also judgements of our confidence that the available data can answer the primary questions of interest.

0.6 An important limitation is that statistics are always an imperfect representation of what we are actually interested in. Tables and graphs of numbers of people infected and their subsequent survival are inevitably a gross, even harsh, summary of the suffering endured by those individuals and the people close to them. We provide no measures of illness, psychological distress, financial harms, family stress, and the many other ways in which infected blood will have damaged lives. In particular, we do not attempt to estimate onward-transmission to partners, children or others. We hope that readers will recognise our understanding that, beneath all the counts and measurements, there are individual human lives. But it is only by summarising all those experiences into bald numbers that we can properly assess the magnitude of what has happened.

0.7 This has been a particularly challenging area to investigate as the data, when available, tend to suffer from many of the issues laid out above and so any numerical conclusions we draw are necessarily cautious and approximate. For HIV and vCJD infections, and for people with bleeding disorders, we can actually count cases of interest from databases, although even then we acknowledge possible incompleteness. But we cannot list those who have been chronically infected with HCV from transfusions, and so we rely on statistical models to estimate what we cannot directly observe – these are necessarily dependent on additional assumptions, and this means that any conclusions are even more uncertain.

Chapter 1 HIV infections in people with bleeding disorders

How many people with bleeding disorders were infected with HIV through blood products in the UK between 1970 and 1991?

How many have subsequently died; and of these deaths, how many were due to HIV/AIDS?

Summary findings

- Three independent data-sources lead to broadly similar conclusions.

Sources	HIV diagnoses	Infected in the UK	Died by 2020	Died by 2020 of HIV-related causes
Macfarlane Trust	1,243	1,243	890 (72%) by 2013	Unknown
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Table S1 HIV diagnoses in people with bleeding disorders reported from three different sources up to the end of 2020.

- We conclude that around 1,250 people with bleeding disorders were infected with HIV in the UK between 1970 and 1991. Around three-quarters of these have died, and around half have died of HIV-related causes.

Confidence that available evidence can answer the questions? Moderate/High.

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1.1 **Terminology:** We follow the relevant Inquiry report[3] in using the term 'people with bleeding disorders', sometimes shortened to PwBD, to include patients diagnosed with haemophilia (A, B or C) or von Willebrand disease.

[3] Expert Report to the Infected Blood Inquiry: Bleeding Disorders and Blood Disorders, 23 January 2020 [EXPG0000002, ep.13]

Background

1.2 The history and current knowledge about HIV have been summarised by an Expert Report to the Inquiry.[4] Relevant milestones regarding data include:

- **1981**: The first recorded case in the UK of what was subsequently known as Acquired Immune Deficiency Syndrome (AIDS) – but human immunodeficiency virus (HIV), as the cause of AIDS, had not yet been identified.
- **1982**: The term 'AIDS' is used for the first time; a definition is agreed and a proforma for collecting data on each case – the AIDS surveillance form – is introduced in the USA and for use worldwide.
- **1983**: The HTLV-III retrovirus, subsequently named "HIV", was identified in France.
- **1984**: Prototype HIV antibody testing introduced in the UK. The UK's national infectious disease surveillance centres, having introduced the AIDS surveillance form in 1982, establish HIV antibody diagnosis reporting systems to determine the characteristics and extent of infection.
- **1985**: HIV antibody screening of the UK's blood supply from October 1985.

Sources of evidence

1.3 There are three main sources of evidence regarding those infected with HIV through blood products. The first source is registrations with the Macfarlane Trust, which provided support to people with bleeding disorders who had been infected with HIV (see Chapter 5).

1.4 The second major source is the National Haemophilia Database (NHD), which is run by the United Kingdom Haemophilia Centre Doctors' Organisation (UKHCDO) and which has evolved from data collection initiated by the Medical Research Council (MRC) in 1969. The NHD data are not used for individual patient care, and therefore are not comparable to the information contained in patient records held by hospitals or haemophilia centres. Our impression is that it has clearly been challenging for the NHD to establish an accurate, up-to-date database without duplicate records.

1.5 The NHD received a request dated 6th April 2020 from the Infected Blood Inquiry for analysis of data held by the NHD ("Rule 9 Request"). The resulting report was *"Bleeding Disorders Statistics for the Infected Blood Inquiry 2020."*[5] The primary source for data on HIV infections in people with bleeding disorders is Chapter 8 of UKHCDO (2022) *"The number of HIV positive and negative persons with bleeding disorders at each Haemophilia Centre in the UK, broken down by year."*[6]

1.6 The third source is the UK Health Security Agency (UKHSA) HIV database, which is a continuation of that held by Public Health Laboratory Service (PHLS), the Health Protection Agency and then Public Health England; this source receives information from Scotland's HIV database as held currently by Public Health Scotland (originally known as the Scottish Centre for Infection and Environmental Health). Part of the data collected on each individual includes how the infection was probably acquired, and

[4] Expert report to the Infected Blood Inquiry: HIV, January 2020 [EXPG0000004]
[5] National Haemophilia Database and the UK Haemophilia Centre Doctors' Organisation, "Bleeding disorders statistics for the Infected Blood Inquiry 2020," August 2022 [WITN3826016]
[6] Ibid., epp.39-42.

a selection of past published results from this database is shown in Table 1.1. Since 2005, all blood-borne infections have been combined and, in recent years, have been reported under 'other'.

Source	Area	Period – up to end of	Reported category of 'how infection probably acquired'	HIV diagnoses
CDR Weekly report Vol 1, No 1 (1991)[7]	UK	1990	Blood factor (e.g. haemophiliacs) Blood/tissue transfer (e.g. transfusion): Abroad UK	226 (154 deaths) 37 (23 deaths) 29 (22 deaths)
CDR Review Number 1, 1996 (Day Review)[8]	England and Wales	1993	Blood or blood factor recipients	Estimated 1,290 (590 deaths)
PHLS AIDS/ HIV Quarterly Surveillance Tables (1996)[9]	UK	1994	Blood factor (e.g. haemophiliacs) Blood/tissue transfer (e.g. transfusion)	1,221 157
CDR Weekly report, vol 14, (2004)[10]	UK	2003	Blood transfusion or blood factor products	1,747
HIV national data tables 2021[11]	England	2020	'Other'	1,975

Table 1.1 A selection of published summaries of HIV blood-borne infection in the UK.

1.7 The UKHSA has supplied to the Inquiry[12] tables that list the number of new HIV diagnoses each year to 2000 in the UK, and the number recorded as being infected by exposure to blood products, as reported by 2020 and re-coded using the 2005 archive when all infections through blood products were merged. 'Exposure' was broken into 'Haemophilia', 'Other blood products', and 'Blood products (undetermined)', and further into whether acquired in the UK, acquired outside the UK, or place of acquisition unknown (or not reported). The spreadsheet also reported deaths from all causes.

1.8 UKHSA acknowledges the problems in ensuring the accuracy of this database. This is not a clinical record, and – to maintain confidentiality – full patient identifiers are not collected for public health surveillance purposes. However, there is an annual

7 Communicable Disease Report, Volume 1, Number 1, 4 January 1991 [NIBS0000165, ep.3, Table 1]
8 Communicable Disease Report, Volume 6, Review Number 1, 5 January 1996 [PHEN0002474, ep.11, Table 8]
9 'AIDS/HIV Quarterly Surveillance Tables, No. 26: Data to end December 1994' by the Public Health Laboratory Service and the Scottish Centre for Infection and Environmental Health [DHSC0004496_003, ep.5, Table 1]
10 Communicable Disease Report, Volume 14, Number 7, 12 February 2004 [NHBT0003595_145, ep.1, Table 1]
11 'England: National HIV surveillance data tables, No. 1 2021' by the UK Health Security Agency in collaboration with Public Health Scotland [PHEN0002468, Table 1a]
12 'Number of new HIV diagnoses to 2000' by the UK Health Security Agency, dated 4 August 2022 [PHEN0002472]

deduplication process, although the great majority (around 98% plus) of identifiers are stable over time. The records are also not necessarily complete and patients' exposure routes are essentially self-reported.[13]

1.9 Although these three databases (Macfarlane, UKHCDO and UKHSA) are concerned with essentially the same cases, there has not been a systematic attempt to reconcile these sources, and therefore they will inevitably arrive at different totals.

Findings – Diagnoses

Source: Macfarlane Trust

1.10 Chapter 5 describes how the Macfarlane Trust was set up in 1988 to provide support for people with haemophilia (including women with von Willebrand disease) infected with HIV in the UK. In 2003[14] they reported 1,242 directly infected registrants, in 2007[15] they recorded 1,243 registrants,[16] and in 2013 reported that 353 were known to be alive and registered with the MFET Ltd[17], and therefore 890 were deceased. An additional 14 HIV-infected registrants with the four national funds (see Chapter 5) died between 2017 and 2022, and most will have been people with bleeding disorders.

1.11 **Limitations:**

- The Macfarlane Trust may have missed some relevant individuals, for example some of those who died before its establishment, but this is likely to be a small number. Others may have chosen not to register with the Trust. The 1,243 should therefore be considered as a lower bound, although the true total is unlikely to be substantially larger.

Source – UKHCDO

1.12 Table 1.2 reproduces Table 8.3.1 of UKHCDO (2022).[18] It records 1,338 people with bleeding disorders diagnosed with HIV between 1979 and 2000 in the UK, the great majority (974) with severe haemophilia A. Forty three were resident abroad. It is assumed that all HIV diagnoses in people with bleeding disorders were due to infection from blood products.

[13] Email from the UK Health Security Agency to the Infected Blood Inquiry, dated 5 August 2022 [PHEN0002471]
[14] The Macfarlane Trust, 'Statistics Summary at 31 October 2003' [MACF0000009_198, ep.4]
[15] The Macfarlane Trust, 'Macfarlane News, Spring 2007' [MACF0000004_046, ep.1]
[16] The additional registrant appears to be an individual who died before the fund was established, but was only identified after the 2003 report [DHSC0004555_123, ep.1]
[17] MFET Ltd was established to make non-discretionary payments to beneficiaries of the Macfarlane and Eileen Trusts. Hansard Written Answer, 24 October 2013 [DHSC6887702, ep.1]
[18] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" August 2022 [WITN3826016, epp. 40-41, table 1.1.4]

Bleeding disorder	Total	No. of Male PwBD	No. of Female PwBD
PwBD not resident abroad as per NHD records			
Severe haemophilia A	941	940	1
Severe haemophilia B	18	18	0
Non-severe haemophilia A or B	305	304	1
Females with Factor VIII deficiency	3	-	3
Haemophilia A with liver transplant[19]	11	11	0
Other bleeding disorders	17	8	9
Total	**1,295**	**1,281**	**14**
Resident abroad as per NHD records			
Severe haemophilia A	33	33	0
Severe haemophilia B	1	1	0
Non-severe haemophilia A or B	9	9	0
Females with Factor VIII deficiency	0	0	0
Haemophilia A with liver transplant	0	0	0
Other bleeding disorders	0	0	0
Total	**43**	**43**	**0**
All HIV antibody positive PwBD	**1,338**	**1,324**	**14**

Table 1.2 HIV antibody positive diagnoses in people with bleeding disorders (PwBD) between 1979 and 2000 in UK (source, UKHCDO report).

1.13 Limitations:

- The UKHCDO data include people with bleeding disorders with documented results for an HIV test in the NHD, plus five people with bleeding disorders who had AIDS as underlying cause of death recorded on either NHD or NHS Digital. The UKHCDO database excludes partners of people with bleeding disorders, and people with bleeding disorders whose records were labelled as 'not yet tested'.
- People with bleeding disorders with milder disorders may have been de-registered if their condition improved over time, or they had infrequent contact with their haemophilia centre.
- There does not seem to have been cross-checking between UKHCDO and UKHSA's register of HIV diagnoses. It is possible that a small number of HIV diagnoses are not known to the NHD.
- Von Willebrand disease is not listed separately, but included in Other Bleeding Disorders.

[19] UKHCDO note that they may not be aware of all liver transplants given to HIV infected people with bleeding disorders [WITN3826016, ep.63]

1.14 Table 1.3 shows the 1,338 HIV diagnoses by nation within the UK, according to NHD.[20] A further breakdown by Centre is shown in the Appendix Table 1.1. However, for the Penrose Inquiry,[21] a review of 74 case-histories for patients attributed to Scotland determined that only 60 were likely to have been infected with HIV in Scotland.

England	1,193
Northern Ireland	16
Scotland	74
Wales	55
Total	**1,338**

Table 1.3 HIV diagnoses up to 2020 in people with bleeding disorders by UK nation (source UKHCDO report).[22]

1.15 Figure 1.1, which displays the HIV diagnoses by year of UKHCDO-registered diagnosis, indicates the year of the first recorded HIV antibody positive test.[23] Testing began in August 1984 and became more widely available in 1985, and so HIV diagnoses in earlier years arise from testing stored samples. Nine UKHCDO-registered HIV diagnoses were made after 1991, three of them after 1995. The year is unknown for eleven diagnoses.

[20] NHD & UKHCDO, Pivot Table 8.3.2, HIV results from 1979 to 2000 [WITN3826020]
[21] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.301 [PRSE0007002, ep.113]
[22] NHD & UKHCDO, Pivot Table 8.3.2, HIV results from 1979 to 2000 [WITN3826020] and NHD & UKHCDO, Pivot Table 9.2.5.1, HCV status of PwBD at-risk of HCV infection [WITN3826021]. 55th Welsh HIV diagnosis was rapidly identified by UKHCDO and has only been recorded in pivot 9.2.5.1, not 8.3.2.
[23] NHD & UKHCDO, Pivot Table 8.3.2, HIV results from 1979 to 2000 [WITN3826020]

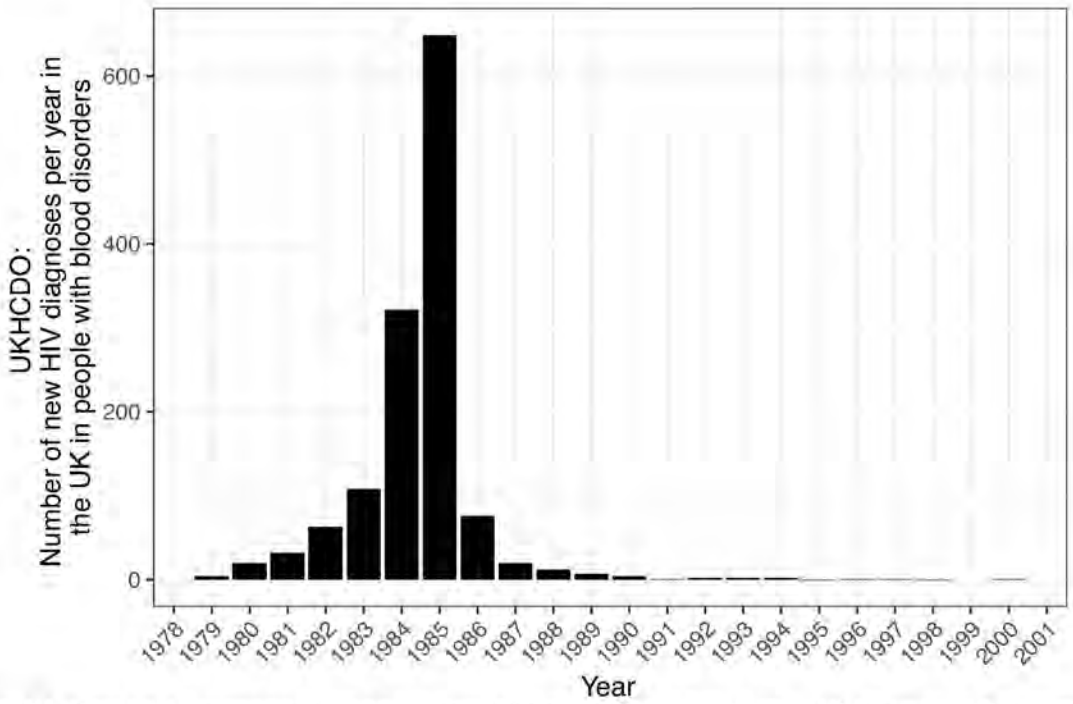

Figure 1.1 New HIV diagnoses in people with bleeding disorders in the UK by year of first record of a positive test (source UKHCDO).[24] *Note that the recorded year of diagnosis does not necessarily represent the year of HIV infection due to delays in diagnosis, missing positive tests, and, for those from abroad, confirmatory HIV diagnosis in the UK.*

1.16 Not all these individuals will have been infected in the UK. UKHCDO report *"When a newly immigrated PwBD [person with a bleeding disorder] with HIV infection was registered on the database, the NHD did not record the country where the infection was potentially acquired. Details of HIV tests and the country where it was acquired are only available in the individual's clinical record held by the centre."*[25] Therefore, if based solely on this source, any assessment of the numbers infected in the UK must be an estimate rather than a count.

1.17 The Penrose Report recorded that of 74 cases for Scotland, 11 had been infected abroad.[26] This provides some information for attempting to estimate how many of the 1,338 cases were infected abroad. Several possibilities arise. First, we note that 63/74 = 85% of the Scottish cases had been infected in the UK. If this proportion were applied generally to the whole of the UK, it would mean that an estimated 0.85 x 1,338 ~1,140 people with bleeding disorders were infected with HIV in the UK. Second, as Scotland had roughly 9% of the UK population in the 1980s, the 11 infected abroad in Scotland could be scaled up to 11/0.09 ~ 122, giving around 1,215 cases infected in the UK. Both these estimates are somewhat below the 1,243 cases recorded by the Macfarlane Trust.

[24] NHD & UKHCDO, Pivot Table 8.3.2, HIV results from 1979 to 2000 [WITN3826020] and NHD & UKHCDO, Pivot Table 9.2.5.1, HCV status of PwBD at-risk of HCV infection [WITN3826021]

[25] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" [WITN3826016, ep.42]

[26] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.301 [PRSE0007002, ep.113]

Findings – Deaths

1.18 Table 1.4 displays deaths recorded in HIV antibody positive individuals for those with exposure given as 'haemophilia' up to 2000 (UKHSA). Also shown are deaths of HIV antibody positive people with bleeding disorders from any cause up to 2020, and from HIV-related causes (UKHCDO).[27] Deaths recorded as 'HIV/AIDS' or 'HIV Lymphoma' are considered as HIV-related.

Year	UKHSA deaths from any cause for HIV infected 'haemophilia'	UKHCDO deaths from any cause for HIV infected PwBD	UKHCDO deaths from HIV-related cause for HIV infected PwBD	UKHCDO Proportion of deaths that were HIV-related	
1980 – 1984	12	14	4	29%	(8% – 58%)
1985 – 1989	186	203	143	70%	(64% – 77%)
1990 – 1994	339	408	309	76%	(71% – 80%)
1995 – 1999	166	213	150	70%	(64% – 76%)
2000 – 2004	54	72	19	26%	(17% – 38%)
2005 – 2009	26	43	8	19%	(8% – 33%)
2010 – 2014	23	35	4	11%	(3% – 27%)
2015 – 2019	12	24	2	8%	(1% – 27%)
2020 – 2024	2	4	0		
Unknown		1	0		
Total	**820**	**1,017**	**639**	**63%**	(60% – 66%)

Table 1.4 Deaths in HIV infected people with bleeding disorders, from any cause and from HIV-related causes (Sources: UKHSA and UKHCDO).[28]

1.19 The UKHCDO data record that 76% of those HIV infected have died (1,017/1,338). As can be seen, the majority (63%, 638/1,017) of these deaths had an underlying cause linked to HIV. Therefore, overall 639/1,338, or 48%, had died from HIV-related causes. Deaths from HIV were greatly reduced after the introduction of more effective treatments in 1995.

1.20 **Limitations:**

- The cause of death is taken from the International Classification of Diseases (ICD) ICD-10 code of the underlying cause registered on the death certificate. It is likely that HIV was implicated in other deaths, but not entered as the underlying cause. In particular, it is likely that, particularly at early stages, stigma may have led to HIV not being mentioned on death certificates.

[27] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" [WITN3826016, epp.54-56]. NHD & UKHCDO spreadsheets, Pivot Table 12.3.1, Mortality trends in PwBD over time [WITN3826027] and 13.6.1, Simplified underlying causes of death in PwBD, Stratified by exposure [WITN3826028]

[28] UKHSA, 'Number of new HIV diagnoses to 2000' [PHEN0002472]; NHD & UKHCDO, Pivot Tables 12.3.1, Mortality trends in PwBD over time [WITN3826027] and NHD & UKHCDO, Pivot Table 13.6.1, Simplified underlying causes of death in PwBD, Stratified by exposure [WITN3826028]

Source – UKHSA

1.21 The UKHSA findings[29] are summarised in Table 1.5. A total of 1,484 individuals are reported as being infected through 'blood products', of whom only 56% have their country of infection recorded.

	'Haemophilia'	'Other blood products'	'Blood products (undetermined)'	Total
Acquired in UK	459	79	102	640
Acquired outside the UK	19	137	38	194
Country of infection not reported	583	25	42	650
(as % of total)	(55%)	(10%)	(23%)	(44%)
Total	**1,061**	**241**	**182**	**1,484**

Table 1.5 New HIV diagnoses in the UK up to 2000 through exposure to infected blood products. HIV diagnosis using the UKHSA 2020 archive, with exposure category based on 2005 archive.

1.22 Of those people with assigned exposure routes, the proportion that are people with haemophilia steadily declined over time. If we allocate each year's 'undetermined' total by this proportion, then we would expect another ~124 cases, giving 1,061 + 124 = 1,185. Table 1.5 also reports that at least 19 of these were acquired abroad and so we might estimate, from this UKHSA source, around 1,185 – 19 = 1,166 HIV infections in people with bleeding disorders were acquired in the UK.

1.23 As an extreme case, assuming all 182 listed as 'undetermined' are people with haemophilia gives 1,061 + 182 = 1,243, a total which matches that of the Macfarlane Trust and has been quoted by a number of sources.[30] However, this appears to be a coincidence, as the UKHSA data included those infected abroad.

1.24 **Limitations:**

- Patients' exposure routes are essentially self-reported.[31]
- It is possible that a proportion of the 241 'other blood products' may refer to people with bleeding disorders who do not have haemophilia, for example patients with von Willebrand disease, and therefore that the 'haemophilia' category is an undercount of people with bleeding disorders who are HIV antibody positive.
- A small number of people with bleeding disorders may have been infected with HIV through other routes.

1.25 Since the successful claimants to the Macfarlane Trust presumably constitute a lower bound on the true number of UK-acquired infections, this suggests that the UKHSA registry is a less reliable source.

[29] UKHSA, 'Number of new HIV diagnoses to 2000' [PHEN0002472]
[30] For example, the 'Tainted Blood' website, accessed on 9 August 2022 [RLIT0001684]. Available online: https://www.taintedblood.info/
[31] Email from the UK Health Security Agency to the Infected Blood Inquiry, dated 5 August 2022 [PHEN0002471]

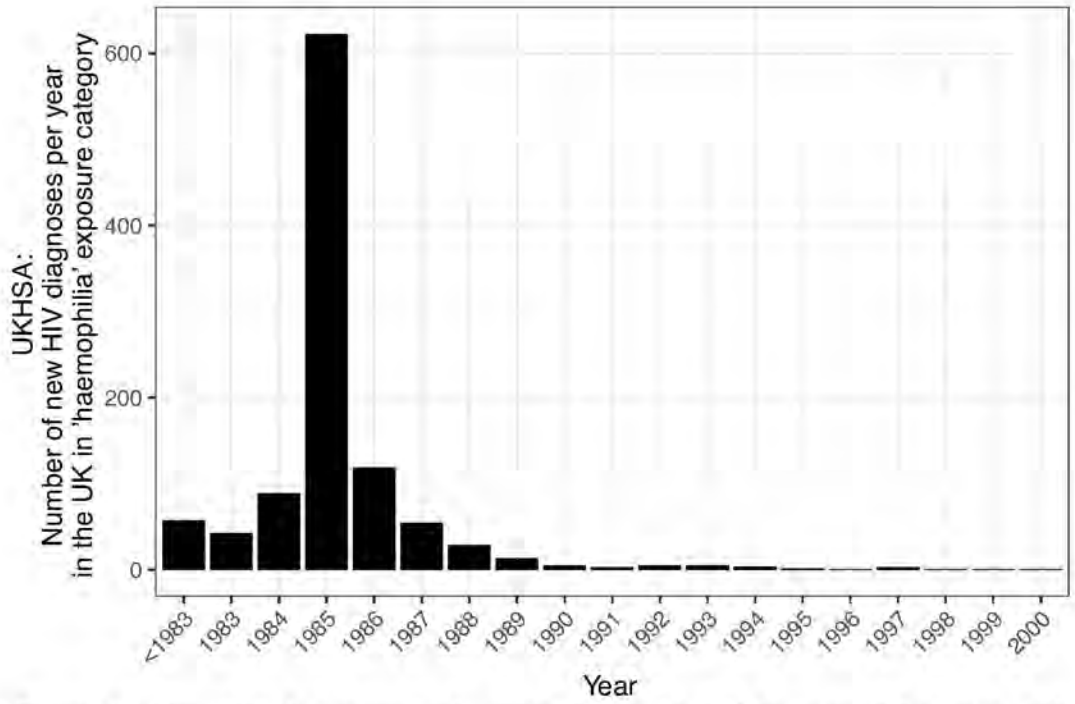

Figure 1.2 New HIV diagnoses in 'haemophilia' in the UK by year of first recorded positive test (source UKHSA).[32] *Note that the recorded year of diagnosis does not necessarily represent the year of infection due to delays in diagnosis, missing positive tests, and, for those from abroad, confirmatory HIV diagnosis in the UK.*

1.26 Figure 1.2 shows the year of first HIV antibody positive test for those classified as 'haemophilia' in the UKHSA database - more detail is provided in Appendix Table 1.2. The diagnoses recorded by UKHCDO tend to be slightly earlier than those registered with the PHLS and now held by UKHSA, due – we assume – to retrospective testing of stored blood samples in order to establish patients' earliest HIV antibody positive date.

1.27 The UKHSA data include the deaths of 25,999 people with HIV diagnoses recorded before 2000, a recorded mortality rate of 56% up to the end of 2020 (25,999/46,030). Table 1.6 shows the outcomes corresponding to the individuals in Table 1.5 who are reported as having been infected through exposure to blood products.

[32] UKHSA, 'Number of new HIV diagnoses to 2000' [PHEN0002472]

	'Haemophilia'	'Other blood products'	'Blood products (undetermined)'	Total
Acquired in UK	357	67	65	489
Acquired outside the UK	9	70	53	132
Country of infection not reported (as % of total)	454 (55%)	11 (7%)	25 (17%)	490 (44%)
Total deaths: (as % of diagnoses) (95% confidence interval)	820 77% (75% – 80%)	148 61% (55% – 68%)	143 79% (72% – 85%)	1,111 75%

Table 1.6 Deaths recorded up to the end of 2020 of those infected with HIV before 2000 through exposure to infected blood products: reported also as percentage of the corresponding total of diagnoses in Table 1.5, and so represents the mortality rate. (Source UKHSA)[33]

1.28 Up to 2020, the overall mortality in the UKHSA database of HIV antibody positive 'haemophilia' cases was 820/1,061, or 77%, while the UKHCDO data recorded a similar proportion: 1,017/1,338, or 76%. The fact that the mortality rate in those with 'undetermined' exposure is close to that of 'haemophilia' adds weight to the assumption that the majority of these are in fact people with bleeding disorders.

1.29 **Limitations:**

- As for UKHCDO, the cause of death is taken from ICD-10 code on death certificate, and may be an undercount for the reasons given previously.
- As noted above, the category 'haemophilia' may miss relevant cases that have been either classified as 'other blood products' or 'undetermined'.

[33] 'Number of new HIV diagnoses to 2000' [PHEN0002472]

Chapter 2 HCV infections in people with bleeding disorders

How many people with bleeding disorders were infected with HCV through blood products in the UK between 1970 and 1991?

How many have subsequently died; and of these deaths, how many were HCV-related?

Summary findings

- In spite of the efforts made by the UKHCDO, it is challenging to establish the number of HCV infections in people with bleeding disorders, due to the limited data on exposure and HCV status.

Source	HCV infections (without HIV)	Deaths
UKHCDO report	Confirmed ~ 2,400 Additional 'possible' at least 2,400	~700 [39% from HCV-related causes] ~1,400
NHD	Well documented (i.e. both born & NHD-registered before 1992 & with record-linkage follow-up): 2,055	Before 2020: 536
Skipton Fund	~ 2,760	~ 900

Table S2 Number of HCV infections and deaths in people with bleeding disorders in the UK between 1970 and 1991: 'possible' infections include those known to have been exposed to at-risk blood products but with unknown HCV status. Additional infections will have occurred in those whose exposure history was unknown and who have not been tested for HCV.

- This table does not include those infected with HIV, who are covered in Chapter 1, though the Skipton Fund number will include some such persons. UKHCDO say it is reasonable to assume that all those infected with HIV will also have been co-infected with HCV.[34]
- We judge that between 2,400 - 5,000 people with bleeding disorders were infected with HCV, excluding those infected with HIV.

Confidence that available evidence can answer the questions? Low/Moderate.

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[34] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" August 2022 [WITN3826016, ep.44]

Background

2.1 The Archer Inquiry[35] clearly summarises the risks facing people with bleeding disorders in the 1970s and 1980s: *"The danger of infection from blood products was directly related to the size of the donor pool from which the blood or plasma was collected and to the lifestyles of the communities from which donors were drawn [...] By the end of 1991, therefore, blood products manufactured in the UK were as safe from infection with Hepatitis C as current technology could make them, although this was not necessarily true of all imports."*

Sources of Evidence

2.2 Our primary source for data on HCV infections in people with bleeding disorders (PwBD) is the UKHCDO (2022) report *"Bleeding Disorders Statistics for the Infected Blood Inquiry 2020,"*[36] Chapter 9: *"The number of people with bleeding disorders at each Haemophilia Centre in the UK showing positive and negative HCV antibody and PCR test result"*.

2.3 Following the UKHCDO review and record-linkage follow-up described below, we had access to preliminary analyses, carried out at our request by a Manchester statistical team working in collaboration with UKHCDO, for well-documented patients, namely: those who were both born and registered with the National Haemophilia Database (NHD) before 1992 and had been followed-up for mortality via record-linkage to 31 December 2019.

2.4 A look-back exercise in 2010 identified over 29,000 people with bleeding disorders registered before universal HCV testing of blood donations was introduced in September 1991, for whom data were requested from the centres.[37] This proved challenging. In 2018, a further look-back exercise tried to identify any people with bleeding disorders who might have missed screening for HCV infection despite exposure to products associated with HCV transmission.[38]

2.5 The UKHCDO report considers a patient potentially 'at-risk of HCV infection' if there was documentation in the NHD of exposure to a pooled plasma-derived concentrate manufactured before 1988 or a blood component before 1992 – those with no record of exposure on the NHD would tend to have milder disorders. UKHCDO describe the coverage as follows: *"All people with bleeding disorders considered at-risk of HCV infection or known to have HCV infection were identified from NHD and allocated to the six groups described (see below). All data from the 2018 look-back exercise and the 2020 update are included in this analysis. Additional at-risk patients were identified when the archived paper records were transcribed into NHD for this analysis and during the review of deceased patients and the causes of death. All at-risk and potentially at-risk patients have been included."*[39] The available data therefore come from a variety of efforts to determine the HCV status of those at risk, including those who had died from causes related to HCV.

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[35] The Archer Inquiry, Inquiry Report, by the Rt. Hon. Lord Archer of Sandwell QC, Chapter 6 [ARCH0000001, epp.55-59]

[36] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" [WITN3826016, epp.42-50]

[37] 'Hepatitis C Lookback Report up to 31/03/2014', provided to the Infected Blood Inquiry by Professor Charles Hay [WITN3289162, ep.2]

[38] Written Statement of Professor Charles Richard Morris Hay, Hepatitis C Look-back Report, 2018-20 [WITN3289039, epp.194-204]

[39] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" August 2022 [WITN3826016, ep.44]

2.6 A discussion with representatives of UKHCDO revealed a belief that the majority of patients with positive HCV test results (at least 95%) would have been reported to the NHD.

2.7 **Analysis and conclusions:** UKHCDO identified 8,752 patients initially considered at-risk of HCV infection, both those who are alive and those known to have died by December 2020. They report six mutually exclusive at-risk HCV categories of people with bleeding disorders based on documentation of infection with HIV and HCV and records of exposure to at-risk products on the NHD. People with bleeding disorders are allocated to each group sequentially, so that, for example, someone who is known to be HIV antibody positive is allocated to the first category regardless of any information about HCV status.

1 **HIV antibody positive:** The analysis assumed that this group was inevitably co-infected with HCV as many people with bleeding disorders who were HIV infected died before HCV antibody testing was available. This group includes people with bleeding disorders with HIV antibody positive results reported to the NHD or had HIV/AIDS or HIV lymphoma documented as their underlying cause of death on their death certificate.

2 **Tested HCV antibody positive:** This group includes people with bleeding disorders with a HCV antibody positive test result reported to the NHD or HCV documented on the death certificate. This group includes a small number of people with bleeding disorders who might have acquired the infection abroad.

3 **HCV presumed positive:** This group includes people with bleeding disorders born before 1992 with HCV-related liver disease or hepatocellular carcinoma (HCC) reported as the underlying cause of death or documented as significant co-morbidity in the absence of any HCV positive antibody result.

4 **Tested HCV antibody negative:** People with bleeding disorders with an HCV antibody negative test result on the NHD.

5 **HCV status unknown, exposed to an at-risk pooled plasma product:** This group includes people with bleeding disorders with a record of exposure to at-risk pooled plasma concentrate including exposure to at-risk blood components in the NHD but without HCV antibody test results reported to the NHD. On a precautionary basis, UKHCDO considered this group as at a high risk of HCV-infection (i.e. if indeed patients had not been HCV-tested locally).

6 **HCV status unknown, exposed at-risk to blood component:** This group includes people with bleeding disorders without HCV antibody test results reported to the NHD and with evidence of exposure to at-risk blood components only.

The remainder were classified as **Not known to be at-risk**. This group includes people with bleeding disorders with no records of exposure to at-risk pooled concentrates or blood components on the NHD. Some of these people may have been exposed to an at-risk blood product without the NHD being aware.

Nation	HIV antibody positive and also HCV-infected	Tested HCV antibody positive	Presumed HCV-infected	HCV status unknown, exposed to an at-risk pooled plasma product	HCV status unknown, exposed to an at-risk blood component	Tested HCV antibody negative	Total
England	1,193	1,754	91	1,291	817	2,106	7,252
Scotland	74	244	16	110	36	406	886
Wales	55	104	4	43	41	172	419
Northern Ireland	16	76	6	23	14	57	192
Missing	0	0	0	2	1	0	3
Total	**1,338**	**2,178**	**117**	**1,469**	**909**	**2,741**	**8,752**
Alive	321	1,661	0	541	452	2,471	
Deceased	1,017	517	117	928	457	270	
Deceased as % of Total	**76%**	**28% of 2,295**		**63%**	**50%**	**10%**	

Table 2.1 HCV status according to UKHCDO in at-risk people with bleeding disorders in the UK (and by nation); and death-rates according to HCV status. UKHDCO have records of 3 persons for whom nation is not recorded.[40]

2.8 The first three columns can be taken as confirmed HCV positive, since 1,338 people with bleeding disorders who were HIV-infected are assumed to be co-infected with HCV. The UKHCDO reports 2,178 + 117 = 2,295 confirmed HCV (mono) infections, plus a further 1,469 + 909 = 2,378 people exposed to at-risk products but with unknown HCV status – but who could be considered 'possible' HCV infections.

2.9 The total of 2,178 people with bleeding disorders in Table 2.1 who were confirmed to be HCV-infected but not HIV-infected is inevitably an underestimate. If 95% coverage is assumed, as discussed above, then we would conclude a minimum of around 2,400 confirmed cases (including the 117 presumed HCV-infected).

2.10 The 1,017 deaths in HIV-positive patients matches the data discussed in Chapter 1. In addition, 517 + 117 = 634 confirmed HCV-infected patients have died: the mortality rate in 'HCV presumed positive' is 100%, reflecting that these cases have been largely identified through death registrations. In addition, 1,385 (928 + 457) exposed patients have died: a rather higher rate than for those confirmed HCV antibody positive.

2.11 UKHCDO report that, of those 634 confirmed and presumed HCV-infected patients (without HIV) who have died, 105 have died from *'liver failure – HCV'*, and 143 have died from HCC.[41] This comprises 248/634 = 39% of all deaths.

[40] NHD & UKHCDO, Pivot Table 9.2.5.1, HCV status of PwBD at-risk of HCV infection [WITN3826021]
[41] UKHCDO spreadsheet, "Simplified underlying cause of death in PwBD stratified by exposure" [WITN3826028]

2.12 **Limitations:**

- The patients featured in Table 2.1 will not include everyone who was exposed to infected blood products, despite the efforts made to determine their status. Some will have died before 1992 (as Table 2.2 demonstrates), let alone before the 2010 look-back, from causes not related to HCV. Others will have not been followed-up by centres.
- In his Statement to the Inquiry, Professor Hay[42] stated that, in the 2010 look-back exercise, of 1,523 patients whose treatment history was reported as 'unknown', but who had been HCV tested, 419 (28%) were HCV antibody positive. This will not be a representative sample, as there will have been a reason for selection for HCV testing, but suggests an additional potential source of undercount.

Analysis of well-documented subset of the NHD

2.13 The death-rates in Table 2.1 differ not only on account of HIV/HCV co-infection but also because the composition of the groups differ including in terms of sex, bleeding disorder and severity.

2.14 The next three tables bring to the fore this additional complexity for the well-documented subset of NHD patients born and NHD-registered before 1992 and for whom record-linkage was successfully achieved so that their survival-status at 31 December 2019 has been ascertained.

2.15 Table 2.2 documents the subset's composition by sex and HCV status (note HCV status is vertical rather than horizontal as in Table 2.1). Males predominate: notably among those who were HIV/HCV co-infected; those who tested HCV antibody positive or were presumed HCV-infected; and those exposed to pooled plasma but whose HCV status is not known to the NHD. By contrast, the male predominance is reduced amongst those who tested HCV antibody negative. A particularly high death-rate, over 90% prior to 2020, is evident for persons classified as Not known to be at-risk.

[42] Written Statement of Professor Charles Richard Morris Hay, dated 7 October 2020 [WITN3289039, ep.197]

HCV status	All eligible	Males			Females		
		Eligible	Deceased by 31/12/1991	Deceased by 31/12/2019 (% mortality)	Eligible	Deceased by 31/12/1991	Deceased by 31/12/2019 (% mortality)
HIV antibody positive	1,326	1,314	358	1,002 (76%)	12	2	6 (50%)
Tested HCV antibody positive	1,973	1,790	16	425 (24%)	183	0	30 (17%)
Presumed HCV positive	82	75	30	74	7	4	7
HCV status not known, exposed to pooled plasma	1,389	1,243	440	834 (67%)	146	31	80 (55%)
HCV status not known, exposed to components	844*	558	128	306 (55%)	285	38	140 (49%)
Tested HCV antibody negative	1,729*	1,231	0	98 (8%)	497	0	37 (7%)
Not known to be at-risk	688	480	193	464 (97%)	208	39	196 (93%)
Total	**8,031**	**6,691**	**1,165**	**3,203**	**1,338**	**114**	**496**

*Table 2.2 HCV status, separately for male and female patients, together with their survival status at 31 December 1991 and 31 December 2019 respectively. *Sex is missing for two patients.*

2.16 For males only, Table 2.3 documents the well-documented subset's composition by bleeding disorder and HCV status. The most common bleeding disorder is Haemophilia A (5 or fewer IU/dl) for men whose HCV status is in the first three rows of Table 2.3, namely: males who were HIV/HCV coinfected, males who tested HCV antibody positive or males who were presumed HCV-infected (generally on account of their cause of death). The fourth row, males whose HCV status is not known but who were exposed to pooled plasma products has a similar pattern in terms of the most common bleeding disorder. The remaining rows are different with *"Haemophilia A other"* as their most common diagnostic group but notice also von Willebrand disease. The corresponding table for females is in Appendix Table 2.1.

2.17 The highest death-rate in Table 2.3 is associated with acquired bleeding disorders.

HCV status	HaemA <= 5 IU/dl	HaemA other	HaemB <= 5 IU/dl	HaemB other	Von Wille-brand	Any Acquired	Other	Total
HIV antibody positive	1,174 (89%)	104 (8%)	28	1	7 (0.5%)	0	0	1,314
Tested HCV antibody positive	699 (39%)	573 (32%)	284	121	95 (5%)	0	18	1,790
Presumed HCV positive	37 (49%)	23 (31%)	9	2	3 (4%)	1	0	75
HCV status not known, exposed to pooled plasma	526 (42%)	347 (28%)	153	113	63 (5%)	26	15	1,243
HCV status not known, exposed to components	130 (23%)	211 (38%)	9	11	162 (29%)	8	27	558
Tested HCV antibody negative	322 (26%)	465 (38%)	76	73	237 (19%)	1	57	1,231
Not known to be at-risk	61 (13%)	202 (42%)	18	21	80 (17%)	38	60	480
Total	**2,949**	**1,925**	**577**	**342**	**647**	**74**	**177**	**6,691**
Deaths (all causes) by								
31 December 1991	675 (23%)	256 (13%)	70 (12%)	44 (13%)	61 (9.4%)	36 (49%)	23 (13%)	1,165 (17%)
31 December 1999	1,211 (41%)	437 (23%)	102 (18%)	73 (21%)	117 (18%)	63 (85%)	47 (27%)	2,050 (31%)
31 December 2009	1,424 (48%)	643 (33%)	161 (28%)	101 (30%)	190 (29%)	70 (95%)	67 (38%)	2,656 (40%)
31 December 2013	1,500 (51%)	728 (38%)	180 (31%)	115 (34%)	216 (33%)	72 (97%)	72 (41%)	2,883 (43%)
31 December 2019	1,606 (54%)	847 (44%)	214 (37%)	129 (38%)	253 (39%)	72 (97%)	82 (46%)	3,203 (48%)

Table 2.3 Bleeding disorder and its severity for males by HCV status, as described in Table 2.2, together with survivorship to the end of 1991, 1999, 2009, 2013 and 2019.

2.18 For males in Table 2.3 who were HIV/HCV co-infected; had tested HCV antibody positive or negative; or whose HCV status was not known but who were exposed to pooled plasma products, Table 2.4 documents how their death-rates, from all causes or from selected major causes of death, have evolved over four epochs of follow-up.

2.19 The four epochs of follow-up are:

(i) from 1 January 1992 to 31 December 1999 (8 years);

(ii) from 1 January 2000 to 31 December 2009 (10 years);

(iii) from 1 January 2010 to 31 December 2013 (4 years);

(iv) from 1 January 2014 to 31 December 2019 (6 years).

2.20 Table 2.4 shows all-cause and cause-specific death-rates per 1000 person-years (pys) of follow-up, each qualified by its 95% confidence interval (CI) which appears in brackets.

2.21 Table 2.4 shows that the all-cause death-rate for HIV-infected males reduced from 90 (82 to 98) per 1,000 pys of follow-up in epoch i through 23 (19 to 27) in epochs ii and iii to 13 (8 to 18) per 1,000 pys in epoch iv.

2.22 HIV/AIDS or HIV lymphoma accounted for 340/474 (72%) of all deaths which occurred in epoch i for HIV infected males, reducing to 30/144 (21%) in epochs ii and iii to 1/26 (4%) during epoch iv.

2.23 The second major cause of deaths in HIV-infected males, all assumed to be HCV-coinfected, was HCC and HCV liver failure which accounted for 70/474 deaths (15%) in epoch i; rose to 49/144 deaths (34%) in epoch ii and iii; but reduced to 2/26 (8%) in epoch iv.

2.24 The death-rate for HIV/HCV co-infected males from HCC and HCV liver failure was 13 (10 to 16) per 1,000 pys in epoch i; 8 (5.6 to 10) during epochs ii and iii; and reduced to 1 (0.1 to 3.7) per 1,000 pys in epoch iv.

2.25 Per epoch, death-rates from intracranial bleed were similar for those HIV-infected and for those whose HCV status was not reported but who had been exposed to pooled plasma products.

2.26 Finally, we comment on the HCC or HCV liver failure death-rates for those who were reported as having tested HCV antibody positive: the rate in epoch i was 2.7 (1.8 to 3.6) per 1,000 pys; rose to 3.9 (3.1 to 4.7) during epochs ii and iii; and to 4.1 (2.7 to 5.4) in epoch iv. The earlier pair of HCC or HCV liver failure death-rates is substantially lower than for males with bleeding disorders who were HIV/HCV co-infected.

2.27 We notice also that the epoch-specific death-rates from intracranial bleed were substantially lower for men whose HCV test result was recorded on the NHD than for those HIV/HCV co-infected or for males exposed to pooled plasma products without their HCV status having been registered on the NHD.

HCV status	Tested HIV positive		Tested HCV positive		Tested HCV negative		HCV status not known, exposed to pooled plasma	
	Epoch i: 1 January 1992 to 31 December 1999 (8 years)							
	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch
	956	5,262	1,774	13,935	1,231	9,826	803	5,801
Cause of death	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys
Deaths, all causes	**474**	**90.0**	**66**	**4.7**	**7**	**0.7**	**156**	**26.9**
Bleed: intracranial	30	5.7	7	0.5	0		33	5.7
Cancer: other	9	1.7	7	0.5	1	0.1	25	4.3
HIV/ AIDS, HIV lymphoma	340	64.4	0					
Heart disease	5	1.0	4	0.3	3	0.3	41	7.1
HCC or HCV liver failure	70	13.3	38	2.7	0		0	

HCV status	Tested HIV positive		Tested HCV positive		Tested HCV negative		HCV status not known, exposed to pooled plasma	
	Epoch ii: from 1 January 2000 to 31 December 2009 (10 years)							
	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch
	482	4,821	1,708	17,042	1,224	12,232	647	6,471
Cause of death	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys
Deaths, all causes	**112**	**23.2**	**110**	**6.5**	**16**	**1.3**	**168**	**26.0**
Bleed: intracranial	15	3.1	10	0.6	3	0.2	34	5.3
Cancer: other	8	1.7	8	0.5	3	0.2	28	4.3
HIV/ AIDS, HIV lymphoma	26	5.4	0					
Heart disease	3	0.6	7	0.4	2	0.2	30	4.6
HCC or HCV liver failure	41	8.5	60	3.5	0		0	

HCV status	Tested HIV positive		Tested HCV positive		Tested HCV negative		HCV status not known, exposed to pooled plasma	
	Epoch iii: from 1 January 2010 to 31 December 2013 (4 years)							
	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch
	370	1,410	1,598	6,200	1,208	4,794	479	1,849
Cause of death	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys
Deaths, all causes	**32**	**22.7**	**89**	**14.4**	**24**	**5.0**	**28**	**15.1**
Bleed: intracranial	7	5.0	7	1.1	2	0.4	2	1.1
Cancer: other	6	4.3	15	2.4	11	2.3	3	1.6
HIV/ AIDS, HIV lymphoma	4	2.8	0					
Heart disease	4	2.8	9	1.5	3	0.6	9	4.9
HCC or HCV liver failure	8	5.7	30	4.8	0		0	

HCV status	Tested HIV positive		Tested HCV positive		Tested HCV negative		HCV status not known, exposed to pooled plasma	
	Epoch iv: from 1 January 2014 to 31 December 2019 (6 years)							
	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch	Alive as epoch starts	Person-years in epoch
	338	1,950	1,509	8,615	1,184	6,973	451	2,536
Cause of death	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys	Number of deaths	Death-rate per 1000 pys
Deaths, all causes	**26**	**13.3**	**144**	**16.7**	**51**	**7.3**	**42**	**16.6**
Bleed: intracranial	2	1.0	18	2.1	1	0.1	3	1.2
Cancer: other	3	1.5	36	4.2	16	2.3	10	3.9
HIV/ AIDS, HIV lymphoma	1	0.5	0					
Heart disease	4	2.1	15	1.7	5	0.7	6	2.4
HCC or HCV liver failure	2	1.0	35	4.1	0		0	

Table 2.4 All-cause death-rates and cause-specific mortality during four epochs of follow-up from 1 January 1992 for males in the well-documented subset according to HCV status. The death-rate in an epoch is calculated as the number of deaths that occur during the epoch divided by the person-years of follow-up contributed by persons alive at the start of the epoch. Person-years are the duration of the epoch for persons who survive through to the start of the next epoch. Person-years contributed by those who die during the epoch are counted up to the date of death.

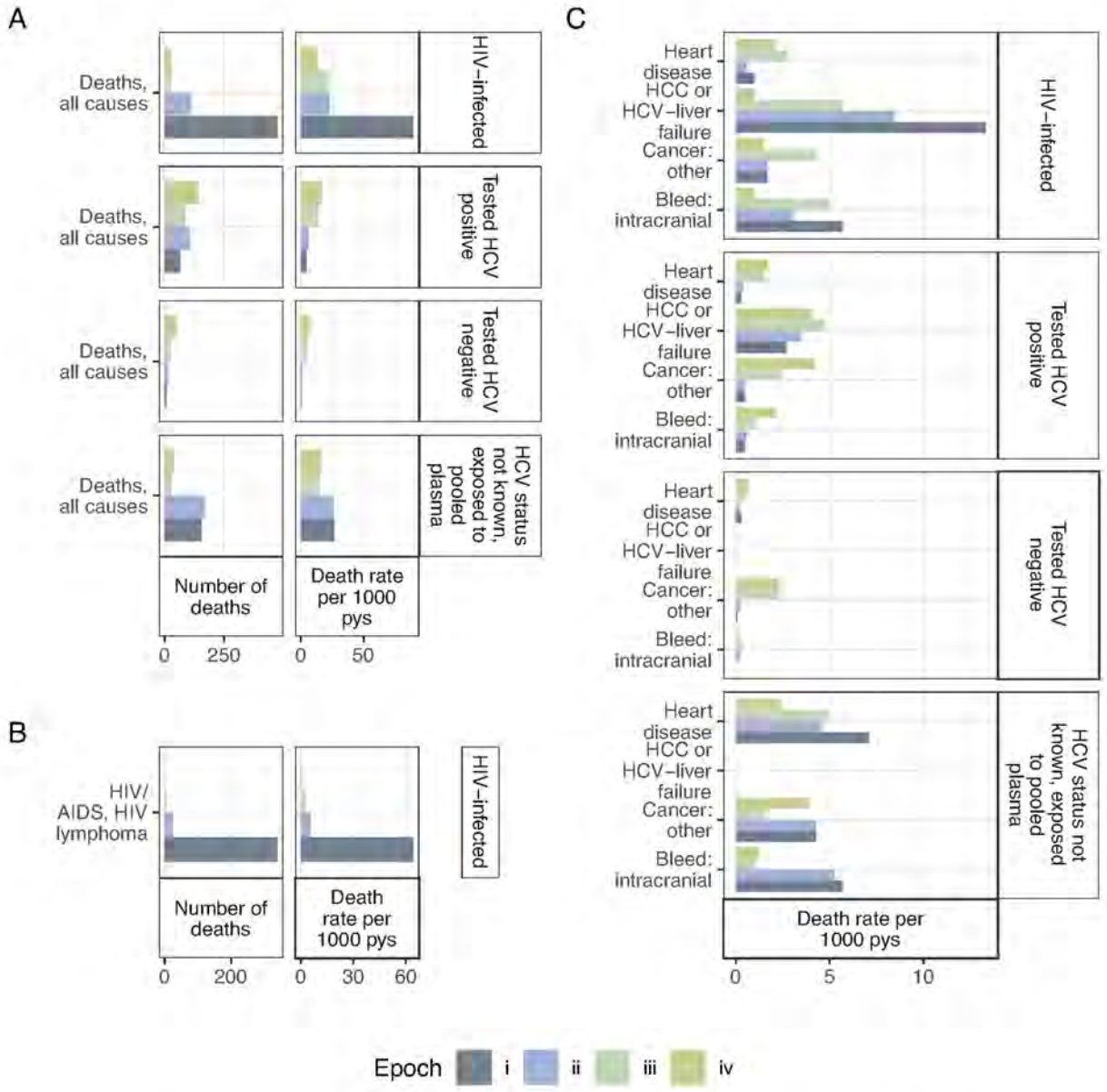

Figure 2.1 Death-rates and cause-specific mortality during four epochs of follow-up from 1 January 1992 for males in the well-documented subset according to HCV status. (A) All-cause mortality. (B) HIV/AIDS, HIV lymphoma related mortality for HIV-infected individuals. (C) Cause-specific mortality.

2.28 We note that, of 409 deaths of those testing HCV positive, 163 (40%) were from HCC or HCV liver failure. This matches the proportion calculated earlier on the dataset provided in the UKHCDO report.[43]

2.29 **Limitations:**

- All people with bleeding disorders who were treated before 1992 should have been counselled about their assessed HCV-risk and offered HCV-testing. However, the information notified to the NHD about patients' HCV test-history is incomplete – even if HCV-status is unknown to the NHD, the patient may be aware about his or her HCV-status.
- Within the well-documented subgroup of people with bleeding disorders born and NHD-registered before 1992, neither HCC nor HCV liver failure featured as an underlying cause of death for any of 803 males with bleeding disorders, alive at the start of 1992, whose HCV status was unknown to the NHD but who had been exposed to pooled plasma concentrate. The explanation is that UKHCDO re-classifies such patients as "Presumed HCV positive" on account of their cause of death.
- Completeness of information on deaths depends upon whether a register relies upon information on deaths being reported by centres or whether, for better assurance, patients' survival status has been checked against mortality records. The success of checking against the UK's death records depends on the quality of information about the patient (such as sex, date of birth, NHS number, first part of postcode of residence) that can be provided to enable the patient to be correctly "matched".
- Over the period from 1970 to the present day, the ICD has been updated more than once (ICD-10 from 2000 with minor updates since), so that clinicians' review of death certificates and case-notes to label cause of death has additional merit – provided that consistency can be maintained.

2.30 For the Penrose report,[44] UKHCDO extracted data from the NHD which indicated that 296 living patients and 216 deceased patients treated at Scottish centres had been exposed to HCV, giving a total of 512. After removing duplicates, these counts were revised down to 254 living and 193 deceased patients (total = 447) treated at Scottish centres – these exclude those known to be infected with HIV. Table 2.1 indicates 260 (244 + 16) confirmed HCV antibody positive patients in Scotland, plus a further 146 (36 + 110) exposed to an at-risk product, although with unknown HCV status. This adds to 406 patients (260 + 146), somewhat fewer than the 447 in the Penrose report.

2.31 **Fund data:** In Chapter 5 we report that by 2017 the Skipton Fund had approved 5,529 applications for support for those infected with HCV from blood and blood products, about half of whom (~2,760) would have been for people with bleeding disorders. Around 33% of these claimants (~900) had died.

[43] NHD & UKHCDO, Pivot 13.6.1, Simplified underlying causes of death in PwBD, Stratified by exposure [WITN3826028]
[44] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.44 and 3.46, March 2015 [PRSE0007002, ep.48]

Chapter 3 HIV infections in transfusion recipients

How many people were infected with HIV through blood transfusions in the UK between 1970 and 1991,

How many have subsequently died; and of these deaths, how many were due to HIV/AIDS?

Summary findings

- At least 79, and possibly up to ~100, people were infected with HIV through blood transfusions in the UK between 1970 and 1991. Around 85% have subsequently died, but we do not know the causes of death. This is based on a data set provided by the UK Health Security Agency (UKHSA).

Confidence that available evidence can answer the questions? Moderate.

****

Background

3.1 Concern about the possibility of HIV-infection through blood transfusions grew in the early 1980s and led to guidance for higher-risk groups to avoid donating blood. Table 3.1 summarises some of the key changes. It is notable that deferral of donations from people who have received blood was not introduced until later.

Date of advice leaflet for blood donors	Groups advised not to donate blood
September 1983, UK[45]	"Drug addicts, male and female, using injections" "Sexual contacts of people suffering from AIDS"
Mid-1984, Scotland[46]	"Present or past abusers of intravenous drugs" "Sexual partners, male or female, of any of the above people"
January 1985[47]	Language changes to "must not give blood" "practising homosexuals or bisexual men" "Drug abusers, both men and women, who inject drugs" "Sexual contacts of people in these groups" Also mentions: "AIDS has also occurred in a small number of haemophiliac patients who are treated with blood products"
September 1985[48]	People with haemophilia now explicitly included, and "practising" reference removed. "Drug abusers, both men and women, who inject drugs" "If you are a haemophiliac who has been treated with blood products" "If you are a sexual contact of any of these people" "Sexual contacts of people in these groups"
July 1987[49]	"Men who have had sex with another man at any time since 1977" "Men and women who have injected themselves with drugs at any time since 1977" "Men and women who have had sex with anyone in these groups" "Sexual partners of haemophiliacs" "Men and women who are prostitutes"

Table 3.1 Changing advice to potential blood donors during the 1980s.

3.2 **Sources of evidence:** As we saw in Chapter 1, the HIV database (now held by UKHSA) collected information on 'exposure' route, and 'blood/tissue transfer' was included as a category, but this category ceased in 2005. We have been provided with UKHSA data up to 2000 in which exposure to blood products has been re-assigned,

[45] Leaflet, 'AIDS and how it concerns blood donors' by the National Blood Transfusion Service, September 1983 [BPLL0007247, ep.2]
[46] Leaflet, 'Important Message to Blood Donors' by the Scottish National Blood Transfusion Service, mid-1984 [PRSE0000286, ep.2]
[47] Leaflet, 'AIDS, Important new advice for blood donors' by the National Blood Transfusion Service, January 1985 [NHBT0096480_022, ep.4]
[48] Leaflet, 'AIDS: Important information for blood donors' by the National Blood Transfusion Service, September 1985 [CBLA0002255, epp.1-2]
[49] Leaflet, 'AIDS: Think before you give blood' by the National Blood Transfusion Service, July 1987 [NHBT0007310, ep.2]

according to the 2005 archive[50], into 'Haemophilia', 'Other blood products', and 'Blood product (undetermined)'. 'Other blood products' primarily comprise infection through transfusion, although a few tissue transplants will also be included.[51]

3.3 **Analysis and conclusions:** As shown in Table 3.2, there were 241 people with HIV diagnoses up to 2000 who were labelled as having been exposed to 'other blood products', of whom 148 were recorded as dying before 2020. Of the 79 people confirmed as HIV-infected through 'other blood products' in the UK up to December 2000, 67 had died up to December 2020 (85%).

HIV infected: where?	Diagnoses up to December 2000	Deaths recorded up to December 2020
Acquired in UK	79	67 (85%)
Acquired outside the UK	137	70 (51%)
Country of infection not reported	25	11 (44%)
Total	241	148 (61%)

Table 3.2 Diagnoses of those infected with HIV before the end of 2000 through exposure to 'other blood products', and subsequent deaths recorded up to the end of 2020 together with the percentage who died. (Source UKHSA).[52]

3.4 However, it is important to note that, of the 241 confirmed HIV infections via 'other blood products', the majority (137, 57%) were acquired abroad. Figure 3.1 shows that the year of diagnosis depends strongly on whether the HIV infection was acquired in the UK or abroad – those infected in the UK declined rapidly after 1986, while those infected abroad increased steadily from that period. Judging by their mortality rate (44%), it seems possible that the great majority of those with 'country of infection not reported' were in fact infected abroad, since the mortality rate for people whose infection was acquired in the UK is so much higher (85%).

[50] UKHSA, 'Number of new HIV diagnoses to 2000' [PHEN0002472]
[51] Email from the UK Health Security Agency to the Infected Blood Inquiry [PHEN0002471, ep.1]
[52] UKHSA, 'Number of new HIV diagnoses to 2000' [PHEN0002472]

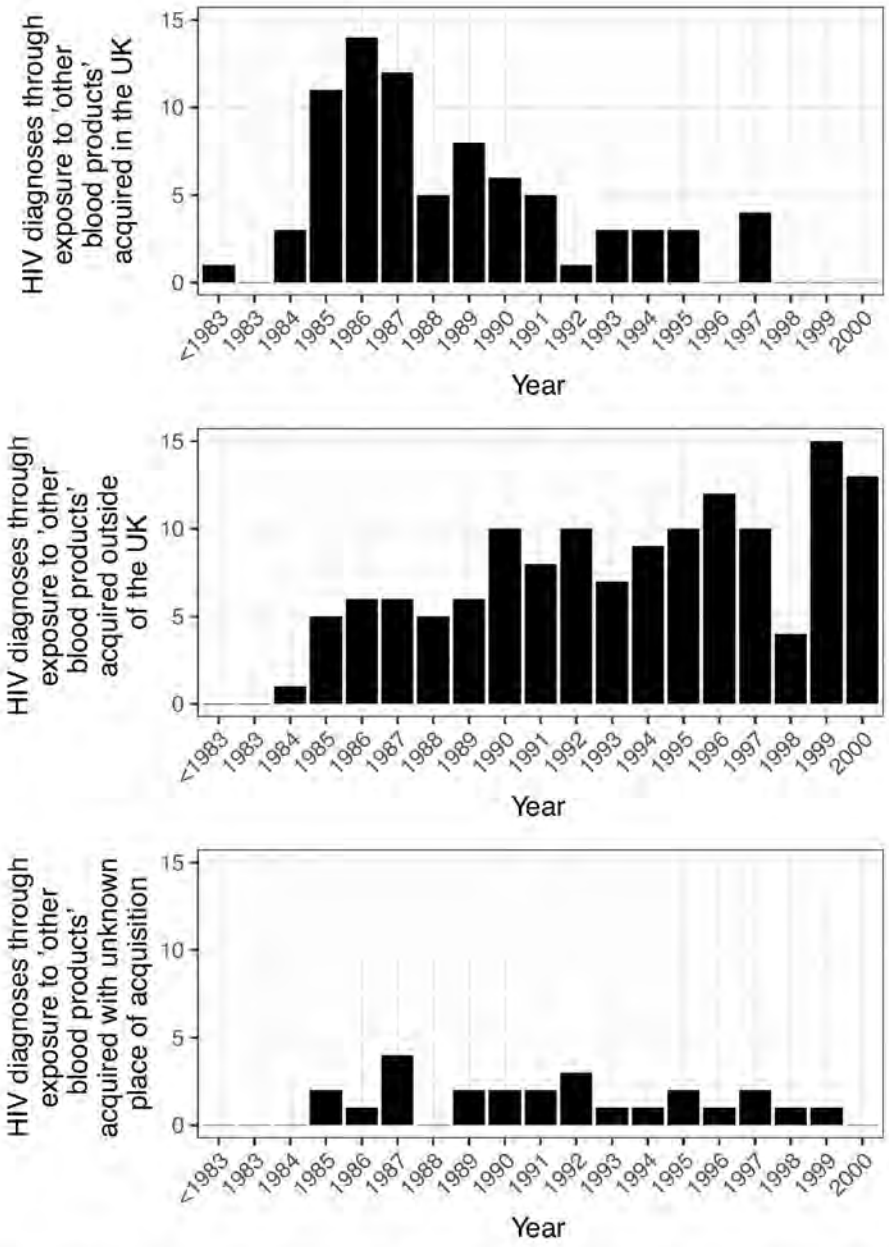

Figure 3.1 Recorded year of HIV diagnosis of those exposed through 'Other blood products', showing difference according to place of acquisition. Note that the recorded year of diagnosis does not necessarily represent the year of infection due to delays in diagnosis, missing positive tests, and, for those from abroad, confirmatory HIV diagnosis in the UK.

3.5 However, as shown in Table 1.5, the UKHSA data record 182 people who were infected with 'blood products (undetermined)'. In 1.22 we suggested around 124 (68%) of these may have been persons with 'haemophilia', suggesting around 182 - 124 = 58 could have been additional 'other blood products', an extra 24% (58/241) to add to Table 3.2. This would add a further 24% x 79 = 19 people who acquired their HIV infection via transfusion in the UK, making a total of perhaps 98 people infected with HIV from transfusion in the UK before the mid-1980s, of whom around 83 (85%) had subsequently died.

3.6 **Scotland:** The Penrose Inquiry reported[53] at least 18 HIV infections from blood transfusions in Scotland, based on data from the Scottish National Blood Transfusion Service (SNBTS) and Health Protection Scotland (HPS), of whom up to 15 had *"died from AIDS"*. In comparison with our estimates for England, this is somewhat higher than we would expect from simple considerations of population, indicating a higher HIV risk by transfusion in Scotland.

3.7 **Information from funds.** The Eileen Trust was responsible for supporting people infected with HIV who were without a bleeding disorder, although responsibility has now passed to funds for individual nations. Table 5.1 in Chapter 5 shows 74 cases of HIV after transfusion in the UK reported prior to the Eileen Trust, plus 17 cases where country of transfusion was unknown.

[53] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.322-3.339 [PRSE0007002, epp.117-121]. See also 'Table 3.21: Estimated numbers of NHS patients infected and outcomes' at 3.341 [ibid. ep.123]

Chapter 4 HCV in transfusion recipients

How many people were infected with HCV through blood transfusions in the UK between 1970 and 1991?

How many were chronically HCV-infected, and subsequently died; and, of these deaths, how many were due to their chronic HCV infection?

Summary findings

- Our analysis is based on a complex statistical model of the stages from HCV-infectious donors, becoming chronically HCV-infected following transfusion, and then survival until the end of 2019, taking into account the increased risk associated with chronic HCV infection. Our primary model was constructed for England, and then adapted for Scotland, Wales and Northern Ireland.
- Numerous sources of evidence have been used in constructing this model, but the many assumptions and inevitable limitations in the data mean that there is considerable uncertainty around our numerical conclusions. We provide central estimates and 95% uncertainty intervals for the results from our 'baseline scenario'. It is important to note that the most likely value is near the central estimate, and that it is very unlikely that the true value is as high as the upper end of the interval, or as low as the lower end.
- Our summary estimates for the UK from our baseline scenarios are:

Quantity of Interest	Estimate	95% uncertainty interval
Number of people infected with HCV through blood transfusion between 1970 and 1991	26,800	21,300 to 38,800
Number chronically infected (were they to survive 6 months post-transfusion)	22,000	17,300 to 31,900
Number chronically infected who survived to 10 years after transfusion	8,120	6,330 to 11,900
Number chronically infected, and survived to end of 2019 (assuming extra HCV risk)	2,700	2,050 to 3,910
Number chronically infected, and died by end of 2019	19,300	15,100 to 28,200
Number of deaths by end of 2019 related to HCV infection	1,820	650 to 3,320

Table S4 Estimates and 95% uncertainty intervals of the main quantities of interest from the statistical model of HCV transmission from transfusions. Estimates are for the whole of the UK. Females accounted for 64% (95% uncertainty interval: 58% to 69%) of the people chronically infected with HCV by transfusion who survived to the end of 2019.

- Extensive sensitivity analyses identified that assumptions about the effect of both HIV antibody screening and changing guidance for potential blood donors were an important factor: assuming a more limited effect would reduce our estimates by around a quarter. There is essentially no direct evidence regarding this effect, and so we are reliant on expert judgements.
- Our estimates for the number of infections are reasonably similar to previous estimates based on look-back exercises.

Confidence that available evidence can answer the questions? Moderate.

****

4.1 **Terminology:** *HCV infection.*[54] The term 'HCV infection' here is used to denote a state in which viral replication is taking place in a patient. All recipients of HCV-contaminated units are assumed to develop HCV infection – see Assumption (a) (paragraph 4.8). A proportion of patients with HCV infection are assumed to clear the virus within 6 months of acquisition – see Assumption (b). Patients who have cleared the infection will test RNA negative but remain HCV antibody positive (anti-HCV positive); they are assumed to be non-infectious and will not transmit HCV, and might be termed HCV-infected. Those who have not cleared the infection will be antigen positive (HCV-RNA positive), and may also be known as having chronic HCV and will be HCV-infectious, unless subsequent antiviral treatment achieves sustained virological clearance.

Our Approach

4.2 Previous Chapters have made use of registries containing details of individuals who have been infected with blood products. The numbers infected can therefore be counted, up to the accuracy and completeness of the database. In contrast, we cannot reliably count individuals who were infected with HCV through blood transfusions, since most would never have known they had been infected and would not ever feature in a registry of HCV diagnoses; others do feature but, typically, not until a decade or more after their HCV-implicated transfusion. There are lists of chronically HCV-infected individuals, say fund claimants and from other sources, but these will be substantial undercounts, both through not including those who have been unaware of their HCV infection, and those who died before registering. We therefore need to build a statistical model to estimate the number of HCV infections; such a model necessarily requires numerous assumptions and numerical inputs, which we shall justify using available evidence and judgement.

4.3 Previous models, for example Soldan et al. (2002),[55] have been based on evidence from look-back studies. These involve identifying infected donors, say through people who have been diagnosed as infected ('trace-back'), and identifying those who had previously received blood from that donor. For example, the 1995 study for England identified 669 people as HCV-infected after receiving a transfusion with a component included in the look-back exercise.[56] While look-back studies contain valuable

[54] Christian Schnier and David Goldberg, "Estimation of the Number of Individuals Infected and Alive in 2011 as a Consequence of Blood Transfusion in Scotland 1970-1991", 11 March 2012 [PRSE0001962, ep.1]

[55] Soldan, K., et al., "The Contribution of Transfusion to HCV Infection in England." *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp. 587–91 [PRSE0000620]

[56] The English National Blood Service HCV lookback collation collaborators, "Transfusion transmission of HCV infection before anti-HCV testing of blood donations in England: results of the national HCV lookback program", *Transfusion*, vol. 42, 2002, pp. 1146-1153 [NHBT0097156_004, ep.7]

information, they are designed to identify individual surviving recipients at increased risk of HCV for further investigation. However, the way they have been identified provides a limited basis for a robust model to estimate overall numbers. The Penrose Inquiry[57] concluded: *"While the look-back exercise was undoubtedly worthwhile, in Dr Gillon's view, as a means of trying to identify, counsel, test and treat those patients at risk of having contracted Hepatitis C as a result of blood transfusion, it was not a reliable guide to the number of patients likely to have become infected with Hepatitis C through transfusion."*

4.4 Our approach closely follows that used by Schnier and Goldberg[58] (from now on referred to as S&G) in their evidence to the Penrose Inquiry.[59] S&G created a 'forward' model, in which estimates of the main outcomes of interest are generated as a result of a series of stages, as shown in Figure 4.1.

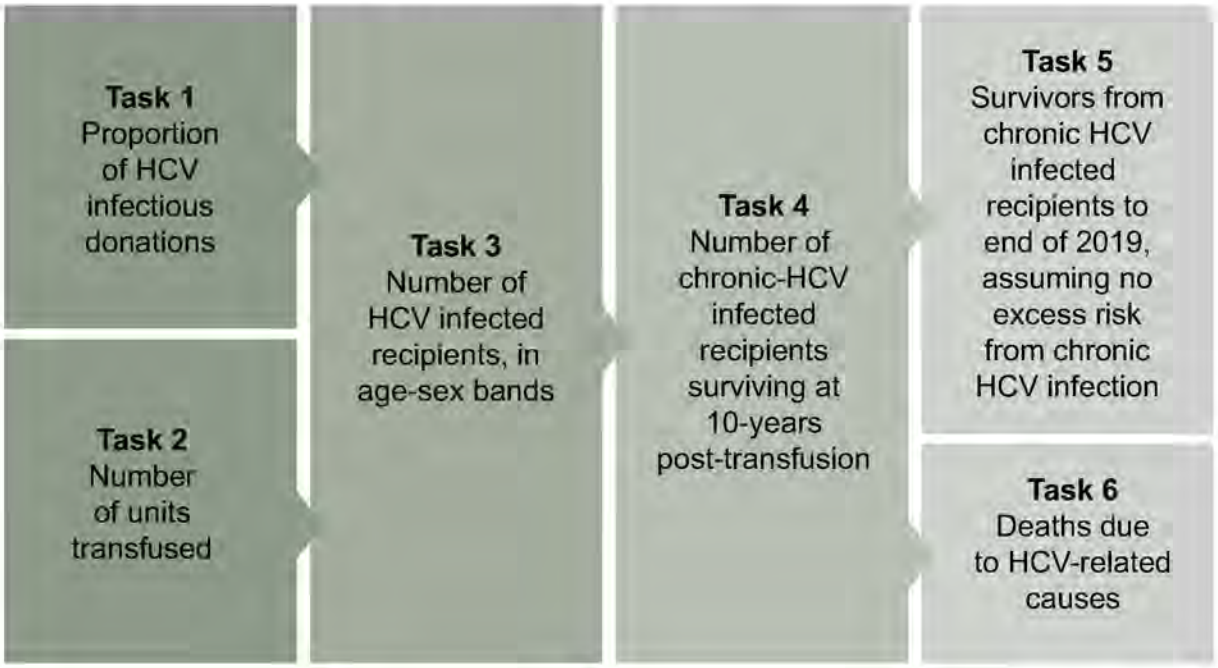

Figure 4.1 Structure of model used to estimate HCV infections following transfusions.

4.5 Essentially, by estimating the proportion of HCV-infectious donations (Task 1), and the number of units transfused (Task 2), we can estimate the number of infected recipients (Task 3) in age-sex bands. We then model their survival to 10 years post-transfusion (Task 4), before any mortality-risks due to chronic HCV infection would start becoming apparent. We go on to estimate the number of people surviving to the end of 2019 assuming excess risk from transfusion but not chronic HCV infection (Task 5). Finally, by including an assessment of the excess risk of death in the 21st century from chronic HCV infection, we can estimate how many deaths were linked to HCV (Task 6).

[57] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.104 [PRSE0007002, ep.65]
[58] Christian Schnier and David Goldberg, "Estimation of the Number of Individuals Infected and Alive in 2011 as a Consequence of Blood Transfusion in Scotland 1970-1991", 11 March 2012 [PRSE0001962]
[59] The Penrose Inquiry, Final Report, March 2015 [PRSE0007002]

4.6 Each stage forms a task in which the following questions are answered both in total, and for each year 1970 to 1991. This modelling is initially for England only.

- Task 1. What proportion of donations were HCV-infectious?
- Task 2. How many units of blood components were transfused?
- Task 3. How many recipients (in age-sex bands) were HCV-infected?
- Task 4. How many chronic HCV-infected recipients survived 10 years after transfusion?
- Task 5. How many chronic HCV-infected 10-year-survivors would have survived to the end of 2019, assuming no excess risk from HCV?
- Task 6. If we allow for excess risk from HCV, how many deaths to the end of 2019 were linked to chronic HCV infection?

Details of each task are given at the end of this Chapter.

4.7 We should emphasise that our conclusions depend not only on the modelling assumptions, but the availability of reliable data. It will become clear, in particular, that there are severe limitations in the information collected about blood transfusions over the period of interest.

Baseline model

4.8 A *baseline* model has been constructed for England, adapting the S&G assumptions. This is then adapted to Scotland, Wales and Northern Ireland. The baseline scenario is dependent on multiple assumptions, which we consider plausible but uncertain. The major baseline assumptions are collected together below – see individual Tasks for discussion of these assumptions:

- **Assumption (a)** Task 1. HCV prevalence in infectious donations is a 'hybrid' model with two components. Component 1 is proportional to chronic HCV prevalence in past or current injecting drug users (IDUs) in the year of transfusion (ever-IDUs). Component 2 comes from non-IDUs, and is set at a constant level.
- **Assumption (b)** Task 1. We assume that a constant proportion of those donors previously infected with HCV (HCV antibody positive) were actively HCV-infectious (RNA positive) and so would transmit the virus in their blood. The proportion is assumed to be around 74%.
- **Assumption (c)** Task 1. In addition to HIV antibody screening of donors, guidance to prospective donors in the mid-1980s led to a substantial fall (deferral) in HCV-infectious donations. Our baseline assumption is that this occurred in 1985 in England, Wales and Northern Ireland, and in 1984 in Scotland.
- **Assumption (d)** Task 1. Self-deferral led to around a 67% reduction in donations from HCV-infectious ever-IDUs.
- **Assumption (e)** Task 1. The contribution to prevalence from non-IDUs (component 2) is a fixed percentage of the proportion of donations that were found to be HCV-infectious when testing began in 1991. The baseline assumption for this percentage is 25%.

- **Assumption (f)** Task 3. All recipients of HCV-infectious units are assumed to develop HCV infection.
- **Assumption (g)** Task 3. There is a negligible chance of a transfusion recipient receiving two infected units.
- **Assumption (h)** Task 4. A proportion (around 18%) of transfusion recipients with HCV-infection is assumed to clear the virus within 6 months of acquisition.
- **Assumption (i)** Task 4. Chronic HCV infection does not influence recipients' survival for the first 10 years post-transfusion.
- **Assumption (j)** Task 5. Having a transfusion increases the annual risk of dying up to 20 years after transfusion.
- **Assumption (k)** Task 6. Chronic HCV infection increases the annual risk of dying from 10 years post-infection: our baseline assumption is a 53% increased risk.

4.9 We first constructed a *deterministic* model, initially using a spreadsheet and then coded using the statistical programming language R. For any set of specified assumptions about the model, this produces a set of estimates of quantities of interest. We have primarily focused on estimates of the number of transfusion recipients who:

- were infected with HCV;
- would have been chronically infected (were they to survive 6 months);
- were chronically infected, and survived to 10 years post-transfusion;
- were chronically infected, and survived to end 2019 (assuming extra HCV risk);
- were chronically infected, and died by end 2019 (assuming extra HCV risk);
- were chronically infected, and died by end 2019, with death linked to HCV infection.

4.10 In what is known as a *deterministic sensitivity analysis*, we have explored the impact of a wide range of varied assumptions about our model on the outputs listed above. Full details are provided at the end of this Chapter in Table 4.16.

4.11 **Uncertainty about parameters**: On top of the sensitivity analysis to the various major modelling assumptions outlined above, there is additional uncertainty about the quantities entered into any specific models – these are known as *parameters*. For example, we cannot know the exact effect of chronic HCV infection on mortality, and so a distribution of uncertainty about the central estimate (a 53% increase) is assumed, based on the available evidence. The effect of this uncertainty is assessed through what is known as a *stochastic Monte Carlo* analysis,[60] and the results presented as a distribution about the outputs – for example, the number of survivors with chronic HCV infection at the end of 2019 – which can be either graphed or summarised by a median and a 95% interval. This is known as a *probabilistic sensitivity analysis*.

[60] In this process, thousands of sets of plausible values for the parameters are simulated from their distributions, and their effects propagated through the model to produce a distribution of possible outputs. This distribution is summarised by an overall average and an uncertainty range comprising 95% of the simulated outputs.

4.12 Results for the baseline scenario are presented in the second row of Table 4.1. The distributional assumptions of the probabilistic model are given in Appendix 4.58. The five rows comprise results from:

- A deterministic baseline model assuming all parameters are fixed at their assumed values.
- A stochastic baseline model, in which parameters and outputs have associated uncertainty.
- Scenario A: A deterministic sensitivity analysis to Assumptions (a) (c) and (d), in which we assume component 1 in HCV-infectious donations comprises past-IDUs rather than ever-IDUs, the deferral effect occurred in 1987 and led to only a 33% reduction in infectious donations.
- Scenario B: A deterministic sensitivity analysis to Assumption (e), in which we assume that there is no component (2) of non-IDU infectious donors. This is analogous to the analysis of S&G.
- Scenario C: A deterministic sensitivity analysis to Assumption (e), in which we assume that component (2) accounts for all infectious donations and that the 1991 proportion of infectious donations applied throughout 1970-1991, i.e., no 'IDU' component in the model. This is analogous to the analysis of the England look-back study by Soldan et al. (2002).[61]

These additional scenarios have been chosen to illustrate the range of possible estimates.

4.13 In this and other Tables in the Chapter, all numbers have been rounded to either 2 or 3 'significant figures' (sf)[62] – any greater accuracy would be meaningless given the overall uncertainties in the modelling.

[61] Soldan, K., et al. "The Contribution of Transfusion to HCV Infection in England." *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp.587-91 [PRSE0000620]

[62] For example, a number 17,273 would be reported as 17,300 (3 significant figures (sf)), or 17,000 (2 sf).

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years after transfusion	Chronically infected, survived to the end of 2019 (assuming extra HCV risk)	Chronically infected, died by the end of 2019 (assuming extra HCV risk)	Chronically infected, died by the end of 2019, extra deaths related to HCV
Estimates from deterministic baseline model	22,100	18,100	6,700	2,230	15,900	1,550
Median estimates from stochastic baseline model, together with upper and lower 95% uncertainty limits	32,300 **22,000** 17,500	26,600 **18,000** 14,100	9,880 **6,670** 5,200	3,240 **2,200** 1,690	23,500 **15,800** 12,400	2,750 **1,540** 610
Scenario A: past-IDUs with deferral effect year 1987 & 33% reduction	15,700	12,800	4,750	1,640	11,200	1,080
Scenario B: All infections due to donations from IDUs	22,800	18,700	6,900	2,300	16,400	1,590
Scenario C: Constant proportion of infectious donations.	20,100	16,500	6,190	2,020	14,500	1,410

Table 4.1 Estimates for England from baseline deterministic model, baseline stochastic model with 95% uncertainty intervals, and deterministic sensitivity analyses using additional scenarios. See above for specification and sensitivity analysis. The deterministic and median stochastic estimates should be similar, but differ slightly due to the complex non-linear structure of the model. All numbers are rounded to 3 significant figures.

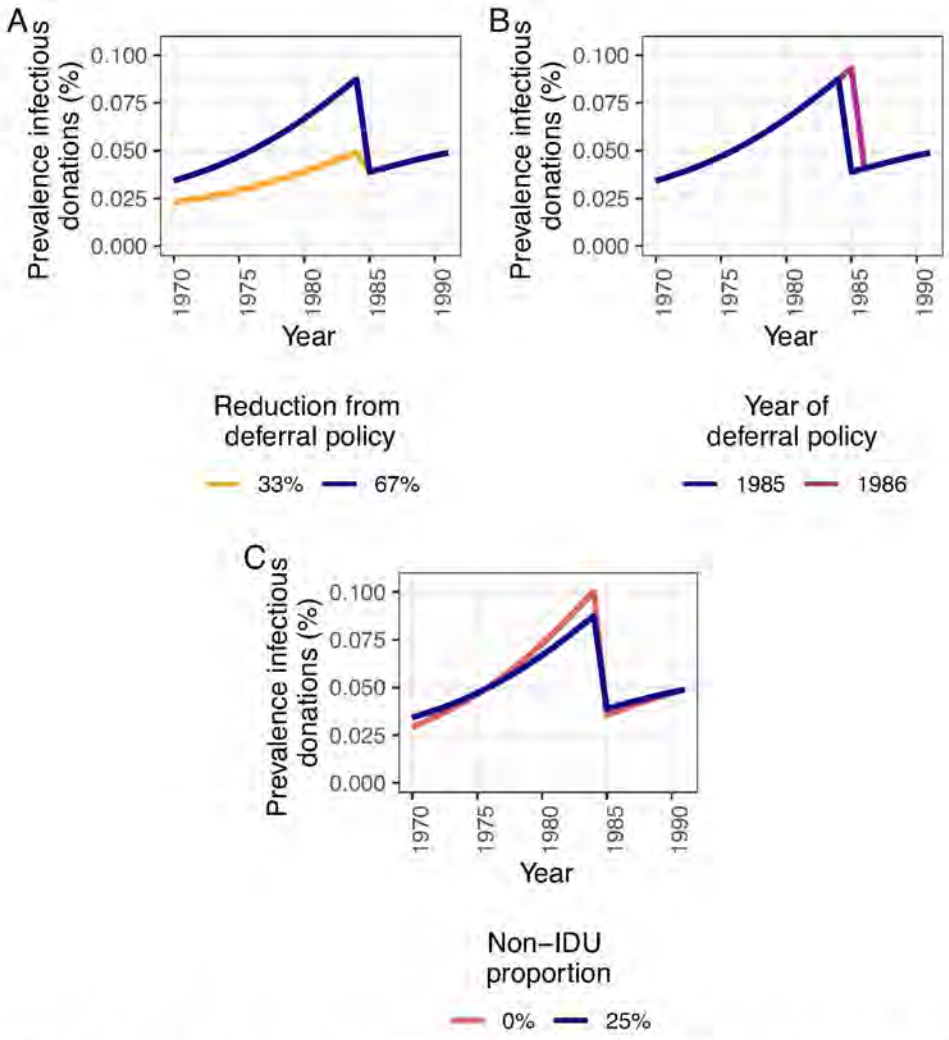

Figure 4.2: Example of the deterministic sensitivity analyses conducted for England. The blue line is the same throughout and corresponds to a deferral effect of 67% in 1985 for ever-IDUs (Assumption (d)) with no proportion of prevalence coming from non-IDUs. (A) Shows the effect of a reduction in the deferral effect to 33%. (B) Shows the impact of the deferral effect occurring in 1986 rather than 1985 (Assumption (c)). Shows the effect of our baseline hybrid model (Assumption (e)), in which there is a constant non-IDU contribution, set at 25% of the prevalence in 1991.

4.14 **Interpretation:**

- Under the stochastic baseline scenario, we estimate around 22,000 transfusion-recipients were infected with HCV in England between 1970 and 1991, with 18,000 becoming chronically infected (were they to survive 6 months). Of these, 6,670 survived for 10 years post-transfusion, when we assume the additional mortality-risk from their chronic HCV infection began.
- Of the 18,000 people with chronic HCV infections, we estimate that 15,800 had died by the end of 2019, and 1,540 of these deaths were HCV-related.
- Of these 15,800 deaths, 11,330 (18,000 - 6,670) had occurred in the first 10 years after transfusion. Of the 4,470 subsequent deaths (15,800 - 11,330), 1,540 (34%) were HCV-related.

- The **baseline stochastic scenario** shows that there is large uncertainty about all of these numbers, for example the number of chronic infections has a 95% uncertainty interval from 14,100 to 26,600. This reflects the uncertainty in all the quantities that have gone into the model, and implies great caution is needed in quoting the central estimates.
- Deterministic Scenario A focuses on infections from past-IDUs with a reduced deferral effect of 33% in 1987, and with 25% contribution from a constant level of non-IDU infections. This lower deferral effect leads to the conclusion that the historical HCV prevalence was never as high as it might have been if self-deferral had a major impact. The estimated number who were HCV-infected reduces substantially from 22,100 to 15,700, and the number of HCV-related deaths from 1,550 to 1,080.
- Deterministic Scenario B removes the contribution from non-IDUs, so that HCV infections depend solely on ever-IDUs, similar to S&G's model. This increases the estimated number of HCV-infections modestly to 22,800.
- Deterministic Scenario C assumes a constant level of infectious donations driven by the observed data in 1991 after testing began. This decreases the estimated number of HCV-infections to 20,100, somewhat lower than the 23,500 estimated by Soldan et al. (2002).[63]

It is clear that the precise proportions of the components in our hybrid model does not have a substantial impact on the conclusions.

4.15 Further sensitivity analyses reported at the end of this Chapter confirm that a major driver is Assumption (c), concerning the impact of guidance to prospective donors. Unfortunately, as we explore below in Task 1, there is little direct evidence about this quantity, and so to a large extent we rely on expert judgement.

4.16 The uncertainty about the outputs can be visualised as distributions, as in Figure 4.3. These communicate the plausibility of a range of values around the central estimate. For example, the final panel shows the number of excess deaths linked to HCV infection in England; while the bulk of the distribution is around the central estimate of 1,540, there is a reasonable 19% chance that it was more than 2,000 and a modest 12% chance that the number of excess deaths linked to HCV was below 1,000.[64]

[63] Soldan, K., et al., "The contribution of transfusion to HCV infection in England", *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp. 587-591 (2002) [PRSE0000620, ep.4-5]. To calculate '23,500', Soldan's estimate of 13,500 infections between 1 January 1980 and 1 September 1991 [ibid., ep.4] is added to Soldan's estimate of 10,000 infections during the 1970s [*ibid.*, ep.5].

[64] A few of the 10,000 simulations even produced a deficit of deaths linked to HCV, but this is more a property of the mathematical assumptions in the model than a plausible scenario.

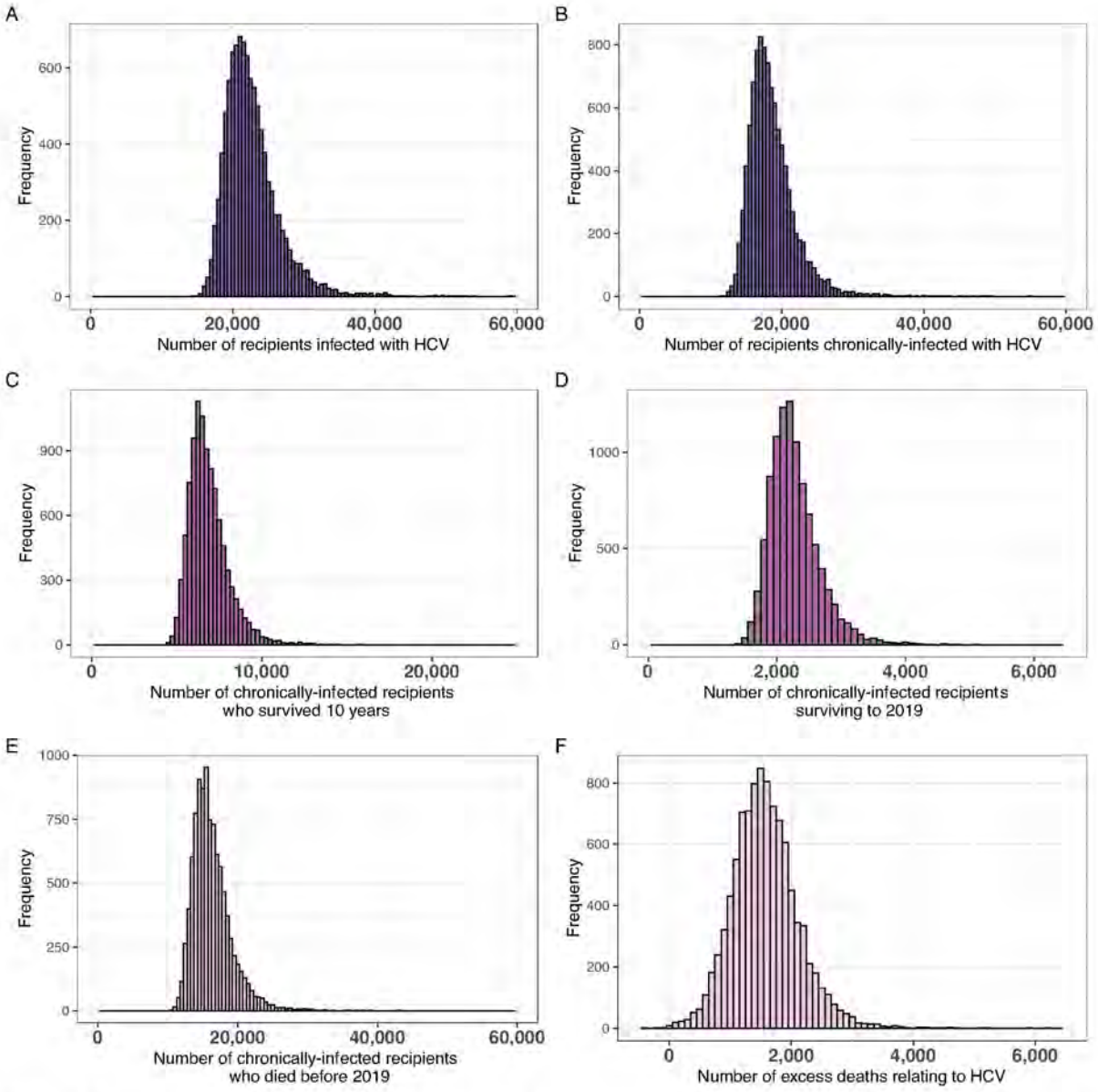

Figure 4.3: Distributions for quantities of interest arising from 10,000 simulations from the stochastic Monte Carlo baseline model for England.

4.17 A wide variety of estimates can be extracted from the model. For example, Figure 4.4 shows the estimated number of chronically-infected recipients alive each year under three different scenarios. The effect of chronic HCV-infection is considerably larger than that of having had a transfusion in the past.

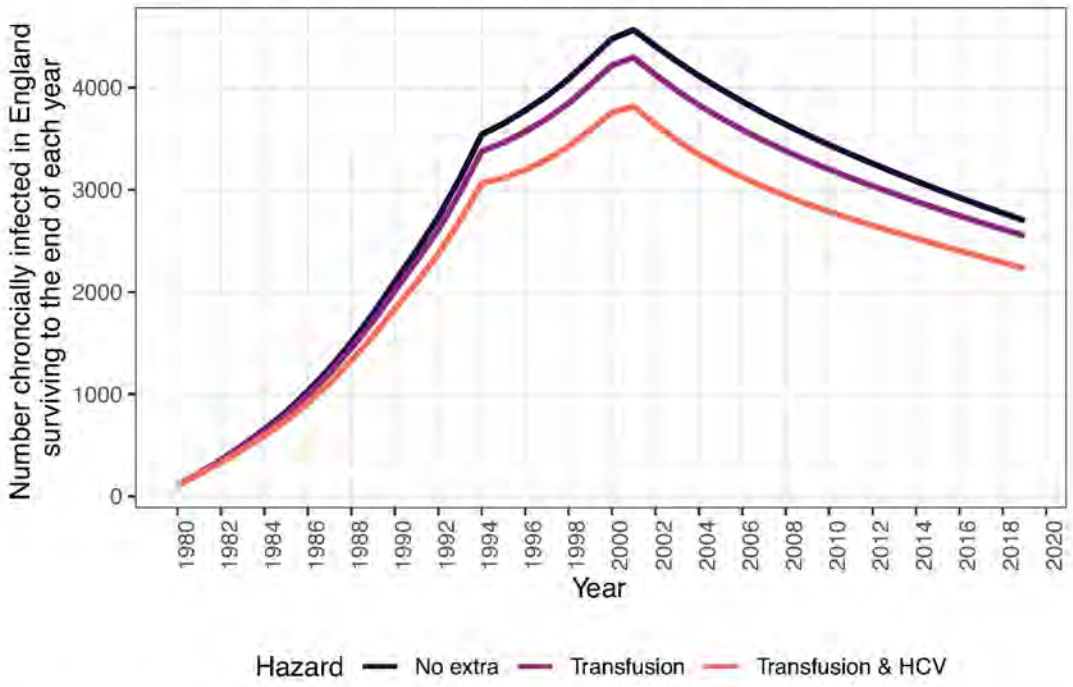

Figure 4.4: The number of chronically-HCV-infected people in England surviving to each year under three different combinations of 'hazards' – the annual risk of dying – in the baseline deterministic model. (1) no increased risk from transfusion or chronic HCV infection, (2) increased risk following transfusion (age-stratified), (3) increased risk following transfusion and infection. There is an increase in the number of people surviving to 2001 (the point at which all people transfused between 1970 and 1991 could have survived to 10 years), and after this there is a steady fall in the number of people surviving.

Numbers identified by funds

4.18 Chapter 5 reports data on successful applicants to the variety of funds established to support those HCV-infected by blood or blood products. The most recent and relevant data from the Skipton Fund[65] seem to be from 2016: there had been 4,165 approved applications in England, with around 50% by persons who did not have bleeding disorders. Hence, we would estimate around 2,080 registered as having been chronically HCV-infected from transfusions in England. Since the Skipton Fund was aware that 619 of its UK-claimants had died, then (pro rata) around 484 of these deaths may have occurred in England which gives a 23% mortality rate (484/2,080), and so around 1,600 chronically HCV-infected claimants (2,080 - 484 = 1,596) in England still surviving in 2016. The current England Infected Blood Support Scheme (EIBSS) does not store registrations separately by blood-disorders or transfusion.

4.19 The number of surviving claimants is below our estimate of 2,200 (see Table 4.1) chronically HCV-infected survivors to the end of 2019, but not substantially so.

[65] The Skipton Fund, 'Stage 1 & Stage 2 application statistics to 31 December 2015' [SKIP0000030_070, ep.1]

Adapting the model to Scotland, Wales and Northern Ireland

4.20 We assume the same model structure and assumptions for each of the four nations of the UK. Nation-specific data were unavailable for many parameters, and so we have adopted the parameters for England that are discussed in detail below, with the following exceptions:

- *Task 1: 1991 HCV infected donor prevalence*: Scotland value (0.088%) from S&G.
- *Task 1: The trend of HCV-infectious IDUs*: Scotland values from S&G.
- *Task 1: Year of deferral reduction (Assumption (c))*: Scotland value (1984) from S&G.
- *Task 2: The number of blood donations: pro rata by population for Wales and Northern Ireland, and S&G values for Scotland.*
- *Task 5 and 6: The probability of surviving to the end of 2019 assuming survival to 10 years post-transfusion, with and without the effect of chronic HCV infection*: these are based on nation-specific life tables as published by the Office for National Statistics[66].

Further details are provided in Appendix Table 4.1.

4.21 The use of blood in Northern Ireland in the 1970s will have been impacted by the Troubles and by the armed forces' use of blood, which may have been donated by combatants at field hospitals. We were unable to obtain data to account for this and, therefore, our estimates for Northern Ireland may be an overestimation.

4.22 Table 4.2 presents the estimates for the baseline models of each of the four nations using the stochastic model. It is clear there is substantial uncertainty around all our UK estimates.

[66] The Office for National Statistics, National life Tables, England, 1980-1982 to 2018-2020 [OFNS0000004]; The Office for National Statistics, National Life Tables, Scotland, 1980-1982 to 2018-2020 [OFNS0000005]; The Office for National Statistics, National Life Tables, Northern Ireland, 1980-1982 to 2018-2020 [OFNS0000007] and The Office for National Statistics, National Life Tables, Wales, 1980-1982 to 2018-2020 [OFNS0000008]

Scenario ***Median estimates*** *from stochastic baseline model, together with upper and lower 95% uncertainty limits*	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post transfusion	Chronically infected, survived to end of 2019 (assuming extra HCV risk)	Chronically infected, died by end of 2019 (assuming extra HCV risk)	Chronically infected, died by end of 2019, extra deaths related to HCV
England	32,300 **22,000** 17,500	26,600 **18,000** 14,100	9,880 **6,670** 5,200	3,240 **2,200** 1,690	23,500 **15,800** 12,400	2,750 **1,540** 610
Scotland	3,440 **2,740** 2,250	2,850 **2,250** 1,820	1,060 **830** 660	360 **270** 210	2,510 **1,970** 1,600	320 **170** 50
Wales	1,960 **1,320** 1,030	1,610 **1,080** 830	600 **400** 300	200 **140** 100	1,420 **950** 730	170 **70** 15
Northern Ireland	1,080 **730** 570	890 **600** 460	330 **220** 160	110 **75** 55	780 **520** 400	100 **30** 2
Total UK	38,800 **26,800** 21,300	31,900 **22,000** 17,300	11,900 **8,120** 6,330	3,910 **2,700** 2,050	28,200 **19,300** 15,100	3,320 **1,820** 650

Table 4.2 Estimates for each of the four nations of the United Kingdom from the respective baseline stochastic model (median with 95% uncertainty intervals). Numbers above 1,000 are rounded to 3 significant figures, numbers between 100 and 1000 are rounded to nearest 10 and numbers below 100 are rounded to nearest 5. For the Total UK, we have added the unrounded medians for the four nations, and assessed the multiplicative uncertainty as a weighted average of those for the constituent nations.[67] We note that 64% of persons in the UK who were chronically infected with HCV through transfusion and survived to the end of 2019 were female (95% uncertainty: 58% to 69%).

4.23 **Limitations:**

- The estimates for Scotland somewhat understate the uncertainty, as we are not including uncertainty in the estimated prevalence of ever-IDUs.

Estimates from other sources – Summary Findings

4.24 There has been substantial variation in previous estimates of the number of HCV infections from blood transfusions, some of which have been strongly contested. In this section, we explore the reasons why past estimates differ so much, and contrast them with our own conclusions.

[67] The stochastic uncertainties in the four nations depend on essentially the same quantities, and so are almost perfectly correlated. We define the 'multipliers' as the ratios of the upper and lower ends of the interval to the median. Then we assume the logarithms of UK multipliers are the average of the logarithms of the nation-specific multipliers, weighted by their medians.

Department of Health (UK)

4.25 A widely discussed estimate is from the Department of Health 2011,[68] who estimated 28,043 post-transfusion HCV-infections for the UK. This is reported as being derived from the estimate by Soldan et al. (2002)[69] for England, which was 23,500 for 1970-1991. The possible derivation of the 28,043 was discussed in the Penrose Inquiry,[70] who observed that between 1970 and 1991 England had around 83% of the UK population. Scaling up proportionately gives 23,500/0.83 = 28,300, a close approximation to the claimed 28,043.[71] The Department of Health estimate for Scotland, based on respective populations in 1991 (5.105m/47.88m), would be around 2,500.

Soldan (England)

4.26 Soldan's (2002) estimates are based on analysis of the English look-back programme. When put within the structure of our model, the ideas behind the steps are essentially as follows:

- 0.066% HCV antibody prevalence in donations in late 1991 is assumed to hold throughout 1970-1991.
- 25,864,035 donations collected in England, 1980 – August 1991.
- 41,382,456 components produced (assuming 1.6 components from each donation).
- 26,898,596 components transfused (assuming 65% of components are transfused).
- 17,753 of these were HCV antibody positive (assuming 0.066% of all donations).
- 13,314 HCV RNA positive (i.e. HCV-infectious) components transfused, each leading to an infected recipient (assuming 25% of HCV antibody positive donors are not infectious).

This does not quite match Soldan's 13,500, as she uses more precise knowledge from the look-back programme.

4.27 **Soldan then adds:** *"If the prevalence of anti-HCV amongst blood donors during the 1970s was assumed to be the same as at the end of 1991, inclusion of the 1970s data would generate approximately 10,000 extra HCV-infected blood recipients."* Hence, the total of 13,500 + 10,000 = 23,500 is based on assuming the prevalence of 0.066% held throughout the whole period.

4.28 Our central baseline estimate of 22,000 for England is slightly below that of Soldan.

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[68] Department of Health, "Review of the support available to individuals infected with Hepatitis C and/or HIV by NHS-supplied blood transfusions or blood products and their dependents", [PRSE0004024, ep.6]

[69] Soldan, K., et al., "The Contribution of Transfusion to HCV Infection in England." *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp. 587–91 [PRSE0000620]

[70] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.166-3.172 [PRSE0007002, epp.80-81]

[71] Whatever the method, given the very rough assessment by Soldan for 1970-1980 (see below), it is inappropriate to give such a precise figure such as 28,043.

Soldan (Scotland)

4.29 For the Penrose Inquiry, Soldan adapted the England methodology estimate,[72] factoring in the higher HCV antibody prevalence among blood donors in Scotland in the first six months of HCV screening (0.088%).[73] She estimated 3,498 HCV infections following transfusion between 1980 and 1991, which is considerably higher than our estimate.

Penrose (Scotland)

4.30 The Schnier and Goldberg (S&G) analysis for the Penrose Inquiry has been discussed previously, and is summarised in Penrose 3.176-3.193.[74] A major difference between the S&G model and Soldan's analysis concerned the proportion of HCV-infectious donations each year between 1970 and 1991; Soldan assumed this was constant, while S&G allowed the proportion to vary according to estimated numbers of HCV-infected ever-IDUs in the population.[75] S&G's reported estimates, with sensitivity analyses, are shown in Table 4.3.

Model	Estimated infections from transfusion, Scotland 1970-August 1991	Alive in 2011
Baseline	**1,533** (1,198 to 1,963)	**296** (228 to 384)
Assuming incremental impact of deferral policy from 1983	**2,200** (1,660 to 2,850)	**440** (320 to 570)
Assuming no effect of deferral policy	**1,110** (876 to 1,413)	**230** (178 to 294)
Assuming constant donation infection rate (0.088% HCV antibody positive)	**6,784** (5,027 to 8,776)	**1,050** (789 to 1,364)

Table 4.3 Estimates with 90% uncertainty bounds from S&G analysis for the Penrose report.

4.31 This Scottish re-analysis shows that the major reason why Soldan's estimates are higher is the assumption of a constant donor HCV-infection rate throughout the period 1970-1991. By relaxing the assumption, and introducing dependence on the changing prevalence of HCV infected ever-IDUs, we would expect the widely-reported 28,000 UK total to decrease, which has been observed.

4.32 Our more complex 'hybrid' model results in a central estimate of 2,740 for Scotland, which is higher than Penrose's baseline, but not as high as Soldan's 'constant' model.

[72] Kate Soldan for Brian McClelland, "Estimated number of individuals infected by blood transfusion in Scotland", [PRSE0003921]

[73] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.173-3.175 [PRSE0007002, epp.81-82]

[74] Ibid., epp.81-87.

[75] Hutchinson, S. J., et al., "Modeling the Current and Future Disease Burden of Hepatitis C Among Injection Drug Users", *Hepatology*, vol. 42, no. 3, 2005 [PRSE0004243]

Claims of above 100,000 infections

4.33 There have been estimates of up to 400,000 HCV infections from blood transfusions in the UK since 1970.[76] This appears to be largely based on assuming an HCV-infection prevalence in the UK donor population of at least 2% between 1970 and 1985, falling to 1% between 1986-1991, quoting a PHLS study by Ramsey et al. published in 1998.[77] Also quoted is Gunson's 1986[78] estimate of a 3% incidence of non-A non-B hepatitis, which in turn uses a 1974[79] study funded by the Medical Research Council (MRC) of 768 patients (474 females, 294 males) who were transfused between 1 July 1969 and 30 June 1971 with 2,824 units of blood and who consented for follow up. During the two-year period, the centre used 8,953 units of blood for transfusion. Hepatitis B antigen was detected in 13 (0.15%) and hepatitis B antibodies in eight (0.09%). Five patients in the MRC survey received blood that was subsequently shown to contain hepatitis B antigen. Gunson also cites supporting evidence from Collins et al. (1983),[80] who concluded six out of 248 (2.4%) cardiac surgery patients had post-transfusion non-A non-B hepatitis. The 1974 MRC study reports eight cases of post-transfusion *"icteric or anicteric post-transfusion viral hepatitis"*, an incidence of 1%. Other estimates include Garson et al. (1990)[81] who found six out of 1,100 (0.55%) transfusion recipients were *"repeatedly reactive in a commercial assay for antibodies to the C100 protein of hepatitis C virus"*. All these estimates are well above the empirical estimate in Section 4.1, based on Soldan's assessment of a prevalence of 0.066% (532/808,938) HCV antibody positive blood donors tested in England between September and December 1991, after both enhanced self-deferral and HIV antibody screening of blood donors.

4.34 There are concerns with the statistics used in the analysis above. For example, it is important to note that the 2.6% prevalence of HCV infection in people given transfusions before 1985, as reported in Ramsey et al. (1998), is *not* based on a sample of transfusions, but a sample of HCV test results carried out in the 1990s. Such tests tend to be taken if HCV infection is suspected, mainly through symptoms or being in a higher-risk group; indeed, in this study, the rate of HCV infection in those who had not received transfusions was 10% (Table 5[82]). Due to this 'targeted' sampling, the quoted rates cannot be used as an indication of the rates in all transfusion recipients. In addition, Collins et al. (1983) did note some short-term rise in liver function tests but concluded: *"The incidence of significant chronic liver disease after blood transfusion possibly attributable to a non-A, non-B hepatitis agent was therefore only 0.4%"*. It is important, in general, to realise that before the availability of testing for the virus itself, the use of abnormal liver function tests as a marker of HCV infection cannot be relied upon to give precise estimates.

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[76] Desmond, Paul. "'When Spin Kills: How the NHS Transfused 400,000 People Hepatitis C and Covered It Up" (2018) [RLIT0000039, epp.9-10]

[77] Ramsay, M.E., et al., "Laboratory Surveillance of Hepatitis C Virus Infection in England and Wales: 1992 to 1996", *Communicable Disease and Public Health*, vol. 1, no. 2, June 1998 [RLIT0000319]

[78] UK Working Party on Transfusion Associated Hepatitis, "Alanine Amino-Transferase and Anti-Hepatitis B Core Screening of Donations: Proposals for a Multi-Centre Study", October 1986 [PRSE0002161, ep.10]

[79] The Medical Research Council Working Party on Post-Transfusion Hepatitis. "Post-Transfusion Hepatitis in a London Hospital: Results of a Two-Year Prospective Study." *The Journal of Hygiene*, vol. 73, no. 2, 1974, pp. 173–88 [PRSE0002988, ep.1]

[80] Collins, J. D., et al., "Prospective Study Of Post-Transfusion Hepatitis After Cardiac Surgery In A British Centre." *British Medical Journal* (Clinical Research Edition), vol. 287, no. 6403, 1983, pp. 1422–24 [PRSE0000766, epp.1-2]

[81] Garson, J. A., et al., "Detection of hepatitis C viral sequences in blood donations by 'nested' polymerase chain reaction and predictions of infectivity", *The Lancet*, vol. 335, 1990, pp. 1419-1422 [OXUH0000030_002, epp.1-2]

[82] Ramsay, M. E., et al., "Laboratory surveillance of hepatitis C virus infection in England and Wales: 1992 to 1996", *Communicable Disease and Public Health*, vol. 1, no. 2, 1998, pp. 89-94 [RLIT0000319, ep.4]

4.35 In her witness statement of October 22nd 2021[83] Dr Soldan responded to requests by the Inquiry to critique estimates of HCV-infection rates in transfusion-recipients of 1% (MRC) and 0.55% (Garson). Regarding the MRC 1974 data, she was unsure that the cases reported would have been confirmed as HCV antibody positive if a definitive test had existed – particularly because acute symptoms from HCV would not be typical – and she felt unable to derive an incidence estimate from the data presented. For the Garson data, she noted that only one of the six notional HCV-infected donations went on to infect the recipient, which casts doubt on the accuracy of the assay.

4.36 It appears clear that the incidence of post-transfusion HCV infections cannot be properly estimated before reliable tests were adopted in the early 1990s, and so estimates of the number infected, when based on pre-1990 studies, need to be treated with great caution.

4.37 Very high numbers of HCV infections have also been quoted in France. An official report on their HCV infections, with lead author Professor Max Micoud, was published in 1993. Discussing the Micoud report, Delorme[84] states: *"If we evaluate this risk (of post-transfusion contamination) at 5%, between 1970 and 1989, 25,000 people have been contaminated each year, potentially leading to chronic hepatitis"*, and *"In 1992, the number of people infected with HCV in France can be estimated at between 500,000 and 2 million. Of these, 100,000 to 400,000 infections could be of post-transfusion origin"*. This estimate of 5% is in contrast to the observed incidence in France when reliable testing was introduced: Nalpas et al. (1998)[85] reported an incidence of infected blood donations of 0.37% in 1991 after self-deferral and HIV testing – around four times that in the UK, but still substantially below the 5% estimated in the Micoud report.

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Task 1 For each year 1970-1991 in England, what proportion of donations was HCV-infectious?

4.38 **Assumption (a)** We adopt a 'hybrid' model of HCV-infectious donors that has been explained previously; a first component comprising HCV-infectious ever-injecting drug users (ever-IDUs), and a second constant component comprising HCV-infectious non-IDUs.

4.39 This allows us to break the task into a series of smaller questions:

- Task 1.1. Just after screening of blood donors started in September 1991, what proportion of donations were HCV antibody positive?
- Task 1.2. Just after screening started in September 1991, what proportion of donations were HCV-infectious (RNA positive)?
- Task 1.3. How many HCV-infectious ever-IDUs were alive during each year between 1970 and 1991?
- Task 1.4. What was the step-down in donations from ever-IDUs due to guidance and HIV antibody testing in the mid-1980s?

[83] Written Statement of Dr Kate Soldan, 19 May 2022 [WITN7088001, epp.7-9]
[84] Delorme Le Concours Medical, 23 January 1993 [RLIT0001685, epp.41-42]
[85] Nalpas, B., et al. "State of epidemiological knowledge and national management of hepatitis C virus infection in the European Community, 1996", *European Journal of Public Health*, vol 8, no 4, 1998, pp. 305-312 [RLIT0001687, ep.2]

- Task 1.5. What constant level of HCV-infectious (RNA positive) non-IDU donors might it be reasonable to assume between 1970 and August 1991?

Together these steps, and the hybrid model, allow us to estimate the proportion of infectious donations in each year.

Task 1.1. Just after screening of blood donors started in September 1991, what proportion of donations were HCV antibody positive?

4.40 **Background:** Reliable screening of donations for antibodies to HCV began in September 1991 and so could provide good information about the proportion of donations that, earlier in 1991, were HCV antibody positive.

4.41 **Confidence that available evidence can answer the question?** High.

4.42 **Available sources of evidence:** National Blood Authority/PHLS Infection Surveillance Report's tables[86] are reported in Soldan's PhD thesis,[87] covering England and Wales. The total of 532 HCV antibody positive donor tests is also confirmed in the UKHSA Witness statement to the Inquiry, with subdivision of the total into 94 new donors and 438 repeat donors.[88]

4.43 **Analysis and conclusions:**

Donations tested	HCV antibody positive donations	(%) with 95% confidence level	Alternative representations
808,938	532	0.066% (0.060% – 0.072%)	66 in 100,000 donations 1 in 1,520 donations

Table 4.4 Results of donations that were tested for HCV antibodies between September and December 1991, England and Wales.

4.44 **Comments and limitations:** In their submission to the Penrose Inquiry, S&G reported that between September 1991 and February 1992, 159 of 180,000 donors tested in Scotland were HCV-antibody positive, which is 0.088%[89], higher than the rate in England and Wales.

Task 1.2. Just after HCV antibody screening of donors started in September 1991, what proportion of donors were HCV-infectious (RNA positive)?

4.45 **Assumption (b)** We assume that a constant proportion of those donors previously infected with HCV (HCV antibody positive) were actively HCV-infectious (RNA positive) and so would transmit the virus in their blood.

[86] National Blood Service Infection Surveillance, "six monthly infection surveillance: October 1995 – June 1999", report no. 10, December 1999 [DHSC0038609_085, ep.15]

[87] Soldan, K., "The Epidemiology of Infections in Blood Donors and Assessment of the Risk of Transfusion Transmitted Infections", July 2001 [SHTM0002679, ep.289]

[88] Written Statement of Dr Robert Kyffin, 17 August 2022 [WITN7123001, epp.32-33]

[89] Christian Schnier and David Goldberg, "Estimation of the Number of Individuals Infected and Alive in 2011 as a Consequence of Blood Transfusion in Scotland 1970-1991", 11 March 2012 [PRSE0001962, epp.3-4]

4.46 **Background:** Of those infected with HCV, a proportion will spontaneously 'clear' the virus naturally, and so stop being infectious. In particular, infected blood donors who clear their virus will not pass on the infection in their donated blood. S&G assumed a value of 75% for the proportion who continue to be infectious.[90]

4.47 **Available sources of evidence:** Micallef et al. (2006)[91] carried out a systematic review of the medical literature and found 31 relevant studies including 675 subjects. They estimated an overall clearance rate of 26% (95% confidence interval: 22% to 29%), with lower rates in males. For transfusion recipients, the clearance-rate was also lower at 18% (95% confidence interval: 13% to 24%).

4.48 **Confidence that available evidence can answer the question?** High

4.49 **Analysis and conclusions:** We assume a donor clearance rate of 26% (95% confidence interval: 22% to 29%) and so a central estimate of 74% of HCV antibody positive blood donors who are infectious. The estimated proportion of HCV-infectious donations in January to August 1991 (i.e. prior to HCV antibody screening of donors) is therefore 0.066% x 0.74 = 0.049%.

Estimated % anti-HCV+	Estimated % HCV-infectious with 95% confidence interval	Alternative representations
0.066%	0.049% (0.044% – 0.054%)	49 in 100,000 donations 1 in 2,040 donations

Table 4.5. Results of donations that were tested for HCV antibodies between September and December 1991, England and Wales.

4.50 **Comments and limitations:** Since Micallef et al. (2006) is a recent systematic review of the literature, we adopt their overall estimate in the model. Although the 26% includes studies on post-transfusion cases, we use the overall figure as donors may themselves have had transfusions.

Task 1.3 How many chronically HCV-infected ever-injecting drug users (ever-IDUs) were alive during each year between 1970 and 1991?

4.51 **Background:** S&G assume that HCV-infectious donations mainly came from those who had ever injected drugs ('ever-IDUs') or had been indirectly infected by injecting drug users, and therefore HCV-infectious donations were related to the prevalence of chronic HCV infection in this population subgroup. MacLennan et al. (1992) reported that *"in this preliminary investigation of our HCV-seropositive donor population, IDU appears to be a predominant risk-factor for transmission of HCV."*[92]

[90] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.181, March 2005 [PRSE0007002, ep.84]

[91] Micallef, J. M., et al., "Spontaneous viral clearance following acute hepatitis C infection: a systematic review of longitudinal studies", *Journal of Viral Hepatitis*, vol. 13, 2006, pp. 34-41 [RLIT0001633, ep.2]

[92] MacLennan, S., et al., "Screening blood donations for HCV", *The Lancet*, vol. 339, 1992, pp. 131-132 [NHBT0000030_068, ep.1]

4.52 We have broadened the S&G model to a 'hybrid' model for England, by assuming HCV-infectious donors are a mixture of ever-IDUs and a group that has a constant HCV antibody prevalence throughout 1970-1991 (**Assumption (a)**). Different mixture proportions are explored, from 0% to 100% of the HCV antibody prevalence in 1991.

4.53 **Available sources of evidence:** There have been estimates of the number of current injecting drug users,[93] but few estimates of the number of HCV-infectious current and past IDUs. We judged the most authoritative to be the Public Health England study, published by Harris et al. (2019).[94] They used an extended back-calculation approach to recreate the HCV infection process leading to observed disease data. An updated version of this model is used to generate UKHSA's annual prevalence estimates of HCV.

We have been provided with previously unpublished estimates for HCV-infectious current and past IDUs and their sum (ever-IDUs) for the period 1971-1991 (see Appendix A.6 for estimation for 1970, and Appendix Figure 4.1 for contrast between England and Scotland).

4.54 **Confidence that available evidence can answer the question?** Moderate/High.

4.55 **Analysis and conclusions:** The estimates are shown in column (a) of Table 4.6, while column (b) shows the estimates normalised to be 100 in 1991. Table 4.6 column (c) and Figure 4.5 display the estimated percentage of HCV-infectious donations (assuming ever-IDUs are the sole source), pegged to the estimated HCV-infectious donations in 1991. There was a steady increase in the prevalence of HCV-infectious ever-IDUs over this period, increasing roughly five-fold between 1970 and 1991.

4.56 **Comments and limitations:** These estimates are highly sensitive to the UKHSA's model assumptions, such as accurate recording of HCV-related outcomes, and that progression probabilities are constant over time. Although the 95% intervals allow for statistical uncertainty, the possibility of bias in the included parameters is not incorporated.

4.57 **Sensitivity analysis:** Current IDUs have poor venous access so that past-IDUs may be more likely to have presented as donors. Hence, we also consider the effect of restricting to past-IDUs (Scenario A in Table 4.1).

Task 1.4 What was the step-down in donations from ever-IDUs due to guidance and HIV antibody testing in the mid-1980s?

4.58 **Assumption (c)** As previously demonstrated in Table 3.1, in the mid-1980s there was strong guidance that those who were currently injecting or had ever injected drugs should avoid giving blood due to the risk of HIV transmission. We therefore assume that in or after 1985 there was a 'step-down' in donations from the HCV-infectious population.

4.59 As we saw in Table 3.1, the advice and language of the leaflets changed: advice against donations from people who had previously injected drugs was introduced in Scotland in 1984, but only for the rest of the UK in 1987.

[93] King, R., et al., "Estimating prevalence of injecting drug users and associated heroin-related death rates in England by using regional data and incorporating prior information", *Journal of the Royal Statistical Society*, ser. A, 2014, pp. 1-28 [RLIT0001637]

[94] Harris, R. J., et al., "Monitoring the hepatitis C epidemic in England and evaluating intervention scale-up using routinely collected data", *Journal of Viral Hepatitis*, vol. 26, 2019, pp. 541-551 [WITN7088003]

4.60 **Confidence that available evidence can answer the question?** Low/Moderate.

4.61 **Available sources of evidence:** There does not seem to be any reliable evidence for the effect of the changed guidance in the mid-1980s. In particular, samples from earlier donations had not been retained, preventing subsequent testing for HCV antibodies. In an analysis of people who had been tested for HCV antibodies,[95] the proportion who were HCV antibody positive among those who had received transfusions fell by roughly 60% between those transfused before 1985 and those after 1985 (from 2.6% to 1.0%), but this is a highly selected group of people who were subsequently HCV tested, favouring those with disease-progression. Moreover, the pre-1985 date-range was large.

In their submission to the Penrose Inquiry, S&G said that the deferral policy introduced by SNBTS in 1984 was assumed to have reduced the HCV prevalence in the donor population persistently by 66%, saying *"This assumption was based on limited local data and expert opinion."*[96] We also base our assessment on informal discussions with members of Infected Blood Inquiry Expert Groups who were knowledgeable about both the contemporary circumstances and the effects of guidance on behaviour: see Appendix (A.8 onwards) for details.

4.62 **Analysis and conclusions:** Two broad opinions emerged concerning the 67% (two-thirds) reduction (the better supported) or 33% (one-third) reduction. Those who thought such guidance would have very limited effect pointed to the general lack of adherence to health advice leaflets, possible unwillingness to identify as someone affected by drug use, and possible incentive to donate in order to get an HIV antibody test without attending a special clinic: those who tested HIV antibody negative would go on to donate, but could be HCV antibody positive.

Assumption (d) We adopt a 67% reduction in donations from HCV-infectious ever-IDUs as part of our baseline scenario.

4.63 **Comments and limitations:** There are inevitable limitations of using expert judgement.

4.64 **Sensitivity analysis:** England's messaging on self-deferral by past-IDUs was not explicit until 1987. Hence, we consider the impact of assuming a 33% step-down in 1987 for past-IDUs. Results are shown in Table 4.1 as Scenario A. Further sensitivity analyses are reported in Table 4.16.

[95] Ramsay, M. E., et al., "Laboratory surveillance of hepatitis C virus infection in England and Wales: 1992 to 1996", *Communicable Disease and Public Health*, vol. 1, no. 2, 1998, pp. 89-94 [RLIT0000319, ep.2]

[96] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.186, March 2005 [PRSE0007002, ep.85]

Task 1.5. What constant level of HCV-infectious (RNA positive) non-IDU donors might it be reasonable to assume between 1970 and August 1991?

4.65 Our 'hybrid' model allows for a lower-level constant threshold with the remainder time-varying in accordance with England's chronically HCV-infected ever (or past) IDUs. IDUs would be expected to be the main but not sole driver of HCV transmission, with other routes including iatrogenic transmission historically, UK personnel being treated overseas, and immigration from countries where HCV was prevalent.

4.66 **Assumption (e)** We assume that a baseline 25% of blood donors' HCV-infected prevalence in 1991 has been persistent throughout 1970-1991. This is based on judgement (and sensitivity analysis reveals that the precise value has little impact).

4.67 **Analysis and conclusions**: Table 4.6 shows the stages in developing our hybrid model, from ever-IDU prevalence, scaled to the main results are shown in Figure 4.5.

4.68 **Sensitivity analysis**: In Table 4.1 we consider the effect of assuming infections arise solely from ever-IDUs (Scenario B) or at a constant level regardless of IDU prevalence (Scenario C).

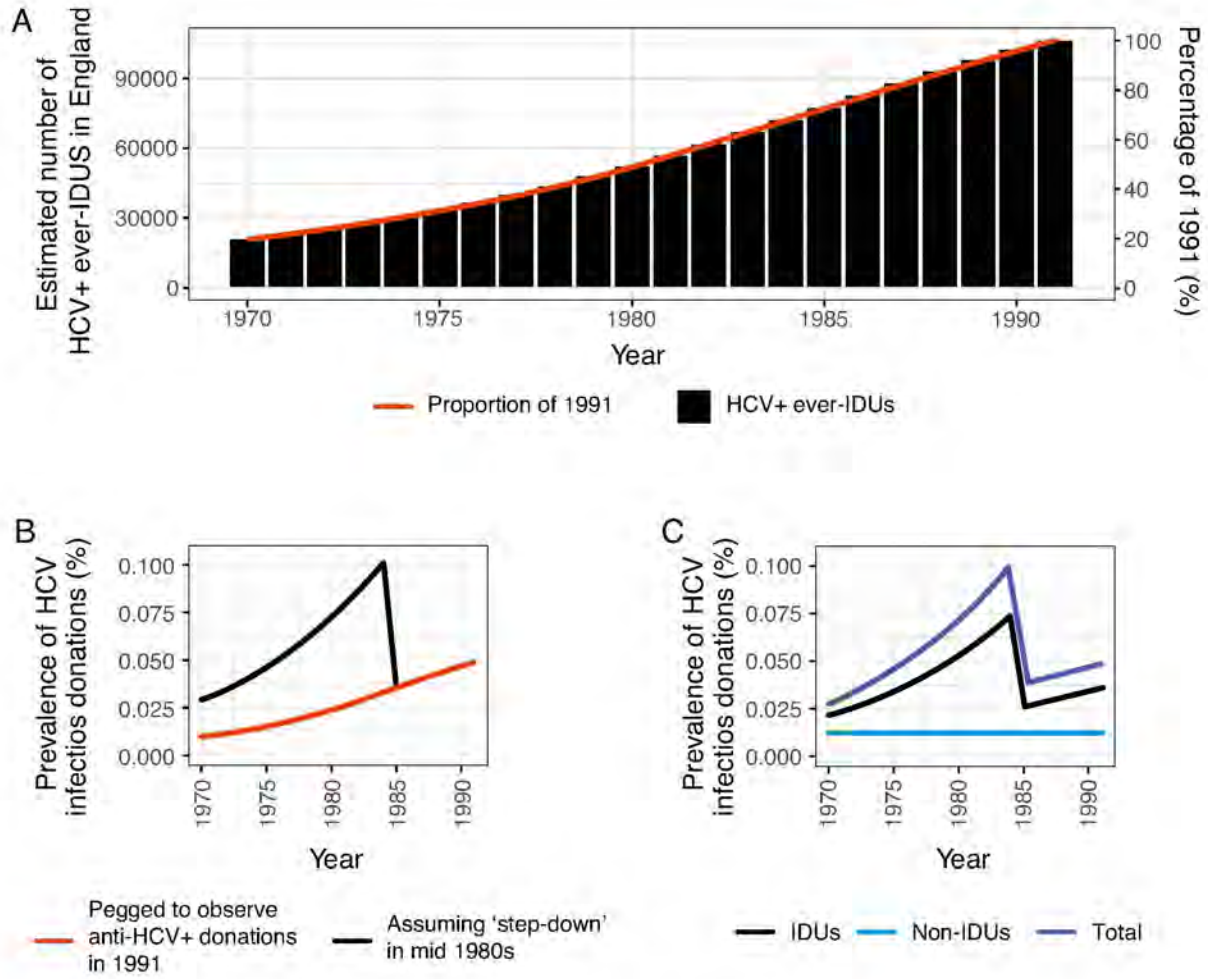

Figure 4.5: Stages in estimating the prevalence of infectious HCV donations:

(A) Estimated number of ever-injecting drug users (black columns) and percentage that each year contributes to the value observed in 1991 (red line) – Table 4.6, column (a).

(B) The trend observed in (A) is pegged to an observed value of HCV antibody positive donations in 1991 of 0.049% (red line) – Table 4.6 column (c). The black line shows an estimated effect (67%) of the deferral policy in 1985, which caused prevalence to increase beforehand – Table 4.6 column (d).

(C) The black line in (B) is adjusted to account for the scenario that 25% of the observed 1991 HCV antibody prevalence is not from IDUs and is constant across the period (light blue line). The dark blue line shows the resulting percentage of HCV antibody positive donations from these two sources. – Table 4.6 column (e).

Summary conclusions

Year	(a) Estimated number of chronically HCV-infected ever-IDUs in England	(b) Estimated ratio of chronically HCV-infected ever-IDUS in England, relative to number in 1991 (set to 100)	(c) Estimated percentage of HCV-infectious donations (assuming ever-IDUs are sole source), pegged to estimated infectious HCV donations in 1991	(d) Estimated percentage of HCV-infectious donations assuming ever-IDUs are sole source, and assuming 'step-down' in 1985	(e) Estimated percentage of HCV-infectious donations, assuming a constant % from non-IDUs, fixed at 25% of observed 1991 rates
1970	21,000 (18,000 - 26,000)	20 (16 - 25)	0.010%	0.029%	0.034%
1971	23,000 (20,000 - 27,000)	22 (18 - 26)	0.011%	0.032%	0.036%
1972	26,000 (22,000 - 29,000)	24 (20 - 29)	0.012%	0.035%	0.039%
1973	28,000, (24,000 - 31,000)	26 (22 - 31)	0.013%	0.039%	0.041%
1974	31,000 (26,000 - 35,000)	29 (24 - 34)	0.014%	0.042%	0.044%
1975	33,000 (29,000 - 38,000)	32 (27 - 38)	0.015%	0.046%	0.047%
1976	37,000 (32,000 - 41,000)	35 (29 - 41)	0.017%	0.051%	0.050%
1977	40,000 (35,000 - 45,000)	38 (32 - 45)	0.018%	0.056%	0.054%
1978	45,000 (39,000 - 50,000)	42 (36 - 49)	0.020%	0.061%	0.058%
1979	49,000 (43,000 - 55,000)	46 (39 - 54)	0.022%	0.067%	0.062%
1980	52,000 (47,000 - 58,000)	49 (42 - 58)	0.024%	0.073%	0.067%
1981	56,000 (50,000 - 62,000)	53 (45 - 61)	0.026%	0.079%	0.072%
1982	60,000 (54,000 - 66,000)	56 (49 - 66)	0.028%	0.086%	0.077%
1983	64,000 (57,000 - 72,000)	60 (51 - 71)	0.031%	0.093%	0.082%

Year	(a) Estimated number of chronically HCV-infected ever-IDUs in England	(b) Estimated ratio of chronically HCV-infected ever-IDUS in England, relative to number in 1991 (set to 100)	(c) Estimated percentage of HCV-infectious donations (assuming ever-IDUs are sole source), pegged to estimated infectious HCV donations in 1991	(d) Estimated percentage of HCV-infectious donations assuming ever-IDUs are sole source, and assuming 'step-down' in 1985	(e) Estimated percentage of HCV-infectious donations, assuming a constant % from non-IDUs, fixed at 25% of observed 1991 rates
1984	69,000 (60,000 - 78,000)	65 (55 - 77)	0.033%	0.100%	0.088%
1985	74,000 (65,000 - 84,000)	70 (60 - 83)	0.036%	0.036%	0.039%
1986	80,00 (71,000 - 90,000)	76 (64 - 89)	0.038%	0.038%	0.041%
1987	87,000 (76,000 - 97,000)	829 (69 - 96)	0.040%	0.040%	0.043%
1988	93,000 (81,000 - 100,000)	88 (74 - 100)	0.043%	0.043%	0.044%
1989	100,000 (87,000 - 110,000)	94 (80 - 110)	0.045%	0.045%	0.046%
1990	100,000 (90,000 - 120,000)	97 (83 - 110)	0.047%	0.047%	0.047%
1991	110,000 (93,000 - 120,000)	100	0.049%	0.049%	0.049%

Table 4.6. Results from our baseline model for England, showing steps in obtaining estimates of the percentage of HCV-infectious donations each year.

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Task 2. For each year between 1970 and 1991, how many units of blood components were transfused?

Approach

4.69 **Terminology:** *Unit (from S&G).* The term 'blood component units' (shortened to 'units') is used here to denote any labile component of a whole blood donation, i.e. red cells, platelets, plasma or cryoprecipitate.

4.70 There does not appear to be a reliable source for the number of transfusions per year in the period 1970-1991. Counsel to the Inquiry have pointed out that in the 1984 specification of minimum requirements for documentation for blood transfusion, *"No attempt was made to prescribe the format of that documentation due to the wide variation in practice across the country."*[97]

4.71 We therefore follow S&G in working from the number of donations, and then estimating the resulting number of units transfused. We have therefore broken this task into a series of smaller questions.

- Task 2.1. How many blood donations were there annually in England between 1970 and 1991?
- Task 2.2. Per donation, on average how many units were actually transfused in hospitals?

Together, these provide the estimate of the number of units transfused per year.

Task 2.1. How many blood donations were there annually in England between 1970 and 1991?

4.72 **Available sources of evidence:** Our primary source is a letter (faxed) from the Department of Health to Roger Moore (National Blood Transfusion Service on 10/02/1992),[98] listing the number of blood and plasma donations each year in England and Wales between 1978 and 1990. These match (for appropriate years) the less precise numbers given in National Blood Transfusion Service Statistics of 1988.[99] For 1975 and 1976, our source is the Expenditure Review Report of the Blood Transfusion Service, 1978.[100] We have therefore been obliged to estimate the donations in other years through statistical modelling.[101]

4.73 **Confidence that available evidence can answer the question?** High.

4.74 **Analysis and conclusions:** We have modelled the counts of donations for 1970 – 1974, 1977 and the first 8 months of 1991 (since HCV antibody screening of donors was introduced in September 1991). The results are shown in Figure 4.8, with details of the model fit and extrapolation to other years in the Appendix (A.16 onwards), including estimates for other nations.

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97 Presentation by Counsel to the Inquiry about the guidance available to clinicians regarding the use of blood transfusions [INQY0000328, ep.14]

98 Fax containing table, "Number of Blood and Plasma Donations Each Year 1977-88, England and Wales", 10 February 1992 [NHBT0007121, ep.3]

99 Department of Health, "NBTS Statistics – England and Wales – 1988", January 1989 [DHSC0003974_036]

100 Department for Health and Social Service (DHSS), "Expenditure Review Report – Blood Transfusion Service", November 1979 [BPLL0007756]

101 NHS Management Consultancy Services, "The National Blood Transfusion Services in England and Wales: An Organisational Study", October 1987 [CBLA0002392]

The England and Wales totals are then scaled to England by the average population across 1971 – 1991 (94.3%). Results are shown in Table 4.8, column (b).

4.75 **Comments and limitations:**

- We have used limited and imperfect historic data, but they appear to be the only viable data of their kind.
- We are assuming that (a) the rate of donations in the population did not differ between England and Wales; (b) the donations in 1970-1974, 1977 followed the general trend of 1975-1976, 1978-1979; and (c) the donations in 1991 followed the general trend of 1978-1990.

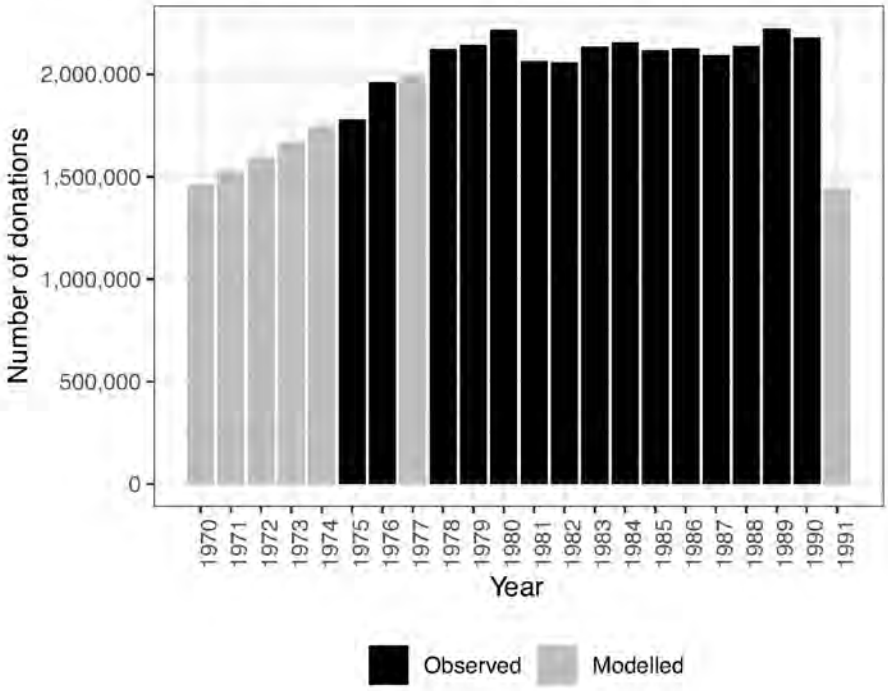

Figure 4.6 Number of blood donations in England and Wales, 1970 to 1991 (Jan-Aug).

Task 2.2. Per donation, on average how many units were transfused?

4.76 **Available sources of evidence:** Our primary source is the National Blood Transfusion Service Statistics of 1988.[102]

4.77 **Confidence that available evidence can answer the question?** Moderate.

4.78 **Analysis and conclusions:** The analysis is illustrated in Table 4.7 for a single year – 1982.

[102] Department of Health, "NBTS Statistics – England and Wales – 1988", January 1989 [DHSC0003974_036]

Quantity for 1982	Number ('000s)	Comments
(a) Number of donations	2,059	
(b) Units issued (whole blood + red blood cells (RBC))	1,785	
(c) Units returned unused	197	Assume returned units are not used.
(d) % returned (c/b)	11%	This decreased from 14% in 1978, to 7% in 1988.
(e) Cryoprecipitate	89	
(f) Donations from which plasma retained	98	This was first recorded in 1982
(g) Platelets	329	This was first recorded in 1982
(h) Total units available for use (b+e+f+g)	2,301	Adding whole blood+RBC, cryoprecipitate, plasma, platelets. Units sent for fractionation are not included.
(i) Available units per donation (h/a)	1.12	
(k) Usage per available unit (1 – d)	0.89	Assuming return rate for whole blood and RBC reflects general non-usage.
(m) Units used per donation (i x k)	1.00	

Table 4.7 Worked example for 1982, showing derivation of estimate of the number of units transfused per donation.

4.79 Full data on the quantities above were only available for 1982 to 1988, which was a time of rapid change in the transfusion service. We extrapolated back to 1970 and forwards to 1991, assuming the rate of change was 25% of that in the period 1982-1988. Summary results are shown in Table 4.8 and Figure 4.7.

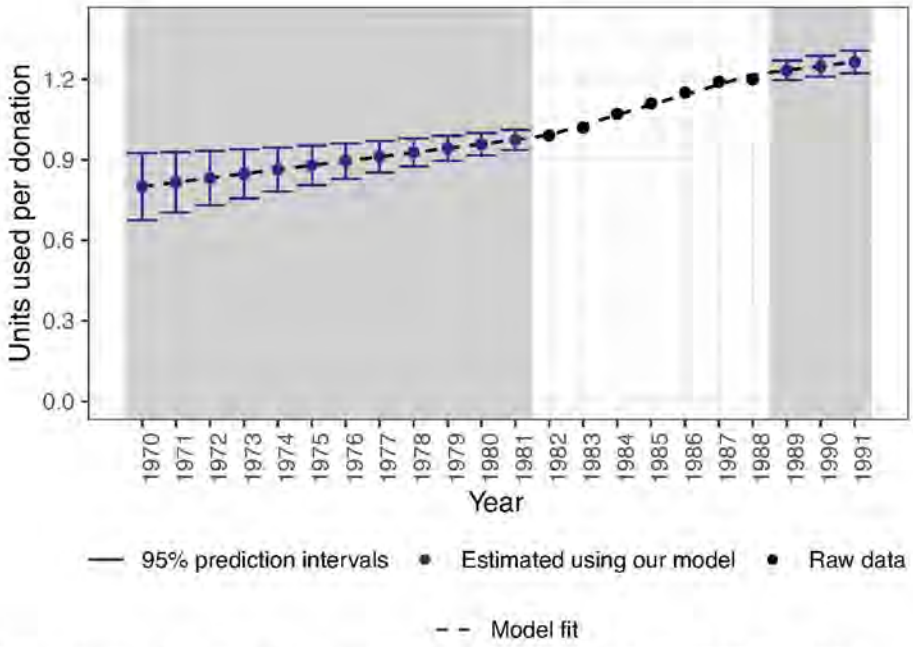

Figure 4.7 Extrapolation of units per donation from observed data in 1982 to 1988.

4.80 **Comments and limitations:**

- The primary limitation is the lack of data on transfusion practice over this period. The 2002 English National Blood Service look-back programme, a 2-year tracing exercise between 1995-1997, was unable to identify the fate of 23% of blood components issued for transfusion.[103]
- A major assumption is that return rates for whole blood and red blood cells (RBC) reflects overall non-usage. Informal discussion with those with contemporary experience suggests there will have been additional 'wastage' that varied between hospitals and declined over time, but that these rates may be lower for cryoprecipitate, platelets and 'plasma for local use'. Overall, our assumption may overstate the units used per donation, but not by a substantial amount.
- Soldan et al. [104] assumed 1.6 units were available per donation in England, and 65% of available units were transfused, leading to an overall estimate of 1.6 x 0.65 = 1.04 units transfused per donation, corresponding to our estimate for around 1983.
- S&G[105] assumed 1.25 units were available per donation for Scotland, based on *"limited local data and expert opinion"*, and 56% of units were transfused, giving an overall estimate of 1.25 x 0.56 = 0.70 as a constant rate of units transfused per donation. Penrose concluded the 56% usage could be too low, and at least 66% was more appropriate,[106] which would lead to 1.25 x 0.66 = 0.825, our estimate for the early 1970s.

[103] The English National Blood Service HCV lookback collation collaborators, "Transfusion transmission of HCV infection before anti-HCV testing of blood donations in England: results of the national HCV lookback program", *Transfusion*, vol. 42, 2002, pp. 1146-1153 [NHBT0097156_004, ep.4, Fig.1]. See also: Soldan, K., et al. "The Contribution of Transfusion to HCV Infection in England," *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp. 587–91 [PRSE0000620, ep.3, Fig.1]

[104] Soldan, K., et al., "The contribution of transfusion to HCV infection in England", *Epidemiology and Infection*, vol. 129, no. 3, 2002, pp. 587-591 (2002) [PRSE0000620, ep.3]

[105] The Penrose Inquiry, Final Report, Chapter 3: Statistics, 3.203, March 2005 [PRSE0007002, ep.89]

[106] Ibid., ep.98.

- Our changing rate should better reflect changing transfusion practices.

Final estimates are shown in Table 4.8. Column (d) is carried forward to the next stage of the model.

Year	(a) Recorded donations, England and Wales	(b) Estimated number of donations, England	(c) Estimated proportion of units transfused per donation	(d) Estimated number of units transfused in England
1970	1,460,000*	1,380,000	0.80***	1,100,000
1971	1,530,000*	1,440,000	0.82***	1,180,000
1972	1,600,000*	1,510,000	0.83***	1,250,000
1973	1,670,000*	1,580,000	0.85***	1,340,000
1974	1,750,000*	1,650,000	0.86***	1,420,000
1975	1,780,000	1,680,000	0.88***	1,480,000
1976	1,960,000	1,850,000	0.89***	1,660,000
1977	2,000,000*	1,880,000	0.91***	1,720,000
1978	2,120,000	2,000,000	0.93***	1,860,000
1979	2,140,000	2,020,000	0.94***	1,910,000
1980	2,220,000	2,090,000	0.96***	2,010,000
1981	2,070,000	1,950,000	0.97***	1,900,000
1982	2,060,000	1,940,000	0.99	1,930,000
1983	2,140,000	2,020,000	1.03	2,070,000
1984	2,160,000	2,040,000	1.07	2,170,000
1985	2,120,000	2,000,000	1.10	2,210,000
1986	2,130,000	2,010,000	1.14	2,290,000
1987	2,090,000	1,980,000	1.18	2,330,000
1988	2,140,000	2,020,000	1.22	2,460,000
1989	2,230,000	2,100,000	1.23***	2,590,000
1990	2,180,000	2,060,000	1.25***	2,570,000
1991	1,440,000**	1,360,000	1.26***	1,720,000

Table 4.8 Stages in estimating the number of units transfused in England, 1970-1991 – results reported to 3 significant figures.

**Estimated by interpolating from known data for 1975, 1976, 1978, 1979. (See Appendix for further details).*

*** Estimated by interpolating from data for 1978-1990: testing introduced in September 1991, and so this is ⅔ of the modelled value. (See Appendix for further details).*

**** Estimated by interpolating from known data for 1982 – 1988. (See Appendix for further details).*

For the years 1977-80, figures relate to the number of donors reporting at blood transfusion centres.

****

Task 3. For each year between 1970 and 1991 in England, how many transfusion-recipients (in age-sex bands) were infected with HCV?

4.81 The analysis in Task 1 has provided estimates for England, for each year between 1970 and 1991, of the proportion of donations that were HCV-infectious (RNA-positive). Task 2 has estimated the number of units transfused each year. Simply multiplying these numbers together estimates the number of infectious units transfused each year. We then follow S&G[107] in making two assumptions.

4.82 **Assumption (f)**. All units from HCV RNA-positive donors are assumed to be equally infectious when transfused to a recipient, and every recipient of a contaminated unit subsequently developed HCV infection.

4.83 **Assumption (g)**. There is a negligible chance of a transfusion recipient receiving two infected units. Table 4.5 shows that around 1 in 2,000 units were infectious: even if someone receives 10 units, the chance that more than one of these was infectious is only 1 in 90,000.

4.84 Assumptions (f) and (g) imply that every infected unit led to a unique infected recipient. Table 4.9 shows the calculations to give the annual number of individuals infected with HCV by transfusion in England for 1970 to 1991.

[107] Christian Schnier and David Goldberg, "Estimation of the Number of Individuals Infected and Alive in 2011 as a Consequence of Blood Transfusion in Scotland 1970-1991", 11 March 2012 [PRSE0001962]

Year	Estimated proportion of donations that were infectious with HCV in England (from Task 1)	Estimated number of units transfused in England (from Task 2)	Estimated number of individuals infected with HCV by transfusion in England (col 2 x col 3)
1970	0.034%	1,100,000	380 (270 - 620)
1971	0.036%	1,180,000	430 (310 - 700)
1972	0.039%	1,250,000	490 (350 - 790)
1973	0.041%	1,340,000	550 (400 - 900)
1974	0.044%	1,420,000	630 (450 - 1,000)
1975	0.047%	1,480,000	700 (500 - 1,200)
1976	0.050%	1,660,000	840 (600 - 1,400)
1977	0.054%	1,720,000	940 (660 - 1,600)
1978	0.058%	1,860,000	1,100 (770 - 1,800)
1979	0.062%	1,910,000	1,200 (850 - 2,100)
1980	0.067%	2,010,000	1,300 (950 - 2,300)
1981	0.072%	1,900,000	1,300 (940 - 2,300)
1982	0.077%	1,930,000	1,400 (1,000 - 2,500)
1983	0.082%	2,070,000	1,600 (1,200 - 2,900)
1984	0.088%	2,170,000	1,800 (1,300 - 3,200)
1985	0.039%	2,210,000	830 (700 - 980)
1986	0.041%	2,290,000	910 (770 - 1,100)
1987	0.043%	2,340,000	980 (830 - 1,200)
1988	0.044%	2,460,000	1,100 (910 - 1,300)
1989	0.046%	2,590,000	1,200 (1,000 - 1,400)
1990	0.047%	2,570,000	1,200 (1,000 - 1,400)
1991	0.049%	1,720,000	840 (730 - 950)
Total		**41,100,000**	**22,000** (17,000 - 32,000)
Total for 1970 to 1979		**17,000,000**	**7,300** (5,400 - 12,000)
Total for 1980 to August 1991		**23,600,000**	**15,000** (12,000 - 20,000)

Table 4.9 Estimation of the annual number of individuals infected with HCV by transfusion in England, 1970-1991 (totals are the rounded sums of the unrounded values).

Age-sex distribution of those infected by transfusions

4.85 Available sources: Wallis et al. (2004)[108] studied 2,899 transfusion recipients during June 1994 in a population of 2.9 million served by a single regional blood transfusion centre (Newcastle). The full data were kindly provided by the researcher-team for more detailed analysis. The age-sex distribution of recipients in the Wallis cohort is shown in Figure 4.8 and Table 4.10.

4.86 We were able to compare this to the age-sex distribution of transfusion recipients within the SNBTS record-linkage study in 1999 described later (4.102). Age groups 0 and 1 – 9 from SNBTS were pooled to be 0 – 9 and age groups 80 – 89 and 90+ from Wallis et al. were pooled to be 80+ in order to allow for direct comparison. This showed close agreement of the age-sex distribution between these two independent sources as shown in Figure 4.8, giving confidence to this application across different settings.

Appendix Tables 4.8 – 4.10 present the age-sex distribution of those estimated to be infected in Northern Ireland, Scotland and Wales, respectively.

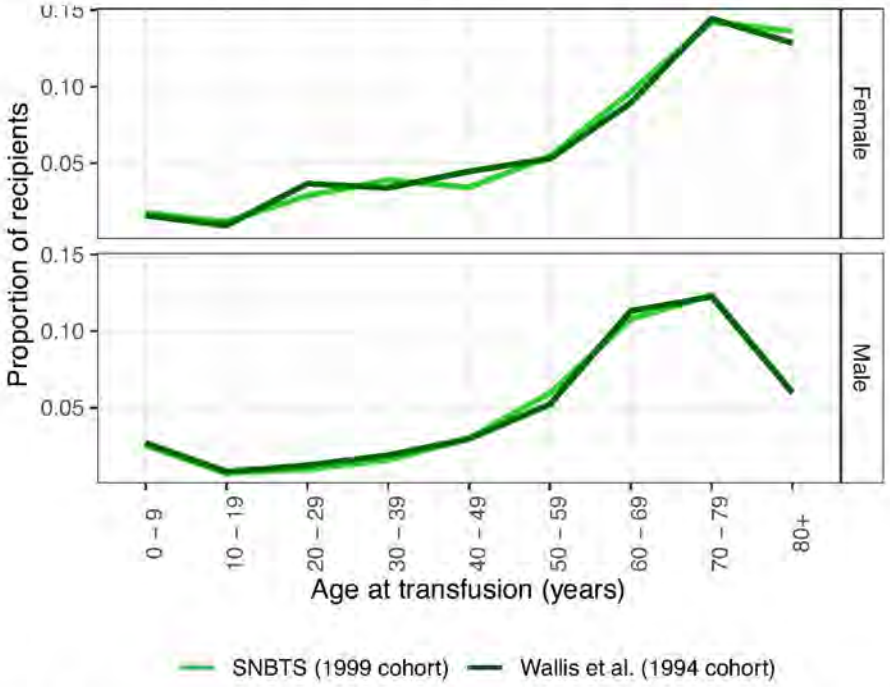

Figure 4.8 Age-sex distribution of two independent transfusion cohorts: Wallis et al. (2004) 1994 cohort from North West England, and Scottish National Blood Transfusion Service (SNBTS) 1999 cohort.

4.87 An alternative English source is the Epidemiology and Survival of Transfusion Recipients (EASTR) by Wells et al.,[109] who studied 68,600 recipients from 29 transfusion centres in the year starting October 2001. Wells et al. provide information by age-band on the survivorship of their transfusion recipients, although their sample is from October 2001 – September 2002, which is further from our period of interest than the June 1994 transfusions in Wallis et al.. Nevertheless, the age-sex distribution of RBC transfusions in EASTR, and the overall distribution in Wallis, are similar.

[108] Wallis, J. P., et al., "Long-term survival after blood transfusion: a population based study in the North of England", *Transfusion Practice*, vol. 44, 2004, pp. 1025-1032 [RLIT0000824, ep.1]

[109] Wells, A. W., et al., "The EASTR Study: indications for transfusion and estimates of transfusion recipient numbers in hospitals supplied by the National Blood Service", *Transfusion Medicine*, vol. 19, 2009, pp. 315-328 [WITN0643026]

4.88 Assuming the age-sex distribution of Wallis et al., Table 4.10 shows how we would expect the total number of HCV infections via transfusion to be distributed among age-sex bands.

Age at transfusion (in completed years)	Females Proportion	Females Estimated number HCV-infected 1970-1991	Males Proportion	Males Estimated number HCV-infected 1970-1991
0 – 9	0.016 (0.012 - 0.021)	350 (230 - 560)	0.027 (0.021 - 0.033)	590 (420 - 920)
10 – 19	0.0093 (0.0062 - 0.013)	200 (120 - 350)	0.0082 (0.0054 - 0.012)	180 (110 - 310)
20 – 29	0.037 (0.030 - 0.044)	810 (590 - 1,200)	0.012 (0.0087 - 0.017)	280 (170 - 450)
30 – 39	0.034 (0.028 - 0.041)	750 (540 - 1,200)	0.019 (0.014 - 0.024)	420 (280 - 680)
40 – 49	0.045 (0.037 - 0.052)	980 (730 - 1,500)	0.030 (0.024 - 0.036)	650 (470 - 1,000)
50 – 59	0.053 (0.045 - 0.061)	1,200 (870 - 1,800)	0.052 (0.044 - 0.061)	1,200 (860 - 1,700)
60 – 69	0.089 (0.079 - 0.10)	2,000 (1,500 - 2,900)	0.11 (0.10 - 0.13)	2,500 (1,900 - 3,700)
70 – 79	0.14 (0.13 - 0.16)	3,200 (2,500 - 4,700)	0.12 (0.11 - 0.13)	2,700 (2,100 - 4,000)
80 – 89	0.11 (0.097 - 0.12)	2,400 (1,800 - 3,600)	0.055 (0.047 - 0.064)	1,200 (910 - 1,800)
90+	0.020 (0.015 - 0.026)	440 (300 - 700)	0.0044 (0.0024 - 0.0073)	97 (47 —190)
Total	**0.56** (0.54 - 0.57)	**12,000** (9,700 - 18,000)	**0.44** (0.43 - 0.46)	**9,800** (7,700 - 14,000)

Table 4.10 Estimated age-sex distribution of those infected with HCV through transfusion in England, 1970-1991.

4.89 **Limitations:** Apart from the assumptions listed previously:

- The totals are not broken down by type of transfusion and so our counts do not reflect the risk to individuals: someone receiving many units will necessarily be at higher risk than a person who receives only one unit.
- We assume the age-sex breakdown of transfusion recipients holds for the whole period, whereas transfusion practice will have changed.

****

Task 4. How many chronic HCV-infected transfusion recipients survived 10 years post-transfusion?

4.90 Task 3 provided estimates of the number of individuals infected with HCV via transfusion in each year. We now extend the horizon to 10 years post-transfusion for those who were chronically infected. We obtain estimated 10-year survival rates for different age-sex bands from studies of transfused patients, and apply these survival-rates to the output of Task 3 to obtain estimated numbers of 10-year survivors.

4.91 We want to focus attention on those who have been chronically infected, i.e. have not cleared the virus, and so it is convenient to estimate first the nominal number of such cases *were they to survive 6 months post-transfusion* (some will actually die before this is determined, but this does not affect our longer-term modelling). We have already determined in Task 1.2 the evidence to support the following assumption: **Assumption (h)** A proportion (18%: 95% confidence interval 13% to 24%)[110] of transfusion recipients with HCV-infection is assumed to clear the virus within 6 months of acquisition.

4.92 **Assumption (i)** Chronic HCV infection does not influence recipients' survival for the first 10 years post-transfusion. Studies of HCV progression often only begin to trace recipients of implicated transfusions several years or more than a decade after the implicated transfusions occurred.[111] Traced recipients are therefore survivor-selected and, in general, can tell us little about the risk of HCV related death in the first decade of follow-up. More generally, meta-analyses[112,113] concentrate on earlier stages of HCV morbidity (rather than mortality) and specifically the development of cirrhosis. Progression rate to cirrhosis by 20 years after HCV infection is 7% (4% to 12%), which underscores that mortality from HCV-infection – although not impossible with adverse risk factors – is very unlikely in the first decade of chronic HCV infection.

4.93 **Confidence that available evidence can answer the question (given previous steps in model)?** Moderate/High.

4.94 **Available Sources of Evidence**. We have already used the demographical data of Wallis et al. (2004)[114] in Task 3, based on 2,899 transfused during June 1994. S&G also used the published 5-year survival data from Wallis et al. (2004). The full data were kindly provided by the research-team for more detailed analysis.

4.95 The follow-up for the Wallis data only goes up to 7 years. Longer follow-up is provided by Morley et al. (2016)[115] in the EASTR study previously discussed in Task 3, based on 68,600 recipients of transfusions in the year from October 2001. They provide 10-year survival rates broken down by RBC, fresh frozen plasma (FFP) and platelet transfusion,

[110] Micaleff, J. M., et al., "Spontaneous viral clearance following acute hepatitis C infection: a systematic review of longitudinal studies", *Journal of Viral Hepatitis*, vol, 13, 2006, pp. 34-41 [RLIT0001633]

[111] Harris, H. E., et al., "Survival of a national cohort of hepatitis C virus infected patients, 16 years after exposure", *Epidemiology and Infection*, vol. 134, 2006, pp. 472-477 [PRSE0002804, ep.1]

[112] Freeman, J., et al., "Estimation progression to cirrhosis in chronic hepatitis virus infection". *Hepatology*, vol. 34, no. 4, 2001, pp. 809-816 [DHSC0032223_124]

[113] Thein, H., et al., "Estimation of stage-specific fibrosis progression rates in chronic Hepatitis C virus infection: a meta-analysis and meta-regression", *Hepatology*, vol. 48, no. 2, 2008, pp. 418-431 [RLIT0001689]

[114] Wallis, J. P., et al., "Long-term survival after blood transfusion: a population based study in the North of England", *Transfusion Practice*, vol. 44, 2004, pp. 1025-1032 [RLIT0000824, ep.1]

[115] Morley, S. L., et al., "Transfusion in adults: 10-year survival of red cells, plasma and platelet recipients following transfusion", *Transfusion Medicine*, vol. 26, 2016, pp. 265-270 [WITN0643027]

and by broad age-groups. The EASTR study does not provide survival by the 10-year age-bands required for our analysis, and also their follow-up period of 2001-2011 is not as appropriate as Wallis's period of 1994-1999. Therefore, we preferred to use the 5-year survival rates from Wallis, and extend them to 10 years using the change in survival between 5 and 10 years in EASTR. The technique for doing this is outlined in the Appendix (A.29), together with comparisons of survival in the two cohorts.

Analysis and conclusions

4.96 The resulting estimates are shown in Table 4.11.

Ages (years)	5-year post-transfusion survival (%)		10-year post-transfusion survival (%)	
	Female	Male	Female	Male
0 – 9	73	83	69	81
10 – 19	84	61	82	56
20 – 29	97	82	97	79
30 – 39	80	73	77	69
40 – 49	61	61	54	54
50 – 59	52	47	45	39
60 – 69	49	46	38	35
70 – 79	43	28	32	18
80 – 89	24	14	10	4
90+	9	9	2	2

Table 4.11 Estimated percentage surviving 5 and 10 years post-transfusion.

4.97 **Limitations**:

- The survival proportions disregard both the reasons for transfusion and type of transfusion. Survival rates for specific groups of people may vary substantially around these averages.
- We are assuming the Wallis et al. (1994) survival rates for the North of England apply to the whole of England.

4.98 Table 4.12 summarises the results of this task, which are passed onto further stages of the model; results for the other nations are provided in Appendix Tables 4.16 - 4.18.

Year	(a) Estimated number of individuals infected by transfusion with chronic HCV, were they to survive for 6 months	(b) Estimated number of people with chronic HCV infection surviving 10 years post-transfusion
1970	310 (220 - 510)	120 (78 - 190)
1971	350 (250 - 580)	130 (88 - 220)
1972	400 (280 - 650)	150 (100 - 250)
1973	450 (320 - 740)	170 (110 - 280)
1974	520 (360 - 850)	190 (130 - 320)
1975	570 (400 - 960)	210 (140 - 350)
1976	690 (490 - 1,100)	260 (180 - 440)
1977	770 (540 - 1,300)	280 (200 - 490)
1978	900 (630 - 1,500)	330 (230 - 570)
1979	990 (690 - 1,700)	370 (250 - 630)
1980	1,100 (770 - 1,900)	410 (280 - 690)
1981	1,100 (770 -1,900)	410 (280 - 710)
1982	1,200 (820 - 2,100)	440 (300 - 770)
1983	1,400 (940 - 2,400)	500 (340 - 890)
1984	1,500 (1,000 - 2,600)	560 (380 - 980)
1985	680 (570 - 820)	250 (200 - 310)
1986	750 (620 - 900)	280 (220 - 340)
1987	800 (670 - 960)	300 (240 - 360)
1988	890 (740 - 1,100)	330 (260 - 400)
1989	990 (820 - 1,200)	360 (300 - 450)
1990	1,000 (830 - 1,200)	370 (300 - 450)
1991	680 (590 - 790)	250 (210 - 300)
Total	**18,000** (14,000 - 27,000)	**6,700** (5,200 - 9,900)

Table 4.12 Estimated annual number of individuals with chronic HCV infection by transfusion in England, 1970-1991, and surviving 10 years post-transfusion. Column (a) is obtained by applying the estimated clearance rate (around 18%) to the estimated number of infections in Table 4.9. Column (b) is obtained by applying the survival rates in Table 4.11 to the age-sex profile in Table 4.10.

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Task 5 How many chronic HCV 10-year-survivors would have survived to the end of 2019, assuming no excess risk from HCV?

4.99 **Background**: Task 4 estimated the number of survivors 10 years after being chronically infected with HCV at transfusion. We now extend this model to 2019, allowing for the additional risk of having had a transfusion in the past, but not yet allowing for any risk linked to chronic HCV infection. We note that S&G assumed no excess risk for being more than 5-years post-transfusion.

4.100 **Confidence (assuming previous modelling is appropriate):** Moderate/High.

4.101 **Available evidence:** For background mortality, contemporary life-tables for England[116] provide the average annual risk (the 'hazard') of dying in any year, given age at the start of the year. We then have to model the excess risk of having had a transfusion as a 'hazard ratio' that multiplies the annual background hazards, and will depend on years post-transfusion, age at transfusion and sex. A major Dutch study[117] followed up over 2 million transfusion recipients in the Netherlands between 1996-2006, but their survival data were not split by sex and used a small number of rather wide age categories. A Scandinavian study[118] of over 1 million transfusion recipients in Denmark and Sweden reported average hazard ratios of 1.4 for 10-15 years post-transfusion, and 1.3 for 15-20 years. Their graphs suggest considerable variation by age.

4.102 To assist the Infected Blood Inquiry, the SNBTS initiated a record-linkage study which follows up for mortality four 5-yearly cohorts of transfusion recipients, who joined their respective cohort at the date of their first transfusion in the cohort-year. The SNBTS database's coverage is not Scotland-wide but accounts for around 40% of Scotland's transfused patients. The cohort data are extracted from the SNBTS blood bank Laboratory Information Management System, eTraceline. The 1999 cohort, for example, represented three large teaching hospitals across Scotland and one large general hospital. The cohort-years are 1999 (1999-cohort); 2004 (2004-cohort); 2009 (2009-cohort); and 2014 (2014-cohort) to allow calendar-year trends in the deployment of units to, and survival outcome for, recipients of RBC transfusions to be monitored up to 20 years post-transfusion.

Follow-up for mortality was to 31 December 2019. The vast majority of first transfusion recipients in any cohort-year has received RBC and so we focus on 1999-RBC-cohort, for whom we have 20 years of follow-up post-transfusion; and on the 2004-RBC-cohort, for whom we know survival status for 15 years post-transfusion.

4.103 **Assumption (j):** Lacking evidence beyond 20 years post-transfusion, but mindful that hazard ratios decreased markedly during the second 10 years of follow-up, we assume that there is no residual transfusion-related hazard for those who survived for 20 years post-transfusion.

4.104 **Analysis and conclusions:** Using the appropriate Scottish life-table for each year between 10 years post-transfusion and 2019 (e.g. 1999 – 2001 for the year 2000), annual hazards were extracted per sex and age-band at transfusion (using, for example,

[116] The Office for National Statistics, National Life Tables, England 1980-1982 to 2018-2020 [OFNS0000004]

[117] Borkent-Raven, B. A., et al., "Survival after transfusion in the Netherlands", *Vox Sanguinis*, vol. 100, 2010, pp. 196-203 [RLIT0001688]

[118] Kamper-Jorgensen, M., et al., "Survival after blood transfusion", *Transfusion Practice*, vol. 48, 2008, pp. 2577-2584 [PRSE0003621, ep.5]

age 25 for those aged 20-29 years at transfusion), and updated to reflect the cohort's age in the year in question. These determined the expected number of deaths in the SNBTS cohorts. The additional risks from 10 years post-transfusion were determined via the ratio of observed to expected deaths from the SNBTS's record-linkage study (see Appendix A.38 onwards) – this was done with and without stratification by age-band. For example, for those aged 50-59 at transfusion, we estimate a hazard ratio of 2.0 for 11-15 years post-transfusion, and 1.5 for 15-20 years.

4.105 The likelihood of surviving 10 years post-transfusion has already been covered in Task 4. Transfusion-adjusted hazard rates were obtained by multiplying the relevant hazards from the nation-specific life-tables for 11-15 years and 16-20 years post-transfusion by the observed/expected ratios calculated previously. The product of one minus the hazards across each year per age-band and sex was used to estimate the probability of survival to 2019, with and without the additional transfusion risk (Figure 4.9 and Appendix Tables 4.20 and 4.27).

4.106 These transfusion-adjusted hazard rates were applied to the output from Task 4 to give the estimated number of survivors to the end of 2019, both without and with allowance for the excess mortality of being post-transfusion. This gives rise to columns (b) and (c) of Table 4.13.

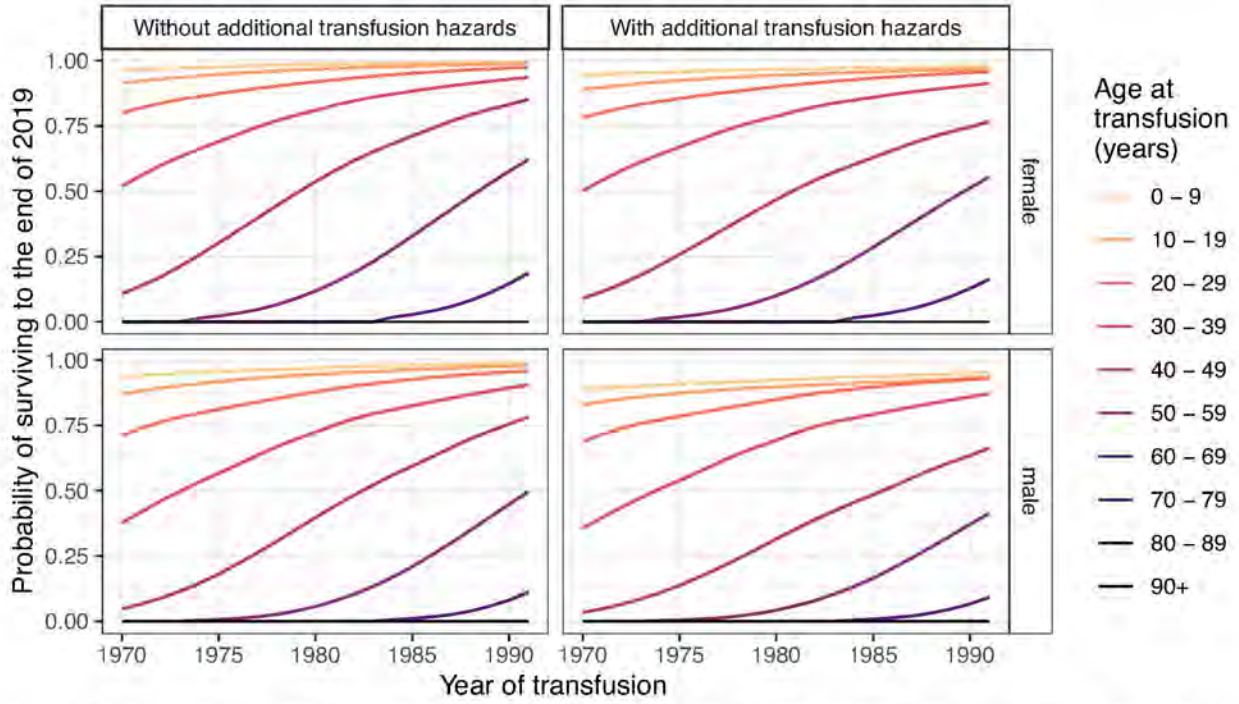

Figure 4.9 Estimated probability of surviving until 31 December 2019 post-transfusion in England, given age and transfusion year and assuming excess age-stratified post-transfusion hazard.

4.107 **Sensitivity analysis:** Our baseline scenario pools the broadly similar age-specific post-transfusion hazard ratios for males and females. We explore two other options in the sensitivity analysis below: no additional transfusion hazard (Scenario G), and not allowing hazard ratios to be age-dependent, merely different ratios for 11-15 years (across all ages) post-transfusion versus for 16-20 years (Scenario H).

Task 6 Of those infected with chronic HCV through transfusion between 1970 and August 1991, how many died of HCV-related causes by 2019?

4.108 **The task:** Task 4 estimated the number of those infected with chronic-HCV who survived 10-years after being infected at transfusion, while Task 5 modelled subsequent survival to the end of 2019, assuming additional risk for being post-transfusion but no effect of HCV infection. We now consider the additional risk for being chronically HCV-infected via transfusion; adding the deaths attributable to HCV in each year provides estimates of the deaths related to (treated) chronic HCV-infection.

4.109 **Available evidence**. Authors of the study[119] used in Task 1.3 to estimate the number of HCV-infected IDUs also examined the long-term effect on mortality of HCV infection post-transfusion. They used a case-control design, whose participants were traced look-back patients in England who had received an HCV-implicated blood transfusion. We were kindly granted access to the results ahead of publication. This UKHSA team compared all-cause and liver-related mortality of 924 patients infected with HCV via transfusion as the route of infection against 443 patients who had received an HCV-implicated transfusion but were not HCV antibody positive. The team found an overall hazard ratio of 1.53 (95% CI 1.17 – 2.00) for all-cause mortality among HCV-RNA positive patients compared to transfused controls who were not HCV-infected. The estimated hazard ratio of 1.53 was constant across three decades of traced follow-up since the HCV-implicated transfusion, and represents *treated* natural history since directly acting antiviral therapy will have had a beneficial impact.

4.110 **Assumption (k)** Chronic HCV infection increases the annual risk of dying from 10 years post-infection: our baseline assumption is a 53% increased risk.

4.111 **Analysis and conclusions:** We applied the additional hazard ratio estimated as described above to the hazards assuming additional transfusion risk for chronically HCV-infected patients surviving at least 10 years post-transfusion. This was applied uniformly to each age-group and sex every year from 10 years post-transfusion. The resulting probabilities of survival are shown in Appendix Tables 4.38 to 4.45, and the estimated number of survivors to 2019 shown in column (d) of Table 4.13: estimates for other nations are provided in Appendix Tables 4.46 to 4.54.

[119] Harris, R. J., et al., "Monitoring the hepatitis C epidemic in England and evaluating intervention scale-up using routinely collected data", *Journal of Viral Hepatitis*, vol 26, 2019, pp. 541-551 [WITN7088003]

Year of transfusion	Year 10-years post-transfusion	(a) Estimated number chronically infected surviving 10 years post-transfusion (from Task 4)	(b) Estimated number chronically infected surviving to 2019, assuming no post-transfusion excess risk	(c) Estimated number surviving to 2019, assuming post-transfusion excess risk	(d) Estimated number surviving to 2019, assuming both post-transfusion and chronic HCV-infection excess risk
1970	1980	120 (75 - 190)	30 (20 - 55)	30 (20 - 50)	25 (15 - 45)
1971	1981	130 (90 - 220)	35 (25 - 65)	35 (20 - 60)	30 (15 - 50)
1972	1982	150 (100 - 250)	45 (25 - 75)	40 (25 - 70)	35 (20 - 60)
1973	1983	170 (110 - 280)	50 (30 - 85)	50 (30 - 80)	40 (25 - 70)
1974	1984	190 (130 - 320)	60 (40 - 100)	55 (35 – 95)	50 (30 - 85)
1975	1985	210 (140 - 360)	70 (45 - 120)	65 (40 - 110)	55 (35 - 95)
1976	1986	260 (180 - 440)	85 (55 - 150)	80 (55 - 140)	70 (45 - 120)
1977	1987	280 (200 - 490)	95 (65 - 170)	95 (60 - 160)	80 (50 - 140)
1978	1988	330 (230 - 570)	120 (75 - 200)	110 (75 - 190)	95 (60 - 170)
1979	1989	370 (250 - 630)	130 (90 - 230)	130 (85 - 220)	110 (70 - 190)
1980	1990	410 (280 - 710)	150 (100 - 260)	140 (100 - 250)	130 (80 - 220)
1981	1991	410 (280 - 710)	160 (110 - 280)	150 (100- 260)	130 (85 - 230)
1982	1992	440 (300 - 770)	180 (120 - 310)	170 (110 - 290)	140 (95 - 260)
1983	1993	500 (340 - 890)	200 (140 - 360)	190 (130 - 340)	170 (110 - 300)
1984	1994	560 (380 - 980)	240 (160 - 420)	220 (150 - 400)	200 (130 - 350)
1985	1995	250 (200 - 310)	110 (85 - 140)	100 (80 - 130)	90 (70 - 120)
1986	1996	280 (220 - 340)	120 (95 - 160)	120 (90 - 150)	100 (80 - 130)
1987	1997	300 (240 - 360)	140 (110 - 170)	130 (100 - 160)	110 (85 - 140)
1988	1998	330 (260 - 400)	160 (120 - 200)	150 (120 - 190)	130 (100 - 170)
1989	1999	360 (300 - 450)	180 (140 - 230)	170 (130 - 210)	150 (110 - 190)
1990	2000	370 (300 - 450)	190 (150 - 230)	180 (140 - 220)	160 (120 - 200)
1991	2001	250 (210 - 300)	130 (110 - 160)	120 (100 - 150)	110 (85 - 140)
Total		**6,700** (5,200 - 9,900)	**2,700** (2,100 - 3,900)	**2,500** (2,000 - 3,700)	**2,200** (1,700 - 3,200)
1970-1979		**2,200** (1,600 - 3,700)	**720** (520 - 1,200)	**690** (490 - 1,100)	**590** (410 – 990)
1980- August 1991		**4,500** (3,600 - 6,300)	**2,000** (1,600 - 2,700)	**1,900** (1,500 - 2,500)	**1,600** (1,300 - 2,300)

Table 4.13 Estimated annual number of individuals infected with chronic HCV by transfusion in England, 1970-1991, and surviving to 2019, both without and with allowing for any effect of chronic HCV infection. Numbers over 100 are rounded to 2 significant figures, whilst those under 100 are rounded to the nearest 5. Note: it is incorrect to estimate the number of HCV-related deaths by subtracting column (d) from (c).

4.112 The 'attributable fraction'[120] among those exposed to a risk is simply 1 - 1/HR, where HR is the hazard ratio, i.e. the relative risk in each year. For HR = 1.53, we would therefore assume the fraction of deaths attributable to chronic HCV infection 1 – 1/1.53 = 35%.

4.113 Table 4.14 presents the estimated number of survivors by age-sex band, pooled over years, and the estimated number of HCV-related deaths.

	Females	Females	Females	Males	Males	Males
Age-band at trans-fusion (years)	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths
0 – 9	290 (190 - 470)	190 (120 - 310)	0 (0 - 10)	490 (340 - 760)	350 (240 - 550)	15 (0 - 35)
10 – 19	170 (100 - 290)	120 (75 - 220)	0 (0 - 10)	150 (85 - 260)	70 (35 – 130)	0 (0 - 10)
20 – 29	660 (480 - 1,000)	550 (400 - 840)	30 (10 - 70)	220 (140 - 370)	140 (85 - 240)	10 (0 - 30)
30 – 39	610 (440 - 950)	330 (230 - 520)	45 (15 - 100)	340 (230 - 540)	140 (90 - 230)	35 (10 - 70)
40 – 49	810 (590 - 1,200)	160 (100 - 260)	95 (35 - 190)	540 (380 - 840)	70 (40 - 120)	75 (30 - 150)
50 – 59	960 (710 - 1,400)	45 (25 - 80)	130 (50 - 250)	940 (700 - 1,400)	20 (10 - 40)	120 (45 - 220)
60 – 69	1,600 (1,200 - 2,400)	5 (0 - 10)	210 (85 - 380)	2,000 (1,600 - 3,000)	1 (0 - 5)	250 (100 - 440)
70 – 79	2,600 (2,000 - 3,900)	0 (0 - 0)	290 (120 - 510)	2,200 (1,700 - 3,300)	0 (0 - 0)	140 (55 - 250)
80 – 89	2,000 (1,500 - 2,900)	0 (0 - 0)	65 (25 - 130)	1,000 (730 - 1,500)	0 (0 – 0)	10 (1 - 35)
90+	360 (240 - 570)	0 (0 - 0)	0 (0 - 10)	80 (40 - 150)	0 (0 - 0)	0 (0 - 0)
Total	**10,000** (7,800 -15,000)	**1,400** (1,100 - 2,100	**880** (350 - 1,600)	**8,000** (6,300 - 12,000)	**800** (590 - 1,200)	**660** (250 - 1,200)

Table 4.14 Estimated number of chronic HCV infections, survivors until 2019, and number of HCV-related deaths in England – by age-sex band, pooled over years of transfusion 1970-1991. Survival estimates take into account additional risk from both transfusion and HCV. Numbers over 100 are rounded to 2 significant figures, whilst those under 100 are rounded to the nearest 5.

[120] Wikipedia page, "Attributable fraction among the exposed", accessed 22 August 2022 [RLIT0001686, ep.1]. Available online: https://en.wikipedia.org/wiki/Attributable_fraction_among_the_exposed

4.114 **Comment:** Table 4.14 shows that females (10,000) outnumbered males (8,000) who were chronically HCV-infected by transfusion during 1970-1991 to a modest extent, whereas females (1,400) greatly outnumber male survivors (800) to the end of 2019 – female proportion is 64% (95% uncertainty interval: 59% to 68%) This reflects both the better female post-transfusion survival (Task 4), and the lower female mortality risk in general.

4.115 Also, whereas 70-79 years was the most common age-band at transfusion for both female and male recipients who were chronically HCV-infected, HCV-infected survivors to the end of 2019 would require to have survived at least 28 years post-transfusion, and so are dominated by those under 50 years of age at transfusion (1,350/1,400 female survivors). Of an estimated 1,400 female HCV-infected survivors to the end of 2019, 880 (over half) were aged 20-39 years at transfusion; with a further 190 aged 0-9 years at transfusion. Of the estimated 800 male HCV-infected survivors to the end of 2019, 280 were aged 20-39 years at transfusion; with a further 350 aged 0-9 years at transfusion.

Age in December 2019	Females Estimated number alive in 2019	Males Estimated number alive in 2019
30 – 39	60 (40 - 90)	120 (80 - 160)
40 – 49	150 (95 - 240)	220 (140 - 380)
50 – 59	280 (220 - 380)	130 (85 - 200)
60 – 69	450 (320 - 700)	140 (100 - 220)
70 – 79	320 (220 - 500)	130 (85 - 210)
80 – 89	140 (85 - 230)	55 (30 - 100)
90+	15 (5 - 40)	5 (0 - 15)
Total	**1,400** (1,100 - 2,100)	**800** (590 - 1,200)

Table 4.15 Estimated age distribution (in years) of people with chronic HCV infection from transfusion between 1970 and 1991 in England, who are alive in December 2019. Numbers over 100 are rounded to 2 significant figures, whilst those under 100 are rounded to the nearest 5.

4.116 Table 4.15 represents the same 1,400 female and 800 male HCV-infected survivors by their estimated age-band in completed years at 31 December 2019. Male survivors outnumber females under 50 years (340 males versus 210 females). At older ages, however, males are substantially outnumbered by female HCV-infected survivors: for example, at ages 50-69 years (270 males versus 730 females) and at 70+ years (190 males versus 480 females).

4.117 We should expect the female dominance displayed in Table 4.15 to be reflected in surviving claimants who were chronically HCV infected by transfusion and whose age in 2019 was 50+ years. The expected female dominance contrasts sharply with male dominance for people with bleeding disorders who were chronically HCV-infected. See further analysis in Chapter 5.

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Further sensitivity analyses

4.118 A larger selection of sensitivity analyses is provided in Table 4.16, with the first five rows identical to those in Table 4.1. The rows comprise:

- Results from a deterministic baseline model assuming all parameters are fixed at their assumed values.
- A stochastic baseline model, in which parameters and outputs have associated uncertainty.
- Scenario A: A deterministic sensitivity analysis to Assumptions (a) (c) and (d), in which we assume the first component in HCV-infectious donations comprise past-IDUs rather than ever-IDUs, the deferral effect occurred in 1987, and led to only a 33% reduction in infectious donations.
- Scenario B: A deterministic sensitivity analysis to Assumption (e), in which we assume that there is no second component of non-IDU infectious donors. This is analogous to the analysis of S&G.
- Scenario C: A deterministic sensitivity analysis to Assumption (e), in which we assume that there is a constant proportion of infectious donations 1970-1991, i.e. no 'IDU' component in the model. This is analogous to the analysis for the England look-back study by Soldan et al. (2002).[121]
- Scenario D: A deterministic sensitivity analysis to Assumption (c), in which we assume that the deferral effect occurred in 1986 rather than 1985.
- Scenario E: A deterministic sensitivity analysis to Assumption (d), in which we assume that the deferral effect led to a reduction of 33% in infectious donations – the lower effect supported by some of the expert respondents.
- Scenario F: A deterministic sensitivity analysis to Assumption (e), in which we assume that the constant level of infectious non-IDU donations is 50% rather than the 25% baseline assumption.
- Scenario G: A deterministic sensitivity analysis to Assumption (j), in which we assume there is no additional risk to the annual hazard of dying from having a transfusion.
- Scenario H: A deterministic sensitivity analysis to Assumption (j), in which we assume a constant rather than age-stratified risk to the annual hazard of dying from having a transfusion.
- Scenario I: A deterministic sensitivity analysis to Assumption (k), in which we assume that there is no increase in the annual risk of dying from HCV.

[121] Soldan, K., et al. "The Contribution of Transfusion to HCV Infection in England." *Epidemiology and Infection*, vol.129, no.3, 2002, pp.587-91 [PRSE0000620]

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post transfusion	Chronically infected, survived to end of 2019 (assuming extra HCV risk)	Chronically infected, died by end of 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Estimates from deterministic model baseline scenario	22,100	18,100	6,700	2,220	15,900	1,550
Median estimates from stochastic baseline model, together with upper and lower 95% uncertainty limits	32,300 **22,000** 17,500	26,600 **18,000** 14,100	9,880 **6,670** 5,200	3,240 **2,200** 1,690	23,500 **15,800** 12,400	2,750 **1,540** 610
Scenario A: past-IDUs with deferral effect year 1987 & 33% reduction	15,700	12,800	4,740	1,640	11,200	1,080
Scenario B: 0% contribution to prevalence from non-IDUs	22,800	18,700	6,900	2,300	16,400	1,590
Scenario C: 100% contribution to prevalence from non-IDUs (constant proportion of infectious donations)	20,100	16,500	6,190	2,020	14,500	1,410
Scenario D: ever-IDUs deferral policy in 1986	23,300	19,100	7,060	2,360	16,700	1,630
Scenario E: ever-IDUs, deferral reduction of 33% with effect in 1985	16,000	13,200	4,860	1,670	11,500	1,110

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post transfusion	Chronically infected, survived to end of 2019 (assuming extra HCV risk)	Chronically infected, died by end of 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Scenario F: 50% contribution to prevalence from non-IDUs	21,400	17,600	6,500	2,160	15,400	1,500
Scenario G: No additional transfusion hazards	22,100	18,100	6,700	2,400	15,700	1,490
Scenario H: Constant transfusion hazard for 11 - 15 and 16 - 20 years post-transfusion	22,100	18,100	6,700	2,350	15,800	1,510
Scenario I: No additional chronic HCV hazard	22,100	18,100	6,700	2,550	15,600	0

Table 4.16 Estimates from baseline deterministic model, baseline stochastic model with 95% confidence intervals and deterministic sensitivity analyses for England: results for other nations are shown in Appendix Tables 4.55 to 4.57.

4.119 **Interpretation:** In addition to the discussion of Scenarios A – C given after Table 4.1, there are some noteworthy differences between our deterministic scenarios, although most are minor compared to the uncertainty about the baseline estimates.

- Scenario E demonstrates that the major driver is the assumption of the step-down in infectious donations following the guidance in the mid-1980s: if we assume only a 33% step-down, the number of infections (and subsequent outcomes) reduces by around 28%.
- The final scenarios explore the impact of different assumptions about survivorship in the second and later decade of post-transfusion follow-up.
- Scenario G reverts to our baseline ever-IDU scenario but assumes that there is no additional transfusion hazard beyond 10-years: an estimated reduction of only 200 deaths. The second option (H) is a constant transfusion-related hazard (pooled across all age-groups), separately for 11-15 years (1.3) and lower for 16-20 years (1.1): a more modest estimated reduction of only 100 deaths.

Chapter 5 Information from funds

Summary findings

- The funds will not be a complete record of those infected, but provide a useful 'calibration' of results derived from alternative sources.

5.1 Since 1988, a variety of funds have provided financial support to those infected or affected by blood-borne infections: for HIV infections, the Macfarlane Trust and Eileen Trust, with MFET Ltd set up to administer lump sum payments; the Skipton Fund and the Caxton Foundation for those with chronic HCV infections transmitted prior to September 1991. After 2017, these funds were replaced by individual schemes for the four UK nations.

5.2 Reported data on successful applicants are summarised in Table 5.1.[122]

Macfarlane Trust (1988)	HIV infections in people with haemophilia (includes women with von Willebrand disease)	2003: 1,242 registrations, of whom 397 were living and 845 deceased; also 67 secondarily infected, of whom 27 deceased[123] 2007: 1,243 registrations, of whom 361 were living, therefore 882 deceased.[124] 2013: 353 were known to be alive and registered with MFET Ltd, therefore 890 deceased.
Eileen Trust (1993)	HIV infections in 'non-haemophiliacs'	1991: Briefing paper prior to the Fund reported 74 cases of HIV after transfusion in the UK, plus 17 cases where country of transfusion was unknown[125] 1995: 57 infected claimants approved for payment (of whom, 31 deceased). Also shows 5 secondarily infected (of whom, 1 deceased)[126] 2002: 43 infected claimants registered (of whom, 33 deceased). Also shows 12 secondarily infected (of whom 4 deceased)[127]
MFET Ltd (2010)		One new beneficiary reported
Skipton Fund (2004)	HCV infections (deceased persons only after 2011)	2015:[128] 5,322 approved applications (England 4,165, Scotland 731, Wales 283, NI 143): • 2,690 with bleeding disorder (51%), • 2,632 without (49%). 1508 known deceased (England 1,172, Scotland 198, Wales 95, NI 43): • 889 with bleeding disorder (33% mortality rate, 889/2,690), • 619 without (24% mortality rate, 619/2632). 2017:[129] 5,529 approved applications

Table 5.1 Summary of historical funds for those infected through blood or blood products.

5.3 **Comments:**

- Registrations to the Eileen Trust are likely to represent nothing more than a lower bound on the number of HIV infections acquired as a result of transfusions within the UK. In 1997, a letter from the Trust explained that under-registration may have occurred because: "*some have chosen not to be introduced to the Trust and in some posthumous cases there was no dependant relative who would*

[122] The Caxton Foundation was established in 2011 to provide discretionary payments to those who received a Stage 1 Payment from the Skipton Fund, and so does not provide additional data [INQY1000099, ep.32]
[123] The Macfarlane Trust, 'Statistics Summary at 31 October 2003' [MACF0000009_198, ep.4]
[124] 'Macfarlane News, Spring 2007' [MACF0000004_046, ep.1]
[125] Department of Health, 'HIV infected blood transfusion recipients – Q&A' with numbers of reported cases at 31 December 1991 [DHSC0002605, ep.5]
[126] The Eileen Trust, 'Scheme of payments for those infected with HIV through blood or tissue transfer,' 15 October 1995 [EILN0000006_164, ep.1]
[127] The Eileen Trust, 'Registration Statistics at 30 September 2002' [EILN0000009_001]
[128] The Skipton Fund, 'Stage 1 & Stage 2 application statistics to 31 December 2015' [SKIP0000030_070, ep.1]
[129] Infected Blood Inquiry, Presentation on the Skipton Fund (2003-2017), dated 22 March 2021 [INQY0000245, ep.15]

be eligible [to apply]."[130] In addition, registration to the Eileen Trust required at minimum clinical proof of HIV infection, *inter alia*.[131] Given that the majority of transfusion-transmitted HIV infections occurred between 1979 and October 1985[132] establishing clinical proof of infection would inevitably have been difficult in some cases. Dr Patricia Hewitt has explained that clinical proof: *"required... the Blood Service to say: yes, we know about this case, we have investigated it and it is a case of transfusion-transmitted infection [...] It all seemed to me to be quite haphazard"*.[133] It is possible a proportion of cases where place of transfusion was unknown or where Eileen Trust applications were rejected constitute further cases of HIV infection via transfusion in the UK.

- For the Skipton Fund, we do not have the breakdown with/without bleeding disorder for the cumulative 5,529 registrations when the fund closed in 2017. However, based on the data from 2015, we might assume roughly 50% in each group, i.e., around 2,765 each, with more than 33% deceased of those with bleeding disorders, and more than 24% in those without. There could be a deficit of applications related to those who died earlier.

5.4 Recent summary data for the current schemes in the four nations are shown in Table 5.2 (primary infections) and Table 5.3 (secondary infections), based on the 'Rule 9' submissions made to the Inquiry (up to July 2022).

[130] Letter from the Macfarlane Trust to the Charity Commission, 8 January 1997 [DHSC0003197_015, ep.2]
[131] Scheme of payments for those infected with HIV through blood or tissue transfer, 24 April 1992 [EILN0000016_001, ep.11 & 8]
[132] Draft submission from Roger Scofield regarding HIV infected blood transfusion and tissue recipients, February 1992 [DHSC0002584_003, ep.2]
[133] Transcript of IBI oral hearing, Witness Dr Patricia Hewitt (continued), held on 10 December 2021 [INQY1000171, ep.20]

Scheme	Number registered (of whom deceased since 2017) HCV alone	Co-infected with HIV & HCV	HIV alone	Notes
EIBSS[134]	2,564 (268)	234 (9)	64 (2)	No data held on whether by transfusion or blood products.
SIBSS[135]	561 (96)	30 (2)	5 (0)	387 transfusion, 174 blood products. HIV alone: 3 transfusion, 2 blood products.
NIIBPS[136]	82 (8)	3 (1)	2 (0)	Incomplete data on whether by transfusion or blood products, or whether primary or secondary infections.
WIBSS[137]	154 (13)	16 (0)	2 (1)	No data on whether by transfusion or blood products, or whether primary or secondary infections.
Total	**3,361 (385)**	**283 (12)**	**73 (3)**	

*Table 5.2. Summary of current UK funds for **primary** infections through blood or blood products, except WIBSS and NIIBPS, which are combined primary and secondary. The figures for the deceased are included in the totals for each scheme.*

[134] 9th and 10th written statements of Brendan Brown, England Infected Blood Support Scheme [WITN4496026 and WITN4496028]. The number of primary infections were calculated by subtracting the number of secondary infections (10th statement) from the total number infected (9th statement)

[135] Response by the Scottish Infected Blood Support Scheme (SIBSS) to request by the Infected Blood Inquiry [SIBS0000132]

[136] Written statement of Karen Bailey on behalf of the Northern Ireland Infected Blood Payment Scheme, dated 1 September 2022 [WITN4936028]

[137] Email from Alison Ramsey, Wales Infected Blood Support Scheme, to the Infected Blood Inquiry, dated 28 July 2022 [WIBS0000082]

Scheme	Number registered (of whom deceased since 2017) HCV alone	Co-infected with HIV & HCV	HIV alone	Notes
EIBSS[138]	22 (4)	3 (0)	2 (0)	No data held on whether by transfusion or blood products
SIBSS[139]	17 (4)	0 (0)	2 (1)	
Total	**39 (8)**	**0 (0)**	**3 (1)**	

*Table 5.3 Summary of current UK funds for **secondary** infections through blood or blood products (excluding WIBSS for which these data are not available and NIIBPS which has records of 2 secondary infections). The figures for the deceased are included in the totals for each scheme.*

5.5 **Comments:**

- There was a substantial fall in registrations in the transition between the original funds and the national schemes.
- For consistency, the EIBSS figures do not include numbers of secondary infectees pre-01/11/2017. EIBSS report that before 2017 there were substantial numbers of secondary infectees: 39 with HCV infection (of whom, 2 deceased) and 41 with HIV infection (of whom, 6 deceased).[140]
- There are 2,586 HCV-alone registrations in England. Given the relative populations of the four nations in 1991, then we would expect 276 in Scotland, 86 in Northern Ireland, and 155 in Wales. Northern Ireland and Wales match closely to that expected from the English data, but Scotland is substantially higher, possibly reflecting the greater proportion of HCV infections through transfusion than the roughly 50:50 recorded in the Skipton Fund.

Comparison with results from Chapter 4

5.6 Our baseline deterministic scenario for England in Chapter 4 provides age-sex bands for survivors from chronic HCV infection by transfusion. We represent here our estimates for survivors at 31 December 2019; and also for survivors at 31 December 2014. In both cases female survivors outnumber males by 1.77 to 1 (1,425/804; 1,614/910); and are older than their male counterparts.

[138] 10th written statement of Brendan Brown, England Infected Blood Support Scheme [WITN4496028, ep.3-4]
[139] Spreadsheet, 'Audit list of all Approved Beneficiaries 2022-07-26' by the Scottish Infected Blood Support Scheme (SIBSS) [WITN4728046]
[140] 10th written statement of Brendan Brown [WITN4496028, ep.3-4]

Age-band in completed years at 31 December 2014	Male survivors	Female survivors	Age-band in completed years at 31 December 2019	Male survivors	Female survivors
20-29	34	18	20-29	NA	NA
30-39	217	124	30-39	117	61
40-49	172	195	40-49	223	149
50-59	133	425	50-59	128	283
60-69	167	437	60-69	144	452
70-79	127	274	70-79	131	321
80+ years	60	141	80+ years	61	158
Total	**910**	**1,614**	**Total**	**804**	**1,425**

Table 5.4 Estimates from our baseline deterministic scenario for England for the number, sex and age-distribution of survivors from chronic HCV infection by transfusion to 31 December 2014 (910 males; 1,614 females) and to 31 December 2019 (804 males; 1,425 females).

5.7 For comparison with the above age-sex distributions, we requested information about Skipton/EIBSS surviving chronically HCV infected claimants without HIV co-infection at 31 December 2014 from an analytical team at the Department of Health and Social Care who have familiarity with those data. We are grateful that this team was able to respond so promptly. First, we document the information provided on survival status at 31 December 2014 for male and female beneficiaries by exposure.

5.8 The sex distribution for DHSC/EIBSS surviving beneficiaries whose exposure was Other (mainly by transfusion, we assume) echoes our baseline scenario for survivors from chronic HCV infection by transfusion in that surviving female beneficiaries outnumber males by 1.5 to 1 (718/473); also for surviving people with bleeding disorders among whom male beneficiaries outnumber females by 7.6 to 1.

Exposure	Male beneficiaries				Female beneficiaries			
	Total	Deceased	Alive	Unknown	Total	Deceased	Alive	Unknown
People with a bleeding disorder**	1,310	197	978	135	170	26	129	15
Other	796	175	473	148	1,057	155	718	184
TOTAL	2,106	372	1,451	283	1,227	181	847	199

***Labelled as "haemophiliac".*

Table 5.5 From DHSC/EIBSS, survival status at 31 December 2014 for chronically HCV infected (mono-infected) beneficiaries – by sex and exposure. We have interpreted the DHSC/EIBSS label "haemophiliac" to mean people with a bleeding disorder.

5.9 Our goal in Table 5.6 is to compare our baseline scenario's sex distribution for survivors at 31 December 2014 who were chronically HCV infected by transfusion in England and the corresponding sex distributions for DHSC/EIBSS surviving HCV infected beneficiaries whose exposure was 'Other' than a bleeding disorder.

5.10 Our baseline deterministic scenario expected around 2,500 survivors at 31 December 2014 who had been chronically HCV infected by transfusion in England. DHSC/EIBSS has around 1200 beneficiaries who were known to be alive at 31 December 2014. Our baseline scenario expected 64% of survivors to be female. This matches well with females representing 60% of DHSC/EIBSS's beneficiaries whose exposure was other than as people with bleeding disorders (95% CI: 57% to 63%). The DHSC/EIBSS data constitute a similar proportion (around half) of the number of survivors estimated by our model.

5.11 We emphasise again the substantial stochastic uncertainty around our estimates from Chapter 4.

Male survivors at 31 December 2014		Female survivors at 31 December 2014	
Estimated by baseline deterministic scenario for England (a)	DHSC/EIBSS known alive beneficiaries – as % of (a)	Estimated by baseline deterministic scenario for England (b)	DHSC/EIBSS known alive beneficiaries – as % of (b)
910	473 (52%)	1,614	718 (44%)

Table 5.6 Sex distribution from our baseline scenario for survivors to 31 December 2014 who had been chronically HCV infected by transfusion in England prior to September 1991; and for known-alive surviving DHSC/EIBSS beneficiaries who were not people with a bleeding disorder.

5.12 Those who were chronically-HCV-infected via blood products or by transfusion and who are alive at the end of 2014 can benefit from directly acting antiviral therapy. Males predominate among people with bleeding disorders who were chronically HCV-infected and among those known to be alive at the end of 2014. By contrast, females who were chronically HCV infected by transfusion predominate among those who have survived to the end of 2014. Further analysis is contained in Appendix A.53 to A.75.

Chapter 6 vCJD infections from blood and blood products

How many people were infected with vCJD from blood and blood products in the UK?

Summary findings

- Out of 178 recorded cases of confirmed or probable vCJD in the UK, 5 were blood-borne infections: 3 symptomatic vCJD cases; one asymptomatic person (positive at autopsy for abnormal prion in her spleen) from transfusion-transmitted infection; and one asymptomatic infectee with severe haemophilia A who had been exposed to vCJD-implicated Factor VIII (positive at autopsy). All five have died.

Confidence that available evidence can answer the questions? High.

Background

6.1 Bovine Spongiform Encephalopathy (BSE) was first officially diagnosed in November 1986, and variant Creutzfeldt-Jakob Disease (vCJD) was first defined in March 1996, based on 10 individuals in the UK.[141] In his witness statement to the Inquiry,[142] Professor James Ironside described vCJD as a unique form of prion disease, from transmission of the BSE agent through food and affecting typically younger people than does sporadic CJD. Once symptomatic, it is a very severe disease with a median of 14 months of illness before death.

6.2 Since 1995 and as of October 2021, there have been 178 UK patients with definite or probable vCJD reported by the National CJD Surveillance Unit in Edinburgh (NCJDRSU)[143] – the last reported case was in 2016. All have died, 55/178 without neuropathological confirmation because consent for autopsy was lacking. The great majority of vCJD cases worldwide has occurred in the UK: France has recorded 28 cases, peaking five years later than in the UK, with 26 others elsewhere in the world than UK or France.

Possible transmission to people with bleeding disorders

6.3 UKHCDO report details an exercise in 2004 whereby all people with bleeding disorders in the UK who were alive and had received UK pooled plasma products between 1980 and 2001 were identified as *"at-risk of vCJD for public health purposes"*.[144] UKHCDO provided summary statistics on 5,147 people with bleeding disorders who were

[141] Parliamentary Question by Tom Clarke MP, answered by Jane Ellison, Parliamentary Under-Secretary of State for Health on 24 October 2013, 06 August 2022 [DHSC6887702, ep.1]
[142] Written statement of Professor James W Ironside, 28 April 2022 [WITN7034001, ep.20]
[143] National CJD Research & Surveillance Unit: Table Showing Creutzfeldt-Jakob Disease in the UK, 7 March 2022 [WITN7034037, ep.1]
[144] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" [WITN3826016, ep.50]

potentially considered at-risk, of whom 785 had received an implicated batch.[145] As we note below (Case 5), one person with haemophilia is thought to have been infected with vCJD through a pooled plasma product.

Possible transmission through blood transfusions

6.4 As yet, there is no screening test which can protect the UK's blood supply against transmission of vCJD. There was, however, early recognition that the disease might be transmitted through blood, leading to the establishment of the Transfusion Medicine Epidemiology Review (TMER). Hence, in 1997, a study was set up to identify recipients of blood that was subsequently found to have been donated by people who developed vCJD. The TMER study reports[146] [147] that 31 vCJD cases were reported to be blood donors, and four more were registered with UKBTS, but only one had given blood. Components from 18 of these 32 vCJD donors were issued to hospitals, and given to 67 identified recipients; six further components are known to have been issued but could not be traced. The current reported status[148] of these 67 individuals is shown in Table 6.1.

Symptomatic vCJD (Cases 1 to 3 below)	3
Died within 5 years of their transfusion – none is thought to have died from vCJD, but none had post-mortem examination to look for PrP^{Sc} deposition	34
Died more than 5 years after transfusion without post-mortem examination to look for PrP^{Sc} deposition.	11
Died more than 5 years after transfusion with post-mortem examination including examination for PrP^{Sc}	
– positive with PrP^{Sc} deposition in the spleen (Case 4)	1
– negative	4
Remain alive	14
Total	**67**

Table 6.1 Recorded outcomes of 67 recipients of blood donated by confirmed cases of vCJD. 'PrP^{Sc} deposition' indicates the abnormal prion protein.

Of the 14 who remain alive, Urwin et al.[149] report that *'One recipient has moved abroad, and their fate is currently unknown while the remaining 13 have now survived more than 10 years after receiving transfusion from vCJD donors. There have been no new cases of vCJD identified by the NCJDRSU among the recipients of blood from vCJD donors.'*

[145] NHD & UKHCDO, Pivot Table 10.3.1, PwBD at risk of vCJD and post-notification exposure assessment [WITN3826024]
[146] The National CJD Research & Surveillance Unit (NCJDRSU), "The Transfusion Medicine Epidemiology Review (TMER)", 6 August 2022 [RLIT0001681, ep.1-3]
[147] Urwin, P.J.M., et al. "Creutzfeldt-Jakob disease and blood transfusion: updated results of the UK Transfusion Medicine Epidemiology Review Study", *Vox Sanguinis*, vol, 110, 2016, pp. 310-316 [NCRU0000109_082, ep.4]
[148] Ibid., epp. 3-4.
[149] Ibid., ep. 4.

Available evidence on individual cases

6.5 The NCJDRSU 2020 Annual Report[150] discusses 4 cases of clinical vCJD following transfusion, while the NHS vCJD website[151] reports 5 cases. Professor Ironside confirmed five cases of vCJD via blood/blood products, with four cases caused via blood transfusion (3 clinical vCJD and 1 asymptomatic), and the fifth, a person with haemophilia who was infected after receiving vCJD-contaminated Factor VIII.[152] Brief details are as follows:

6.6 *Case 1.* Details of the first case of vCJD via blood transfusion were announced in Parliament in December 2003,[153] and later published in the Lancet.[154] The 24-year-old donor had no signs of vCJD when they gave blood in 1996, although the donor later developed symptoms and died in 2000. A 62-year-old recipient subsequently developed vCJD symptoms and died in 2003, over 6 years after transfusion, and was linked to the donor by the TMER.

6.7 *Case 2.* A second case of vCJD via blood transfusion was found in Glasgow and reported in the Lancet,[155] having been identified by the TMER study. The elderly patient had received blood in 1999 from a donor who died of vCJD in 2001, and subsequently died from a non-neurological disorder in 2003, with vCJD being confirmed at autopsy.[156]

6.8 *Case 3.* This young man died in May 2006 after receiving a blood transfusion in September 1997 and developing vCJD 8 years after transfusion – details are contained in a moving witness statement by his father,[157] and published in the Lancet.[158] Before his diagnosis he had been identified as being at-risk.

6.9 Case 4.[159] This 65-year-old man received blood from the same donor as case 3 in late 1997,[160] and subsequently developed vCJD symptoms and died in March 2007. He was identified as a potential case by the TMER study, and had been in touch with the National Prion Clinic before developing symptoms.

6.10 *Case 5.* This was a 73 year old male with severe haemophilia who had been treated with vCJD-implicated Factor VIII, and who died in September 2009[161] with no history of neurological disease. An autopsy was performed under Her Majesty's Coroner's Instructions. The deceased was positive for the abnormal prion in his spleen and was

[150] The National CJD Research & Surveillance Unit, "Creutzfeldt-Jakob Disease Surveillance in the United Kingdom", 29th Annual Report, January 2020 [RLIT0000816, epp.16-17]

[151] NHS website: Prevention, Creutzfeldt-Jakob Disease, Accessed 6 August 2022 [RLIT0001682, ep.1] Available online: https://www.nhs.uk/conditions/creutzfeldt-jakob-disease-cjd/prevention/

[152] Written statement of Professor James W Ironside, 28 April 2022 [WITN7034001, epp.23-24]

[153] House of Commons: Hansard Debates, "Developments in Variant CJD", 17 December 2003 [DHSC0004040_009, ep.1]

[154] Llewelyn, C. A., et al., "Possible transmission of variant Creutzfeldt-Jakob disease by blood transfusion", *The Lancet*, vol. 363, 2004, pp. 417-421 [NHBT0008743_013, epp.4-5]

[155] Peden, A., et al., "Preclinical vCJD after blood transfusion in a PRNP codon 129 heterozygous patient", *The Lancet*, vol. 364, 2004, pp. 527-528 [DHSC0004215_039, epp.1-2]

[156] Heterozygous MV at codon 129, reflecting susceptibility of heterozygotes to sub-clinical prion-related disease.

[157] Written Statement of Peter Buckland, 8 January 2019 [WITN0694001]

[158] Wroe, S., et al., "Clinical presentation and pre-mortem diagnosis of variant Creutzfeldt-Jakob disease associated with blood transfusion: a case report", *The Lancet*, vol. 368, 2006, pp 2061-2067 [RLIT0000157, epp.4-7]

[159] Health Protection Agency (HPA), "Fourth case of transfusion-associated variant-CJD", *Health Protection Report*, vol. 1, no. 3, 2007 [PHEN0002470, ep.2]

[160] Letter from David Body, Irwin Mitchell, to Stephen Janisch, RadcliffesLeBrasseur, 21 November 2007 [DHSC0031276, ep.2]

[161] Peden, A., et al., "Variant CJD infection in the spleen of a neurologically asymptomatic UK adult patient with haemophilia", *Haemophilia*, vol. 16, 2010, pp. 296-304 [HCDO0000799, ep.5]

heterozygous at codon 129 of the prion protein. The most likely route of vCJD infection was through a UK plasma product. Professor Ironside notes this was *'not proven conclusively on independent review by the DH Health Protection Analytical Team'*.[162]

6.11 In addition to TMER, and because there is no screening test in blood, the UK has conducted three studies in appendix tissue to assess the prevalence of abnormal prion protein (referred to as PrP^{SC}) by birth-cohort and sex.

6.12 Steps taken to protect the UK blood supply included leucodepletion and, from 2004, those who received blood or tissue were asked not to donate. In addition, anyone who has donated to a person who subsequently developed vCJD is asked to abstain from blood and tissue donation. See Professor Ironside's witness statement for a fuller account.[163]

[162] Written statement of Professor James W Ironside, 28 April 2022 [WITN7034001, ep.24]
[163] Ibid., epp.55-57.

Chapter 7 HBV infections from blood and blood products

How many people were infected with Hepatitis B Virus (HBV) between 1970 and 1991 through blood and blood products, and what were the impacts?

Summary findings

Due to the limitations in the data available, it is not possible to answer the questions set with any reasonable accuracy when compared to other infections we investigated. There was a 'lack of an integrated approach at the onset of donor screening in 1971/72'[164] to identify donors who were infectious HBV carriers. Furthermore, people infected with HBV have never received financial support, and so funds are not a source of data.

Confidence that available evidence can answer the questions? Low.

****

Terminology[165]

7.1 *HBsAg (Hepatitis B surface antigen, formerly the Australia antigen/HAA).* A *"positive"* or *"reactive"* HBsAg test result means that the person is infected with hepatitis B virus. This test detects the actual presence of the hepatitis B virus (the *"surface antigen"*) in blood. If a person tests positive, further testing is needed to determine if this is a new *"acute"* infection or *"chronic"* hepatitis B (HBV carrier). A positive HBsAg test result means that you are infectious and can spread HBV to others through blood and other secretions.

7.2 *Anti-HBs or HBsAb (Hepatitis B surface antibody)* – A *"positive"* or *"reactive"* anti-HBs (or HBsAb) test result indicates that a person has antibodies and is protected against HBV. This protection can be from receiving the hepatitis B vaccine or successfully recovering from a past HBV infection. You are not infectious and cannot spread hepatitis B to others. This test is not routinely included in blood screening.

Results of screening donors

7.3 Screening for Hepatitis B surface antigen (HBsAg) was routine throughout the UK by December 1972. Before screening, some high rates of HBsAg had been reported; for example, the MRC Working Party on post-transfusion hepatitis[166] described 782 patients who were tested after transfusion of whole blood during 1969-1971, of whom eight tested positive for HBsAg, an incidence rate of 1%. The study population in this report was urban with a high proportion of people with close family links to regions

[164] Preliminary report 'National Register of Blood Donors Found Positive for HBsAg: Analysis for 1987', January 1987 [NHBT0000043_028, ep.1]

[165] The Penrose Inquiry, Final Report, Chapter 25: Screening of Donated Blood for Hepatitis B. See in particular paragraph 25.8 [PRSE0007002, ep.1102]

[166] The Medical Research Council Working Party on Post-Transfusion Hepatitis. "Post-Transfusion Hepatitis in a London Hospital: Results of a Two-Year Prospective Study." *The Journal of Hygiene*, vol. 73, no. 2, 1974, pp. 173–88 [PRSE0002988, ep.1]

with high incidence of HBV infection during childhood (which increases the risk of developing chronic carriage) – which suggests that 1% may be an upper limit for transfusion risk pre-screening.

7.4 Risks remained post-1970, although these are difficult to quantify. It was claimed in 1976[167] that the available tests for HBsAg would detect no more than about 50% of HBV carriers, and so there would have been 'breakthrough' HBV infections. Therefore, detected HBsAg infections in donors could give an idea of the likely number of breakthrough HBV infections.

7.5 The National Blood Transfusion Service Register of HBsAg Positive Donations[168] provides data for 1971-1991 from all UK Regional Transfusion Centres (RTCs), including total number of donations, total confirmed HBsAg positive, and overall positivity rate in both repeat and new donors. Figure 7.1 shows the HBsAg positive count per 100,000 donations in the UK (not all centres contributed to all years).

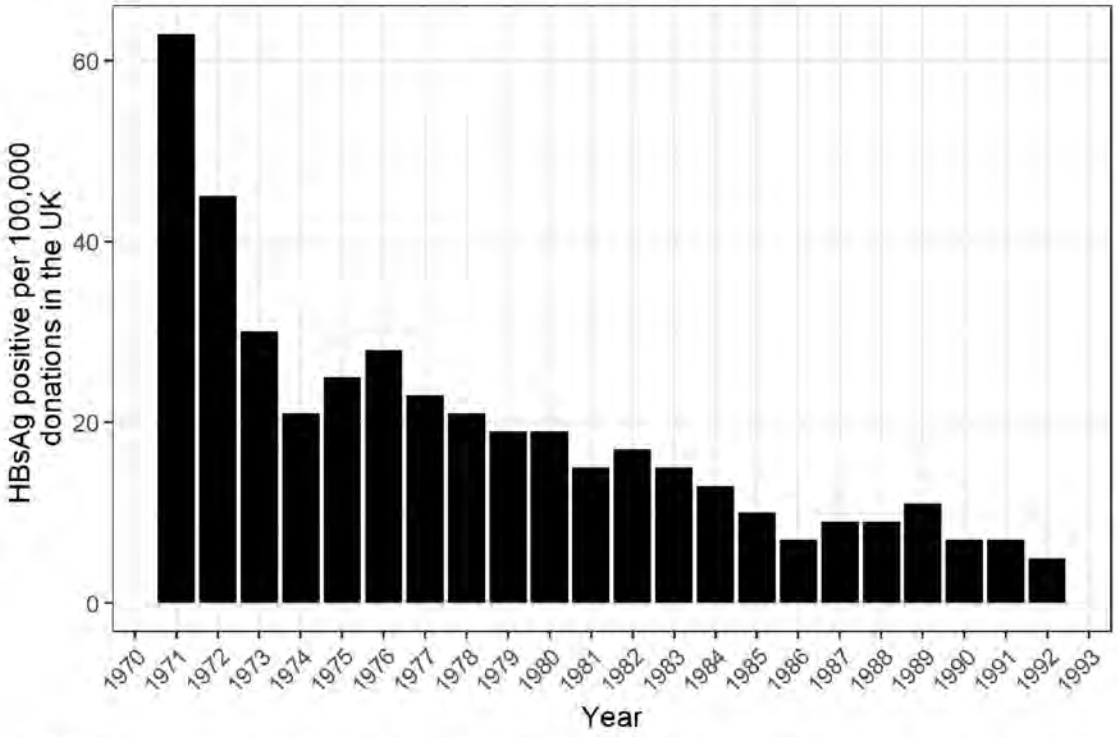

Figure 7.1 HBsAg positives per 100,000 donations in the UK. Centres started testing and reporting data in different years, and so not all centres contribute to each year's results.[169]

7.6 For example, just after screening began, 9 out of 22 UK RTCs returned results in 1972, and reported 45 HBsAg positive per 100,000 donations. Extrapolating to approximately 1.5m donations suggests that perhaps 800 HBV infectious donations were screened out. Maycock[170] estimated that exclusion of antigen-positive donors in 1970 would have prevented some 575 cases of icteric or anicteric hepatitis.

[167] International Society of Blood Transfusion, 'Hazards of Blood Transfusion', January 1976 [PRSE0000799, ep.12]
[168] National Blood Transfusion Service, "Register of HBsAg Positive Donations", 24 April 1993 [SBTS0000458_053]
[169] Ibid., epp.10-13.
[170] Maycock, W. d'a., et al., "Hepatitis in Transfusion Service", *British Medical Bulletin*, vol. 28, no. 2, 1972, pp. 163-169 [CBLA0000123, epp.1-7]

7.7 Between 1983 and 1986, the HBsAg count per 100,000 donations halved, at a time of enhanced self-deferral of donors to reduce HIV-related risks and the introduction of HIV antibody screening of blood donors.

7.8 Few HBV cases following transfusion have been reported since 1991. Soldan et al. 2002[171] list 14 cases in the UK between 1991-1997, with 11 being the result of chronic infection in donors. In contrast, of the 6 cases listed between 1998 and 2001, all donors had acute rather than chronic infections. These counts understate the true incidence as there will be cases that have been missed. Other fragmentary pieces of evidence include a report of two cases of post-transfusion hepatitis B reported during 1988 from Trent RTC,[172] and a Public Health Laboratory Service report[173] that out of 1,061 cases of acute hepatitis B reported during July 1975 to June 1976, 4% (~40) had received blood transfusions.

Risk to people with bleeding disorders

7.9 Very limited data are available. In their report to the Inquiry,[174] UKHCDO say *"HBV test results have not been collected from centres since vaccination was introduced early in 1980. Jaundice surveys were carried out intermittently over the years, either at the centre level or individual people with bleeding disorders level, but with no consistency. These were not submitted to the NHD."*

7.10 Craske et al. (1978)[175] discuss 371 people with haemophilia who were treated with commercial Factor VIII over 1974-1975, in whom 30 cases of HBV were found. Of the original concentrates, 4 of 6 batches were positive for HBsAg. Tables[176] show that of 2,308 people with haemophilia given FVIII and IX in 1977, 18 cases of HBV were recorded.

Comments

7.11 The majority of infections are brought into the UK with migration,[177] and the multiplicity of transmission routes makes it almost impossible to assign a cause for individual cases. Where data are available to make infected blood the most likely route, the numbers are small, largely because of the introduction of donor screening soon after the virus was discovered.

7.12 If we make assumptions about the sensitivity of the screening test, it might be possible to use the data above to estimate the number of breakthrough infections. Allowing for 90-95% of recipients of infected donations to clear the virus naturally, the number of chronically infected recipients might be estimated in an exercise similar to that of Chapter 4. But, given the quality of the information, the numbers would be very approximate, and in any case would not represent a large number compared to the other infections of interest. We have therefore not conducted a detailed modelling exercise.

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[171] Soldan, K., et al., "Transfusion-transmitted hepatitis B virus infection in the UK: a small and moving target", *Vox Sanguinis*, vol. 93, 2002, pp. 305-208 [JPAC0000138_019]
[172] Flanagan, P., et al., 'Post transfusion hepatitis within Trent Regional Health Authority 1988' [NHBT0053628]
[173] Report from the Public Health Laboratory Service (PHLS) on Hepatitis B, 9 January 1977 [DHSC0037622, ep.1]
[174] NHD & UKHCDO, "Bleeding disorder statistics for the Infected Blood Inquiry 2020" [WITN3826016, ep.64]
[175] Craske, J., et al., "Commercial Factor VIII Associated Hepatitis, 1974-75, in the United Kingdom: A Retrospective Survey." *The Journal of Hygiene*, vol. 80, no. 3, 1978, pp. 327–36 [HSOC0000009, ep.1]
[176] Table of Factor VIII and IX Associated Hepatitis attack rates, 1977 [CBLA0001077_004, ep.1]
[177] Guidance, 'Hepatitis B: migrant health guide', accessed on 22 August 2022 [DHSC6887704]. Available online: https://www.gov.uk/guidance/hepatitis-b-migrant-health-guide

7.13 Combatting viral hepatitis is part of the United Nations Sustainable Development Goals. As described by Mandal (2019), the UK took a big step forward in August 2017 in its fight against viral hepatitis – specifically hepatitis B – with the incorporation of hexavalent combination vaccine (including against HBV) into the routine childhood immunization programme. This vaccine is now offered to all infants at 8, 12 and 16 weeks, replacing the pentavalent vaccine which protected against diphtheria, tetanus, pertussis, polio and haemophilus influenzae type B. In May 2022, the World Health Organization announced new targets that aimed to eliminate viral hepatitis by 2030 by driving new infections and deaths down to half a million for both hepatitis B and hepatitis C, as well as reducing HBsAG in children under 5 years to below 0.1%.[178]

[178] Mandal, S., "Introduction of universal infant hepatitis B immunisation in the UK - paving the way to elimination", *Human Vaccines and Immunotherapeutics*, vol. 15, no. 2, 2019, pp. 440-443 [RLIT0000698, ep.1]

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  Professor Daniela De Angelis, Deputy Director, MRC Biostatistics Unit, Cambridge University.

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  Andrew Parker, Principal Operational Research Analyst, Department of Health and Social Care (DHSC)

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Stephen Evans convened the Statistics Expert Group; Sheila Bird, Ruth McCabe, Sarah Hayes and David Spiegelhalter were responsible for the initial draft of this report; and then all members of the Statistical Expert Group contributed to critique and final editing.

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Verifying Statements

The standard verifying statement is as follows:

All contributing group members confirm that in respect of those parts of the report to which they have contributed:

(i) They have made clear which facts and matters referred to in this report are within their knowledge and which are not.

(ii) Those that are within their knowledge they confirm to be true.

(iii) The opinions they have expressed represent their true and complete professional opinions on the matters to which they refer.

Sections *(i)* and *(ii)* are somewhat unsuitable to statistical analyses, since we rely on data provided from a wide variety of sources, and so cannot say that the information we present is 'within our knowledge' or that we can confirm it to 'be true'.

However, we can confirm that we have exercised our best professional judgement as to the quality and interpretation of the evidence that was available.

Appendix

A.1 This document contains additional material related to the Expert Report. Minimal background is provided for the tables, graphs and technical explanations – please refer to the relevant Chapters and Sections in the main report for further explanation, context and references.

Chapter 1

Year	HIV Diagnoses
1979	4
1980	20
1981	32
1982	63
1983	108
1984	322
1985	649
1986	76
1987	20
1988	12
1989	7
1990	4
1991	1
1992	2
1993	2
1994	2
1995	0
1996	1
1997	1
1998	0
2000	1
Missing	11
Total	1,338

Appendix Table 1.1 HIV Diagnoses of people with bleeding disorders in the UK by year (Source UKHCDO data).

Year of diagnosis (or earlier date of HIV infection if ascertained by retrospective testing of stored blood samples)	HIV diagnoses: 2020 archive		HIV diagnoses 2020 archive - exposure updated using 2005 archive: All Blood Products		
	All new HIV/AIDS diagnoses	All Blood products	Haemophilia	Other blood products	All Blood products (undetermined)
<1983	120	72	58	1	13
1983	183	52	43	0	9
1984	650	124	89	4	31
1985	2,947	683	623	18	42
1986	2,654	154	119	21	14
1987	2,379	85	55	22	8
1988	1,945	44	29	10	5
1989	2,183	35	14	16	5
1990	2,605	28	5	18	5
1991	2,863	22	3	15	4
1992	2,933	22	5	14	3
1993	2,859	20	5	11	4
1994	2,848	22	4	13	5
1995	2,930	21	2	15	4
1996	2,902	18	1	13	4
1997	2,863	22	3	16	3
1998	2,921	11	1	5	5
1999	3,269	26	1	16	9
2000	3,976	23	1	13	9
Total	**46,030**	**1,484**	**1,061**	**241**	**182**

Appendix Table 1.2 New HIV diagnoses in the UK up to 2000, overall and through exposure to infected blood products by year of diagnosis. The numbers reflect the year the diagnoses were made which is not necessarily the same as the year the infections were acquired.

Chapter 2

HCV status	HaemA <= 5 IU/dl	HaemA other	HaemB <= 5 IU/dl	HaemB other	Von Wille-brand	Any Acquired	Other	Total
HIV antibody positive	2	0	0	0	6 (50%)	1	3 (25%)	12
Tested HCV antibody positive	0	0	1	0	104 (57%)	0	78 (43%)	183
Presumed HCV antibody positive	0	0	0	0	5	1	1	7
HCV status not known, exposed to pooled plasma	1	2	1	1	52 (36%)	23 (16%)	66 (45%)	146
HCV status not known, exposed to components	1	0	0	0	196 (69%)	6	82 (29%)	285
Tested HCV antibody negative	1	0	0	0	334 (67%)	1	161 (32%)	497
Not known to be at-risk	0	0	1	0	97 (46%)	32 (15%)	80 (38%)	210
Total	**5**	**2**	**3**	**1**	**794**	**64**	**471**	**1340**
Deaths (all causes) by								
31 December 1991	5				51 (6.4%)	28 (44%)	30 (6.4%)	114 (8.5%)
31 December 1999	7				98 (12%)	42 (66%)	69 (15%)	216 (16%)
31 December 2009	8				175 (22%)	51 (80%)	119 (25%)	352 (26%)
31 December 2013	8				221 (28%)	55 (86%)	140 (30%)	424 (32%)
31 December 2019	8				270 (35%)	57 (89%)	173 (37%)	508 (38%)

Appendix Table 2.1 Bleeding disorder and its severity for females by HCV status, as described in Table 2.2, together with survivorship to the end of 1991, 1999, 2009, 2013 and 2019. (Analogous to Table 2.3 in main report).

Chapter 4

Adapting the model to Scotland, Wales and Northern Ireland

A.2 The model structure is applicable to each country within the UK, with the only necessary changes coming from specific data inputs. Appendix Table 4.1 presents an overview of the inputs and sources for each of the four nations' baseline models.

A.3 As outlined in Appendix Table 4.1, six inputs were identified as requiring setting-specific data. This was possible with the following exceptions:

- 1991 HCV infected donor prevalence in Northern Ireland.
- Number of HCV infectious ever-IDUs in Northern Ireland and Wales.
- Year of deferral reduction in Northern Ireland and Wales.
- Effect of deferral reduction in Northern Ireland and Wales.
- The number of blood donations in Northern Ireland.

A.4 For all missing data, with the exception of the number of blood donations, the values were assumed to be as observed in England. The number of blood donations in Northern Ireland were estimated by assuming population pro-rata of Northern Ireland in comparison to England, as detailed below.

A.5 All other parameters were assumed to be setting-independent and could thus be applied to each of the four nations.

Task	Input	Source			
		England	Northern Ireland	Scotland	Wales
1.1	1991 HCV infected donor prevalence	0.066% *National Blood Authority/ PHLS Infection Surveillance report tables*	0.066% *Assumed to be as in England and Wales*	0.088% *S&G*	0.066% *National Blood Authority/ PHLS Infection Surveillance report tables*
1.2	HCV infectious donations (Assumption (b))	74% *Micallef et al. (2006)*			
1.3	Number of HCV infectious ever-IDUs	*UKHSA modelling (unpublished)*	*UKHSA modelling (unpublished)*	*S&G (without uncertainty)*	*UKHSA modelling (unpublished)*
1.4	Year of deferral reduction (Assumption (c))	1985 *Informal discussions with members of Inquiry Expert Groups*	1985 *Informal discussions with members of Inquiry Expert Groups*	1984 *S&G*	1985 *Informal discussions with members of Inquiry Expert Groups*

Task	Input	Source			
		England	Northern Ireland	Scotland	Wales
1.4	Effect of deferral reduction (Assumption (d))	67% *Informal discussions with members of Inquiry Expert Groups*	67% *Informal discussions with members of Inquiry Expert Groups*	67% *S&G*	67% *Informal discussions with members of Inquiry Expert Groups*
1.5	Percentage contribution to prevalence from non-IDUs (Assumption (e))	25% *Based on judgement (and sensitivity analysis reveals that the precise value has little impact).*			
2.1	Number of blood donations	*National Blood Transfusion Service*	*Population pro-rata from National Blood Transfusion Service*	*S&G*	*National Blood Transfusion Service*
2.2	Units used per donation	*National Blood Transfusion Service Statistics*			
3	Age-sex distribution of recipients	*Wallis et al. (2004)*			
4	Survival to 10 years post-transfusion	*Wallis et al. (2004) & Morley et al. (2016)*			
4	Percentage of people infected with HCV who naturally clear the virus (Assumption (h))	82% *Micallef et al. (2006)*			
5	Probability of surviving until the end of 2019	*ONS life-tables for England*	*ONS life-tables for Northern Ireland*	*ONS life-tables for Scotland*	*ONS life-tables for Wales*
5	Additional risk to survival from having a transfusion (Assumption (j))	*Scotland National Blood Transfusion Service*			
6	Additional risk to survival from chronic HCV infection (Assumption (k))	*UKHSA modelling (unpublished)*			

Appendix Table 4.1 Model inputs for each of the four nations of the UK.

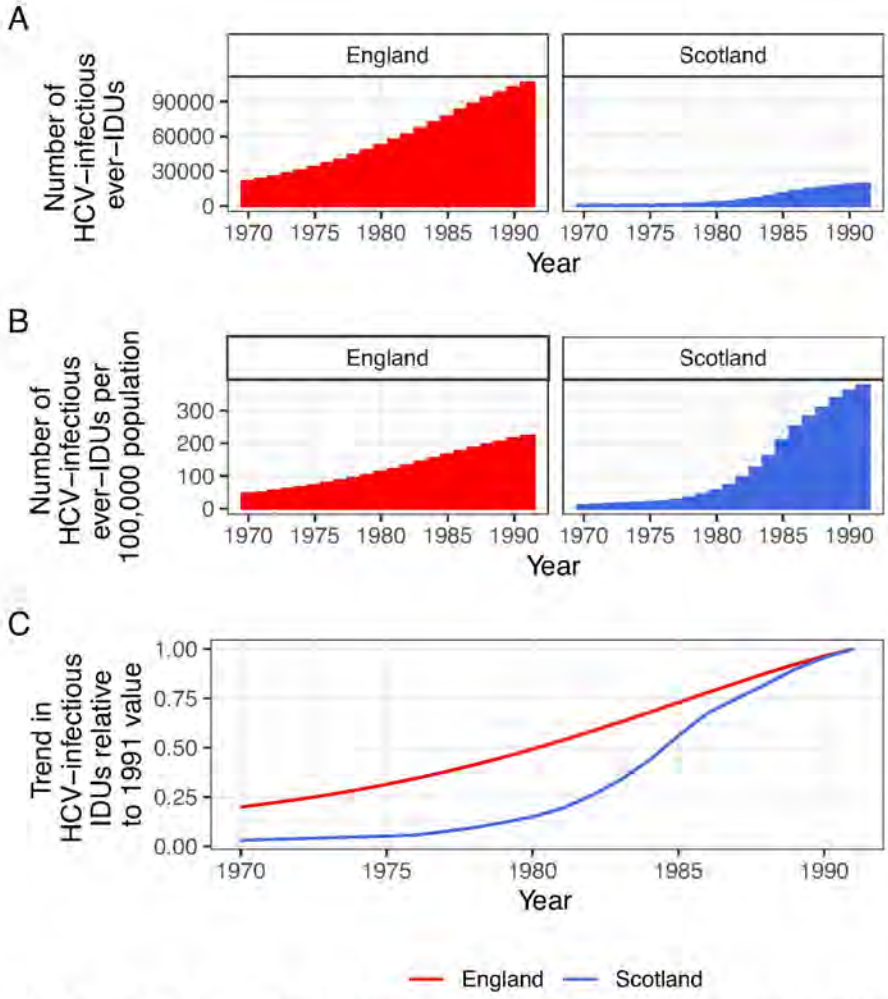
Chapter 4. Task 1.3 How many chronically HCV-infected ever-injecting drug users (ever-IDUs) were alive during each year between 1970 and 1991?

A.6 We were provided with estimates of the number of past, current, and ever IDUs in England across 1971 - 1991. As the scope of the model encompasses 1970, we estimated a value for 1970 by:

$$I_{1970} = I_{1971} \times \left(\frac{I_{1971}}{I_{1975}}\right)^{¼}.$$

Ever-IDUs in Scotland compared to England

A.7 Appendix Figure 4.1 shows the number of HCV-infectious ever-IDUs in Scotland compared to England, highlighting a greater number per capita in Scotland. While England observes a steady increase in the proportion of HCV-infectious ever-IDUs in comparison to its 1991 value over time, Scotland observes a sharp increase across the 1980s, with extremely low levels observed in the 1970s.



Appendix Figure 4.1 (A) The number of HCV-infectious ever-IDUs in England and Scotland. (B) As in (A) but scaled to per 100,000 population. (C) The trend in HCV-infectious ever-IDUs relative to the value observed in 1991.

Chapter 4. Task 1.4. What was the step-down in donations from ever-IDUs due to self-deferral guidance and HIV antibody testing in the mid-1980s?

A.8 A key uncertainty in forward projection of the numbers of people infected with HCV in England by blood transfusion during 1970-1991, is how effective self-deferral information-leaflets for blood donors in the HIV/AIDS era, together with the advent of HIV antibody testing of the blood supply, were in dissuading donations from past and current IDUs who (unknowingly) were HCV-infected.

A.9 At short notice, we sought expert opinion from selected members who serve on other expert groups for the Infected Blood Inquiry and were in professional practice in the 1980s. This was relatively successful: only one non-response (on account of annual leave) out of eight, and six provided some quantification.

A.10. Six assessments are summarised in Appendix Table 4.2 in terms of the % of HCV-infected ever-IDUs who were dissuaded from donation by self-deferral leaflets, HIV antibody testing or other awareness about the risk of blood-borne infection. Our informants had been given the following instructions:

Please place 20 betting tokens in the betting streets below to express your opinion about the likely percentage-reduction in HCV-infected donations from early in 1985 to 1986.

	Six assessments (A), please see footnote																		Total
Betting												1	4	10	4	1				20
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Counters				6		10		4												20
TOTALS	1	1	1	1	1	1	2	3	2	1	1	1	1	1	1	1				20
										4	4	4	4	4						20
													4	6	6	4				20
																				**
	2	2	2	8	2	12	3	8	3	6	6	7	14	22	12	7	1	1	1	119
% reduction	5 %	10 %	15 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %	55 %	60 %	65 %	70 %	75 %	80 %	85 %	90 %	95 %	
From baseline 100 to	95	90	85	80	75	70	65	60	55	50	55	40	35	30	25	20	15	10	5	

*Appendix Table 4.2 Elicitation on % reduction in HCV-infected donations by **ever-injectors** across England in 1986 (versus 1985 as baseline) that was achieved by self-deferral advice & HIV antibody-testing.*

*** Seventh assessor judged that, on account of venous access, the number of current injectors who would have attended as blood donors would be very low – even before HIV antibody testing was introduced. There would have been a further 50% (with 50% confidence).*

A.11 The resultant distribution is bimodal. Ignoring outlying votes which sum to fewer than 3 [9 of them], the lower mode has accrued 36/110 votes. These 36 votes support a mean reduction of 31% (1130/36; most likely 30%). The upper mode accrued 74/110 votes. These 74 votes support a mean % reduction of 67% (4960/74; most likely 70%). Consistent with the elicited bimodal distribution, our baseline scenario in our simulation model is a 67% reduction, with a sensitivity analysis of a one-third reduction for England; as well as no reduction to mimic the English HCV lookback model assumptions.

A.12 In addition, a seventh assessor judged that, on account of venous access, the number of current IDUs who would have attended as blood donors would be very low – even before HIV antibody testing was introduced. There would have been a further 50% (with 50% confidence).

A.13 Other contexts that respondents mentioned included:

- greater impact on HCV-infected current IDUs;
- potentially greater impact from HIV antibody testing than from self-deferral leaflets;
- literature on limited impact on public health behaviours via leaflets;
- reluctance of blood donors to be turned down and hence minimization or oversight of historical risk-factors;
- attendance as blood donor specifically to access HIV antibody testing;
- whether potential donors appreciated that past history of having ever-injected mattered (vs being a current injector);
- sensitivity of the HIV antibody test used for initial screening of blood supply;
- how risks to blood supply from non-A, non-B hepatitis infections in ever-IDUs were appreciated in contemporary medical reports, let alone by potential donors;
- in the early 1990s, the proportion of blood donors who, having tested HCV antibody positive, admitted a history of injecting or sexual risk being less than 40%;
- much health education literature requires too high a level of literacy and that written in the 1980s often appeared hectoring.

Past-IDUs

A.14 Six respondents offer an opinion on the % of HCV-infected past-IDUs who were dissuaded from donation by self-deferral leaflets, HIV antibody testing or other awareness about the risk of blood-borne infection. See Appendix Table 4.3.

	Five assessments (A)																			Total
Betting											1	4	10	4	1					20
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Counters		6		10		4														20
TOTALS																				
				4	4	4	4	4												20
											4	6	6	4						20
												2	2	5	5	5	1			20**
	1	7	1	15	5	9	5	5	1	1	6	13	19	14	7	6	2	1	1	119
% reduction	5 %	10 %	15 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %	55 %	60 %	65 %	70 %	75 %	80 %	85 %	90 %	95 %	
From baseline 100 to	95	90	85	80	75	70	65	60	55	50	55	40	35	30	25	20	15	10	5	

*Appendix Table 4.3 Elicitation on % reduction in HCV-infected donations by past-IDUs across England in 1986 (versus 1985 as baseline) that was achieved by self-deferral advice & HIV antibody-testing? ** Until 1987, leaflets asked drug addicts or drug abusers to refrain from donating: they did not specifically encompass past users. Someone who used intravenous drugs occasionally, decades previously might not consider themselves a "drug abuser". After 1987, leaflets are specific that this applies to an ever-user in the previous decade. Hence, 70 to 80% decrease amongst past users in response (certainty level: 70-80%).*

A.15 The resultant distribution is again bimodal. Ignoring outlying votes which sum to fewer than 3 [six of them], the lower mode has accrued 48/113 votes. These 48 votes support a mean reduction of 24% (1160/48; most likely 20%). The upper mode accrued 65/113 votes. These 65 votes support a mean reduction of 67%% (4330/65; most likely 65%). Consistent with the elicited bimodal distribution, sensitivity analysis for the simulation model has used 67% and 20% reductions for England's chronically infected past-IDUs.

Chapter 4. Task 2.1 How many blood donations were there annually between 1970 and 1991?

England and Wales

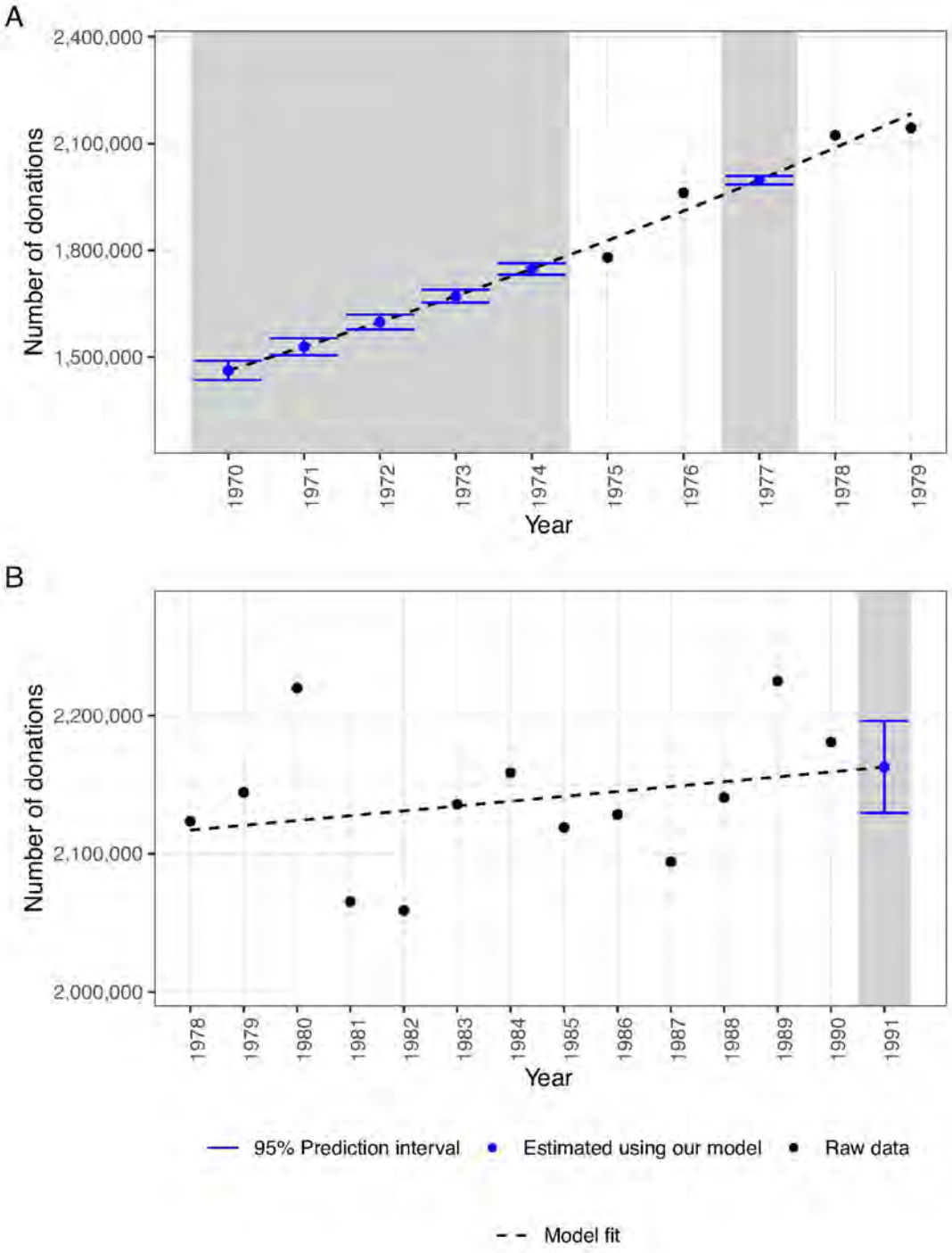
A.16 Data on the number of donations per year in England and Wales were observed for 1975 - 1976 and 1978 - 1990. To estimate the number of donations in years without data, we used Poisson regression as in Schnier and Goldberg (S&G).

A.17 There was a distinct difference in the number of donations from 1978 compared to that observed in 1975 - 1976. Similar trends were observed in Scotland during this period.[179] Consequently, we used two separate Poisson regression models (donations as response and year as predictor) in order to accurately capture this difference in trends (Appendix Figure 4.2).

A.18 First, we produced a model fitted to observed data from 1975 - 1976 and 1978 - 1979 as shown in Appendix Figure 4.2A, and used this to estimate the donations in 1970 - 1974 and 1977. Secondly, we fitted using the observed data from 1978 - 1990 as shown in Appendix Figure 4.2B and used this to estimate the number of donations in 1991.

A.19 The number of donations attributable to England and to Wales separately was obtained by scaling the value in accordance with the respective populations of each country. This makes the assumption that the rate of donations in the population did not differ between England and Wales. Across 1970 - 1991, on average England accounted for 94.3% of the population of England and Wales, and thus 94.3% of donations were attributed to England, with the remaining 5.7% attributed to Wales.[180]

[179] National Blood Transfusion Service, "Register of HBsAg Positive Donations", 24 April 1993 [SBTS0000458_053]
[180] The Office for National Statistics, England and Wales population mid-year estimate, 1971-2020 [OFNS0000006]



Appendix Figure 4.2 Estimating the number of donations in England and Wales in years without data using Poisson regression. (A) Missing years are interpolated using a model fit to 1975 - 1976 and 1978 - 1979. (B) Missing year is interpolated using a model fit to 1978 - 1990.

Northern Ireland

A.20 We were unable to obtain specific information on the number of donations in Northern Ireland. Therefore, analogous to the case of England and Wales, we assumed that the number of donations in Northern Ireland could be approximated by assuming that this is proportional to Northern Ireland's population in comparison to England. Across

1970 - 1991, on average Northern Ireland's population was 3.3% that of England's and so the number of donations in Northern Ireland was assumed to be 3.3% the number of those observed in England.[181]

Scotland

A.21 In their analysis, S&G published the number of donations in Scotland between 1970 - 1991 and thus we used these values.

A.22 Appendix Table 4.4 presents the estimated number of donations in each of the four nations.

Year	(a) Recorded donations, England and Wales	(b) Estimated number of donations England	(c) Estimated number of donations in Wales	(d) Estimated number of donations in Northern Ireland	(e) Estimated number of donations in Scotland
1970	1,462,577*	1,380,032	82,545	45,584	244,463
1971	1,529,182*	1,442,878	86,304	47,660	248,216
1972	1,598,820*	1,506,586	90,234	49,831	252,026
1973	1,671,629*	1,577,286	94,343	52,100	255,895
1974	1,747,754*	1,649,114	98,640	54,472	259,823
1975	1,780,000	1,679,540	100,460	55,477	248,558
1976	1,962,000	1,851,269	110,731	61,150	262,549
1977	1,997,568*	1,884,829	112,739	62,258	277,772
1978	2,123,607	2,003,755	119,852	66,187	283,306
1979	2,144,484	2,023,454	121,030	66,837	290,078
1980	2,220,036	2,094,742	125,294	69,192	289,324
1981	2,065,428	1,948,859	116,569	64,373	293,501
1982	2,058,994	1,942,788	116,206	64,173	297,851
1983	2,135,840	2,015,297	120,543	66,568	302,233
1984	2,158,626	2,036,797	121,829	67,278	308,617
1985	2,119,060	1,999,464	119,596	66,045	304,914
1986	2,128,450	2,008,325	120,125	66,338	309,748
1987	2,094,316	1,976,117	118,199	65,274	289,006
1988	2,140,810	2,019,987	120,823	66,723	310,785
1989	2,225,009	2,099,434	125,575	69,347	321,588
1990	2,180,858	2,057,775	123,083	67,971	331,979
1991	1,441,838**	1,360,464	81,374	44,938	238,979

Appendix Table 4.4 The number of blood donations in each nation of the UK across 1970 - 1991.

[181] The Office for National Statistics, National Life Tables, Northern Ireland, 1980-1982 to 2018-2020 [OFNS0000007]

Chapter 4 Task 2.2. Per donation, on average how many units were transfused?

A.23 Data on the number of units transfused per donation were obtained annually for 1982 - 1988 from the National Blood Transfusion Service Statistics (NBTSS) for England and Wales[182] as shown in Appendix Table 4.5.

A.24 We sought to extrapolate the trend observed during this period to 1970 - 1981 and to 1989 - 1991 using a linear model (units transfused per donation as response and years as predictor). However, there is a steep increase observed in the number of units transfused per donation between 1982 - 1988 which is unlikely to hold throughout the entire period 1970 - 1991. Therefore, we scaled the gradient down to 25% of its estimate values for the periods without data and took the values expected under this model (Figure 4.7 in report).

A.25 We assume that this is able to be applied to all four nations within the UK. Appendix Table 4.6 shows the resulting estimates of units transfused in each nation.

[182] Department of Health, "NBTS Statistics - England and Wales – 1988," January 1989 [DHSC0003974_036, ep. 5]

Year	(a) Number of donations	(b) Units issued (whole +RBC)	(c) Units returned unused	(d) % returned (c/b)	(e) Cryo-precip-itate	(f) donations from which plasma retained	(g) plate-lets	(h) total units available for use (b+e+f+g)	(i) Available units per donation (h/a)	(j) not used (assuming % returned) (d x h)	(k) usage per unit (1 - j/h)	(l) total units used (h - j)	(m) units used per donation (l/a)
1978	2,124	1,663	239	14%	164								
1979	2,145	1,705	226	13%	145								
1980	2,220	1,793	234	13%	127								
1981	2,065	1,837	234	13%	103								
1982	2,059	1,785	197	11%	89	98	329	2,301	1.12	254	0.89	2,047	0.99
1983	2,136	1,830	172	9%	94	122	364	2,410	1.13	227	0.91	2,183	1.02
1984	2,159	1,873	149	8%	96	135	404	2,508	1.16	200	0.92	2,308	1.07
1985	2,119	1,844	143	8%	81	157	462	2,544	1.20	197	0.92	2,347	1.11
1986	2,128	1,861	144	8%	73	172	547	2,653	1.25	205	0.92	2,448	1.15
1987	2,094	1,833	148	8%	75	188	613	2,709	1.29	219	0.92	2,490	1.19
1988	2,141	1,867	128	7%	63	208	631	2,769	1.29	190	0.93	2,579	1.20

Appendix Table 4.5 Data from the National Blood Transfusion Service Statistics (NBTSS) from which the number of units transfused per donation was approximated.

Year	(a) Estimated proportion of units transfused per donation	(b) Estimated number of units transfused in England	(c) Estimated number of units transfused in Northern Ireland	(d) Estimated number of units transfused in Scotland	(e) Estimated number of units transfused in Wales
1970	0.80***	1,104,023	36,467	195,570	66,036
1971	0.82***	1,177,145	38,883	202,502	70,409
1972	0.83***	1,254,637	41,443	209,601	75,044
1973	0.85***	1,336,746	44,155	216,870	79,955
1974	0.86***	1,423,732	47,027	224,313	85,159
1975	0.88***	1,476,592	48,773	218,523	88,321
1976	0.89***	1,656,882	54,729	234,981	99,104
1977	0.91***	1,716,761	56,707	253,003	102,686
1978	0.93***	1,856,809	61,333	262,530	111,063
1979	0.94***	1,907,101	62,994	273,398	114,071
1980	0.96***	2,007,457	66,309	277,268	120,073
1981	0.97***	1,898,509	62,710	285,918	113,557
1982	0.99	1,926,829	63,646	295,404	115,251
1983	1.03	2,074,316	68,517	311,084	124,073
1984	1.07	2,172,826	71,771	329,228	129,965
1985	1.10	2,207,980	72,933	336,712	132,068
1986	1.14	2,293,077	75,744	353,666	137,157
1987	1.18	2,330,407	76,977	340,821	139,390
1988	1.22	2,457,891	81,188	379,158	147,016
1989	1.23***	2,587,802	85,478	396,395	154,786
1990	1.25***	2,569,034	84,859	414,460	153,663
1991	1.26***	1,720,015	56,814	302,138	102,880

**** indicates estimates from extrapolation.*

Appendix Table 4.6 The estimated number of units transfused in England, Northern Ireland, Scotland and Wales.

Chapter 4. Task 3. For each year 1970-1991 in England, how many transfusion-recipients (in age-sex bands) were infected with HCV?

A.26 Appendix Tables 4.7 - 4.9 present the estimated number of individuals infected with HCV by transfusion in Northern Ireland, Scotland and Wales, respectively.

Year	Estimated proportion of donations that were infectious with HCV in Northern Ireland (from Task 1)	Estimated number of units transfused in Northern Ireland (from Task 2)	Estimated number of individuals infected by HCV by transfusion in Northern Ireland (col 2 x col 3)
1970	0.034%	36,467	13 (6 - 23)
1971	0.036%	38,883	14 (7 - 26)
1972	0.039%	41,443	16 (8 - 29)
1973	0.041%	44,155	18 (10 - 33)
1974	0.044%	47,027	21 (11 - 37)
1975	0.047%	48,773	23 (13 - 41)
1976	0.050%	54,729	28 (16 - 49)
1977	0.054%	56,707	31 (18 - 55)
1978	0.058%	61,333	36 (21 - 65)
1979	0.062%	62,994	40 (24 - 71)
1980	0.067%	66,309	45 (27 - 80)
1981	0.072%	62,710	45 (27 - 79)
1982	0.077%	63,646	48 (29 - 86)
1983	0.082%	68,517	54 (33 - 99)
1984	0.088%	71,771	61 (37 - 110)
1985	0.039%	72,933	27 (17 - 40)
1986	0.041%	75,744	30 (19 - 44)
1987	0.043%	76,977	32 (20 - 46)
1988	0.044%	81,188	36 (23 - 51)
1989	0.046%	85,478	40 (26 - 56)
1990	0.047%	84,859	40 (26 - 57)
1991	0.049%	56,814	27 (17 - 40)
Total		**1,359,456**	**730** (570 - 1,100)
1970 - 1979		**492,510**	**240** (170 - 400)
1980 - 1991		**866,945**	**490** (390 - 680)

Appendix Table 4.7 Estimation of the annual number of individuals infected with HCV by transfusion in Northern Ireland, 1970-1991 (totals are the rounded sums of the unrounded values).

Year	Estimated proportion of donations that were infectious with HCV in Scotland (from Task 1)	Estimated number of units transfused in Scotland (from Task 2)	Estimated number of individuals infected by HCV by transfusion in Scotland (col 2 x col 3)
1970	0.021%	195,570	41 (27 - 58)
1971	0.021%	202,502	44 (29 - 62)
1972	0.022%	209,601	47 (32 - 66)
1973	0.023%	216,870	50 (34 - 70)
1974	0.023%	224,313	53 (36 - 75)
1975	0.024%	218,523	53 (36 - 76)
1976	0.025%	234,981	59 (41 - 84)
1977	0.027%	253,003	70 (49 - 100)
1978	0.030%	262,530	81 (57 - 120)
1979	0.034%	273,398	95 (66 - 140)
1980	0.038%	277,268	110 (75 - 170)
1981	0.045%	285,918	130 (90 - 200)
1982	0.054%	295,404	160 (110 - 260)
1983	0.066%	311,084	210 (140 - 340)
1984	0.038%	329,228	120 (95 - 160)
1985	0.044%	336,712	150 (110 - 180)
1986	0.049%	353,666	170 (140 - 220)
1987	0.053%	340,821	180 (140 - 220)
1988	0.056%	379,158	210 (170 - 260)
1989	0.060%	396,395	240 (190 - 290)
1990	0.063%	414,460	260 (210 - 320)
1991	0.065%	302,138	200 (160 - 240)
Total		**6,312,546**	**2,700** (2,200 - 3,400)
Total for 1970 - 1979		**2,291,292**	**590** (470 - 800)
Total for 1980 - Aug 1991		**4,021,254**	**2,100** (1,800 - 2,700)

Appendix Table 4.8 Estimation of the annual number of individuals infected with HCV by transfusion in Scotland, 1970-1991 (totals are the rounded sums of the unrounded values).

Year	Estimated proportion of donations that were infectious with HCV in Wales (from Task 1)	Estimated number of units transfused in Wales (from Task 2)	Estimated number of individuals infected by HCV by transfusion in Wales (col 2 x col 3)
1970	0.034%	66,036	23 (13 - 40)
1971	0.036%	70,409	26 (15 - 45)
1972	0.039%	75,044	29 (17 - 50)
1973	0.041%	79,955	33 (20 - 57)
1974	0.044%	85,159	38 (23 - 66)
1975	0.047%	88,321	42 (26 - 72)
1976	0.050%	99,104	51 (32 - 89)
1977	0.054%	102,686	56 (35 - 98)
1978	0.058%	111,063	65 (42 - 120)
1979	0.062%	114,071	73 (46 - 130)
1980	0.067%	120,073	81 (52 - 140)
1981	0.072%	113,557	81 (52 - 140)
1982	0.077%	115,251	87 (56 - 150)
1983	0.082%	124,073	99 (63 - 170)
1984	0.088%	129,965	110 (71 - 200)
1985	0.039%	132,068	50 (34 - 67)
1986	0.041%	137,157	54 (38 - 73)
1987	0.043%	139,390	58 (41 - 78)
1988	0.044%	147,016	65 (46 - 87)
1989	0.046%	154,786	72 (52 - 95)
1990	0.047%	153,663	73 (53 - 97)
1991	0.049%	102,880	50 (34 - 67)
Total		**2,461,730**	**1,300** (1,000 - 2,000)
Total for 1970 - 1979		**891,848**	**430** (310 - 730)
Total for 1980 - Aug 1991		**1,569,881**	**880** (710 - 1,200)

Appendix Table 4.9 Estimation of the annual number of individuals infected with HCV by transfusion in Wales, 1970-1991 (totals are the rounded sums of the unrounded values).

Chapter 4. Task 3. Age-sex distribution of those infected by transfusions

A.27 We used the age-sex distribution as observed by Wallis et al. (2004) in the north of England in 1994.[183] We were able to compare this to the age-sex distribution of transfusion recipients within the SNBTS record-linkage study in 1999. Age groups 0 and 1 - 9 from SNBTS were pooled to be 0 - 9 and age groups 80 - 89 and 90+ from Wallis et al. were pooled to be 80+ in order to allow for direct comparison. This showed close agreement of the age-sex distribution between these two independent sources as shown in Figure 4.8 in the main report, giving confidence to the application of this across different settings.

A.28 Appendix Tables 4.10 - 4.12 present the age-sex distribution of those estimated to be infected in Northern Ireland, Scotland and Wales, respectively.

Age at transfusion (in completed years)	Females Proportion	Females Estimated number HCV-infected 1970-1991	Males Proportion	Males Estimated number HCV-infected 1970-1991
0 – 9	0.016 (0.012 - 0.021)	12 (5 - 22)	0.027 (0.021 - 0.033)	20 (10 - 34)
10 – 19	0.0092 (0.0062 - 0.013)	7 (2 - 14)	0.0082 (0.0054 - 0.012)	6 (1 - 13)
20 – 29	0.037 (0.030 - 0.044)	27 (15 - 45)	0.012 (0.0088 - 0.017)	9 (3 - 18)
30 – 39	0.034 (0.028 - 0.041)	25 (14 - 41)	0.019 (0.014 - 0.024)	14 (6 - 25)
40 – 49	0.045 (0.037 - 0.052)	33 (19 - 53)	0.030 (0.024 - 0.036)	22 (12 - 37)
50 – 59	0.053 (0.045 - 0.061)	39 (24 - 63)	0.052 (0.044- 0.061)	38 (23 - 61)
60 – 69	0.089 (0.079 - 0.10)	65 (44 - 100)	0.11 (0.10 - 0.13)	83 (57 - 130)
70 – 79	0.14 (0.13 - 0.16)	100 (75 - 160)	0.12 (0.11 - 0.13)	89 (62 - 140)
80 – 89	0.11 (0.097 - 0.12)	79 (54 - 120)	0.055 (0.047 - 0.064)	40 (25 - 65)
90+	0.020 (0.015 - 0.025)	15 (7 - 26)	0.0044 (0.0024 - 0.0072)	3 (0 - 8)
Total	**0.56** (0.54 - 0.57)	**400** (310 - 600)	**0.44** (0.43 - 0.46)	**320** (240 - 480)

Appendix Table 4.10 Estimated age-sex distribution of those infected with HCV through transfusion in Northern Ireland, 1970-1991.

[183] Wallis, J. P., et al. "Long-term survival after blood transfusion: a population based study in the North of England", *Transfusion Practice*, vol. 44, 2004, pp. 1025-1032 [RLIT0000824]

Age at transfusion (in completed years)	Females Proportion	Females Estimated number HCV-infected 1970-1991	Males Proportion	Males Estimated number HCV-infected 1970-1991
0 – 9	0.016 (0.012 - 0.021)	43 (26 - 66)	0.027 (0.021 - 0.033)	74 (49 - 110)
10 – 19	0.0092 (0.0062 - 0.013)	25 (13 - 43)	0.0082 (0.0054 - 0.012)	22 (11 - 38)
20 – 29	0.037 (0.030 - 0.044)	100 (70 - 140)	0.012 (0.0088 - 0.017)	34 (19-55)
30 – 39	0.034 (0.028 - 0.041)	93 (64 - 130)	0.019 (0.014 - 0.024)	52 (33 - 78)
40 – 49	0.045 (0.037 - 0.052)	120 (87 - 170)	0.030 (0.024 - 0.036)	81 (55 - 120)
50 – 59	0.053 (0.045 - 0.061)	140 (110 - 200)	0.052 (0.044- 0.061)	140 (100 - 190)
60 – 69	0.089 (0.079 - 0.10)	240 (190 - 320)	0.11 (0.10 - 0.13)	310 (240 - 400)
70 – 79	0.14 (0.13 - 0.16)	400 (310 - 510)	0.12 (0.11 - 0.13)	340 (260 - 430)
80 – 89	0.11 (0.097 - 0.12)	300 (230 - 390)	0.055 (0.047 - 0.064)	150 (110 - 200)
90+	0.020 (0.015 - 0.025)	55 (35 - 81)	0.0044 (0.0024 - 0.0072)	12 (4 - 24)
Total	**0.56** (0.54 - 0.57)	**1,500** (1,200 - 1,900)	**0.44** (0.43 - 0.46)	**1,200** (990 - 1,500)

Appendix Table 4.11 Estimated age-sex distribution of those infected with HCV through transfusion in Scotland, 1970-1991.

Age at transfusion (in completed years)	Females Proportion	Females Estimated number HCV-infected 1970-1991	Males Proportion	Males Estimated number HCV-infected 1970-1991
0 – 9	0.016 (0.012 - 0.021)	21 (11 - 37)	0.027 (0.021 - 0.033)	36 (21 - 59)
10 – 19	0.0092 (0.0062 - 0.013)	12 (5 - 24)	0.0082 (0.0054 - 0.012)	11 (4 - 22)
20 – 29	0.037 (0.030 - 0.044)	49 (30 - 78)	0.012 (0.0088 - 0.017)	16 (8 - 30)
30 – 39	0.034 (0.028 - 0.041)	45 (28 - 73)	0.019 (0.014 - 0.024)	25 (13 - 43)
40 – 49	0.045 (0.037 - 0.052)	59 (38 - 93)	0.030 (0.024 - 0.036)	39 (24 - 65)
50 – 59	0.053 (0.045 - 0.061)	70 (46 - 110)	0.052 (0.044- 0.061)	69 (46 - 110)
60 – 69	0.089 (0.079 - 0.10)	120 (83 - 180)	0.11 (0.10 - 0.13)	150 (110 - 220)
70 – 79	0.14 (0.13 - 0.16)	190 (140 - 290)	0.12 (0.11 - 0.13)	160 (120 - 240)
80 – 89	0.11 (0.097 - 0.12)	140 (100 - 220)	0.055 (0.047 - 0.064)	74 (49 - 110)
90+	0.020 (0.015 - 0.025)	26 (14 - 45)	0.0044 (0.0024 - 0.0072)	6 (1 - 14)
Total	**0.56** (0.54 - 0.57)	**730** (570 - 1,100)	**0.44** (0.43 - 0.46)	**590** (450 - 870)

Appendix Table 4.12 Estimated age-sex distribution of those infected with HCV through transfusion in Wales, 1970-1991.

Chapter 4. Task 4. How many chronic HCV-infected transfusion recipients survived 10 years post-transfusion?

Extending survival from 5 to 10 years post-transfusion

A.29 The Cox proportional hazard model is based on assuming a survival function $S(t)$ (the probability of surviving beyond (t) of the form

$$S(t) = S_0(t)^{e^{\sum \beta_i}},$$

where $S_0(t)$ is the survival function of a 'baseline' patient (with all factors at 0), and βi is the coefficient (log hazard ratio) associated with the ith group.

So for group i,

$$log\ S_i(t) = log\ S_0(t) \times e^{\beta_i},$$

and

$$\frac{log\ S_i(t)}{log\ S_0(t)} = e^{\beta_i}$$

is the hazard ratio.

So for times $t = 5,10$,

$$\frac{log\ S_i(5)}{log\ S_0(5)} = \frac{log\ S_i(10)}{log\ S_0(10)}$$

or

$$\frac{log\ S_i(10)}{log\ S_i(5)} = \frac{log\ S_0(10)}{log\ S_0(5)}$$

So for all groups, $\frac{log\ S_i(10)}{log\ S_i(5)}$ should be a constant, depending on i.

A.30 We estimate $r_i = \frac{log\ S_i(10)}{log\ S_i(5)}$ for each age-group in the EASTR study and apply this to the appropriate age-group in the Wallis study, as shown in Appendix Table 4.13.

If $S_{jW}(5)$ is the 5-year survival in the ith age-group in Wallis, we estimate $S_{jW}(10)$ as follows:

Assume the change from 5 to 10 years matches that in EASTR, and so

$$r_j = \frac{log\ S_{jW}(10)}{log\ S_{jW}(5)}$$

or

$$S_{jW}(10) = S_{jW}(5)^{r_j}$$

A.31 The probability of surviving to 1, 5 and 7 years post-transfusion, independent of age-group, was broadly similar within the Wallis and EASTR cohorts, as shown in Appendix Tables 4.14 and 4.15. In particular, similar values were observed for Wallis compared to recipients of RBC in the EASTR study. We also compared the aforementioned survival probabilities across the Wallis cohort and EASTR RBC cohort using the EASTR age-groups in both settings. Again, there was broad agreement between the two sources, with the age categories 40 - 59 and 60 - 74 appearing to have the greatest differences.

A.32 Appendix Figure 4.3 presents the resulting probabilities of surviving 5 and 10 years post-transfusion, respectively.

Age-group in EASTR study	r_i		Age-groups to apply to in Wallis data
16 - 24	1.157	Average 1.161	0 - 9 10 - 19 20 - 29 30 - 39
25 - 39	1.164		
40 - 59	1.237		40 - 49 50 - 59
60 - 74	1.368		60 - 69 70 - 79
75+	1.670		80 - 89 90+

Appendix Table 4.13 For each age-group in the EASTR study we estimate $r_i = \frac{log\ S_i(10)}{log\ S_i(5)}$ *and then determine which age groups (in years) to apply this to in the Wallis study.*

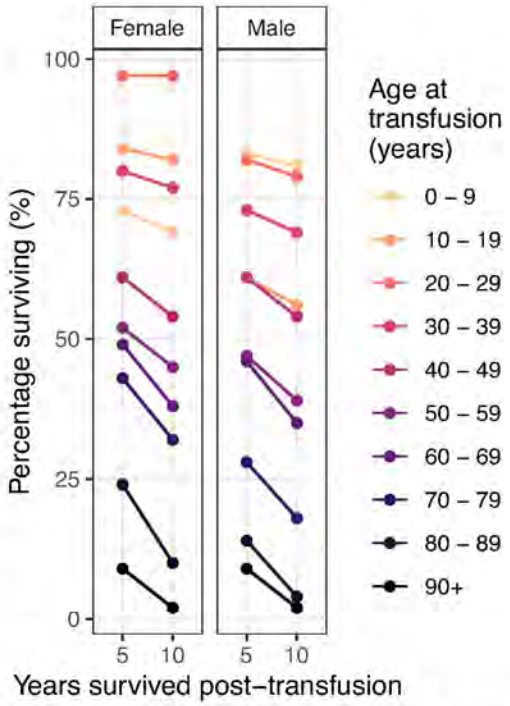
Comparison of Wallis et al. (2004) and EASTR

Data	1 year survival (%)	5 year survival (%)	7 year survival (%)
Wallis - all	67.5	46.8	41.3
EASTR - RBC	66.0	47.0	41.5
EASTR - FFP	55.0	41.0	35.3
EASTR - PLT	53.0	38.0	34.2

Appendix Table 4.14 Percentage of transfusion recipients surviving to 1, 5, and 7 years post-transfusion using data from the Wallis study and different blood products from the EASTR study without age stratification.

Age group	Sample size		1 year survival (%)		5 year survival (%)		7 year survival (%)	
	EASTR (RBC)	Wallis	EASTR (RBC)	Wallis	EASTR (RBC)	Wallis	EASTR (RBC)	Wallis
16 - 24	288	91	93.1	93.4	89.8	88.9	88.9	85.4
25 - 39	841	241	89.4	89.1	83.7	82.8	82.7	80.2
40 - 59	1,625	537	75.1	71.6	60.3	54.6	57.3	51.8
60 - 74	2,666	1,032	66.2	64.5	47.1	44.1	42.0	36.9
75+	3,255	846	54.1	56.9	27.5	24.4	20.4	17.7

Appendix Table 4.15 Percentage of transfusion recipients surviving to 1, 5, and 7 years post-transfusion using data from the Wallis study and the EASTR study (RBC only) using the age groups (in years) in EASTR.



Appendix Figure 4.3 The probability of surviving to 5 and 10 years post-transfusion by age-sex group.

A.33 Appendix Tables 4.16 - 4.18 present the estimated number of people with chronic HCV infection surviving 10 years post-transfusion in Northern Ireland, Scotland and Wales, respectively.

Year	(a) Estimated number of individuals infected by transfusion with chronic HCV, were they to survive for 6 months	(b) Estimated number of people with chronic HCV infection surviving 10 years post-transfusion
1970	10 (4 - 19)	4 (1 - 9)
1971	12 (5 - 22)	4 (1 - 10)
1972	13 (6 - 25)	5 (1 - 11)
1973	15 (7 - 28)	5 (1 - 12)
1974	17 (9 - 31)	6 (2 - 13)
1975	19 (10 - 34)	7 (2 - 14)
1976	23 (12 - 41)	8 (3 - 17)
1977	25 (14 - 46)	9 (4 - 19)
1978	30 (17 - 54)	11 (5 - 21)
1979	33 (19 - 59)	12 (5 - 24)
1980	37 (21 - 66)	14 (6 - 26)
1981	37 (21 - 66)	14 (6 - 26)
1982	39 (23 - 71)	15 (6 - 28)
1983	45 (27 - 81)	17 (8 - 32)
1984	50 (29 - 92)	19 (9 - 36)
1985	22 (13 - 34)	8 (3 - 15)
1986	25 (15 - 36)	9 (4 - 16)
1987	26 (16 - 39)	10 (4 - 17)
1988	29 (18 - 43)	11 (5 - 18)
1989	32 (20 - 47)	12 (6 - 20)
1990	33 (21 - 47)	12 (6 - 20)
1991	22 (13 - 34)	8 (3 - 15)
Total	**600** (460 - 890)	**220** (160 - 330)

Appendix Table 4.16 Estimated annual number of individuals with chronic HCV infection by transfusion in Northern Ireland, 1970-1991, and surviving 10 years post-transfusion. Column (a) is obtained by applying the estimated clearance rate (around 18%) to the estimated number of infections in Appendix Table 4.7. Column (b) is obtained by applying the survival rates in Table 4.11 (main report) to the age-sex profile in Appendix Table 4.10.

Year	(a) Estimated number of individuals infected by transfusion with chronic HCV, were they to survive for 6 months	(b) Estimated number of people with chronic HCV infection surviving 10 years post-transfusion
1970	33 (21 - 49)	12 (6 - 21)
1971	36 (23 - 52)	13 (6 - 22)
1972	38 (25 - 56)	14 (7 - 23)
1973	41 (27 - 58)	15 (8 - 24)
1974	43 (29 - 63)	16 (8 - 26)
1975	43 (29 - 64)	16 (8 - 26)
1976	48 (32 - 70)	18 (9 - 29)
1977	57 (39 - 85)	21 (12 - 34)
1978	66 (45 - 98)	24 (14 - 39)
1979	78 (53 - 120)	29 (17 -46)
1980	88 (60 - 140)	33 (20 - 54)
1981	100 (72 - 170)	39 (24 - 64)
1982	130 (90 - 220)	49 (30 - 82)
1983	170 (120 - 280)	63 (39 - 110)
1984	100 (76 - 130)	37 (24 - 52)
1985	120 (91 - 150)	44 (30 - 61)
1986	140 (110 - 180)	53 (36 - 72)
1987	150 (110 - 190)	54 (38 - 74)
1988	180 (140 - 220)	64 (46 - 86)
1989	200 (150 - 240)	72 (51 - 96)
1990	210 (170 - 270)	79 (58 - 100)
1991	160 (120 - 200)	59 (42 - 80)
Total	**2,200** (1,800 - 2,800)	**830** (660 - 1,100)

Appendix Table 4.17 Estimated annual number of individuals with chronic HCV infection by transfusion in Scotland, 1970-1991, and surviving 10 years post-transfusion. Column (a) is obtained by applying the estimated clearance rate (around 18%) to the estimated number of infections in Appendix Table 4.8. Column (b) is obtained by applying the survival rates in Table 4.11 (main report) to the age-sex profile in Appendix Table 4.11.

Year	(a) Estimated number of individuals infected by transfusion with chronic HCV, were they to survive for 6 months	(b) Estimated number of people with chronic HCV infection surviving 10 years post-transfusion
1970	19 (10 - 34)	7 (2 - 14)
1971	21 (12 - 38)	8 (3 - 16)
1972	24 (14 - 42)	9 (3 - 17)
1973	27 (15 - 47)	10 (4 - 20)
1974	31 (18 - 55)	11 (5 - 22)
1975	34 (20 - 60)	13 (6 - 24)
1976	42 (25 - 73)	15 (7 - 29)
1977	46 (28 - 81)	17 (8 - 32)
1978	54 (34 - 95)	20 (10 - 37)
1979	60 (37 - 100)	22 (11 - 41)
1980	66 (42 - 120)	25 (13 - 45)
1981	66 (42 - 120)	25 (13 - 46)
1982	71 (45 - 130)	26 (14 - 49)
1983	81 (51 - 140)	30 (16 - 56)
1984	90 (57 - 160)	33 (19 - 62)
1985	41 (27 - 57)	15 (8 - 24)
1986	45 (30 - 62)	16 (9 - 26)
1987	48 (32 - 66)	18 (9 - 28)
1988	53 (36 - 73)	20 (11 - 30)
1989	59 (41 - 80)	22 (12 - 33)
1990	60 (42 - 81)	22 (13 - 33)
1991	41 (27 - 57)	15 (8 - 24)
Total	**1,100** (830 - 1,600)	**400** (300 - 600)

Appendix Table 4.18 Estimated annual number of individuals with chronic HCV infection by transfusion in Wales, 1970-1991, and surviving 10 years post-transfusion. Column (a) is obtained by applying the estimated clearance rate (around 18%) to the estimated number of infections in Appendix Table 4.9. Column (b) is obtained by applying the survival rates in Table 4.11 (main report) to the age-sex profile in Appendix Table 4.12.

Chapter 4. Task 5. How many chronic HCV 10-year-survivors would have survived to the end of 2019, assuming no excess risk from HCV?

Estimating long-term survival without additional transfusion-risk

A.34 Long-term post-transfusion survival requires the annual hazards for each individual surviving from 10 years-post transfusion until 2019. (Note that 2019 can be substituted for preceding years of interest during the study period using this methodology). Accounting for the 10 age-groups at transfusion, two sexes, 21 transfusion years and all possible years between 1980 (10 years after the first transfusion year) and 2019, a total of 12,980 hazards were required to be extracted from 38 life-tables (in three-year intervals from 1980 - 1982 until 2017 - 2019). Note that for the year 1980, the life-table used was 1980 - 1982 rather than 1979 - 1981 which was not available online. Similarly, for 2019 the life-table used was 2017 - 2019 rather than 2018 - 2020 which was likely obscured by changes in mortality caused, directly and indirectly, by the COVID-19 pandemic. For each nation, the methodology was applied to the national life-tables as published by the ONS.

A.35 An illustrative example is now provided. Consider a female aged 40 - 49 transfused in England in 1985. This female's age can be represented as 45 (years) (the mean and median of this age group). The likelihood of surviving 10 years post-transfusion was already accounted for in Task 4.4, and so 10 years later in 1995, this female is 55. There are 24 years (2019 - 1995) that this female has to survive in order to still be alive in 2019, with this hazard changing annually both due to their ageing and also to revisions in life-expectancy within life-tables. Appendix Table 4.19 illustrates the hazards to be extracted relevant to this female.

Years since transfusion	Year between 10-years post transfusion and 2019	Age in this year	Life-table to extract from	Hazard (q_x)
10	1995	55	1994 - 1996	0.004461
11	1996	56	1995 - 1997	0.004757
12	1997	57	1996 - 1998	0.005295
...	...	...	...	...
32	2017	77	2016 - 2018	0.039053
33	2018	78	2017 - 2019	0.042587
34	2019	79	2017 - 2019	0.046928

Appendix Table 4.19 An illustrative example of the hazards required to estimate the probability of survival to 2019 for a female aged 40 - 49 at transfusion in 1985.

A.36 By denoting $S_x = 1 - q_x$ as the probability of surviving each year, the probability of surviving to 2019 is the product of all S_x for the number of years between transfusion and 2019. In the example above, this is 24 years and thus 24 values of S_x contributing to overall probability of surviving to 2019.

A.37 The probability of surviving to 2019 per age-group and year of transfusion for females and males per country is set out in Appendix Tables 4.20 - 4.27, respectively.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.96	0.91	0.80	0.52	0.11	0.00	0.00	0.00	0.00	0.00
	1971	0.97	0.92	0.82	0.56	0.14	0.00	0.00	0.00	0.00	0.00
	1972	0.97	0.93	0.84	0.60	0.17	0.00	0.00	0.00	0.00	0.00
	1973	0.97	0.93	0.85	0.63	0.21	0.00	0.00	0.00	0.00	0.00
	1974	0.97	0.94	0.86	0.66	0.25	0.01	0.00	0.00	0.00	0.00
	1975	0.98	0.95	0.87	0.69	0.30	0.02	0.00	0.00	0.00	0.00
	1976	0.98	0.95	0.88	0.72	0.35	0.03	0.00	0.00	0.00	0.00
	1977	0.98	0.96	0.89	0.74	0.40	0.05	0.00	0.00	0.00	0.00
	1978	0.98	0.96	0.90	0.77	0.44	0.06	0.00	0.00	0.00	0.00
	1979	0.98	0.96	0.91	0.79	0.49	0.09	0.00	0.00	0.00	0.00
	1980	0.98	0.97	0.92	0.81	0.53	0.12	0.00	0.00	0.00	0.00
	1981	0.99	0.97	0.93	0.83	0.58	0.15	0.00	0.00	0.00	0.00
	1982	0.99	0.97	0.93	0.84	0.62	0.19	0.00	0.00	0.00	0.00
	1983	0.99	0.97	0.94	0.86	0.65	0.23	0.00	0.00	0.00	0.00
	1984	0.99	0.98	0.95	0.87	0.68	0.28	0.02	0.00	0.00	0.00
	1985	0.99	0.98	0.95	0.88	0.71	0.33	0.03	0.00	0.00	0.00
	1986	0.99	0.98	0.96	0.89	0.74	0.38	0.04	0.00	0.00	0.00
	1987	0.99	0.98	0.96	0.90	0.77	0.43	0.06	0.00	0.00	0.00
	1988	0.99	0.98	0.96	0.91	0.79	0.48	0.08	0.00	0.00	0.00
	1989	0.99	0.99	0.97	0.92	0.81	0.53	0.11	0.00	0.00	0.00
	1990	0.99	0.99	0.97	0.93	0.83	0.57	0.14	0.00	0.00	0.00
	1991	0.99	0.99	0.97	0.94	0.85	0.62	0.18	0.00	0.00	0.00

Appendix Table 4.20 Probability of a female in England in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0 - 9	10 - 19	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.94	0.87	0.71	0.38	0.05	0.00	0.00	0.00	0.00	0.00
	1971	0.94	0.88	0.74	0.42	0.07	0.00	0.00	0.00	0.00	0.00
	1972	0.95	0.89	0.76	0.46	0.09	0.00	0.00	0.00	0.00	0.00
	1973	0.95	0.90	0.78	0.50	0.11	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.91	0.80	0.53	0.15	0.00	0.00	0.00	0.00	0.00
	1975	0.96	0.92	0.81	0.56	0.18	0.01	0.00	0.00	0.00	0.00
	1976	0.96	0.92	0.83	0.60	0.22	0.01	0.00	0.00	0.00	0.00
	1977	0.96	0.93	0.84	0.63	0.26	0.02	0.00	0.00	0.00	0.00
	1978	0.96	0.94	0.85	0.67	0.30	0.03	0.00	0.00	0.00	0.00
	1979	0.97	0.94	0.87	0.70	0.35	0.04	0.00	0.00	0.00	0.00
	1980	0.97	0.94	0.88	0.72	0.40	0.06	0.00	0.00	0.00	0.00
	1981	0.97	0.95	0.89	0.75	0.44	0.08	0.00	0.00	0.00	0.00
	1982	0.97	0.95	0.90	0.77	0.48	0.10	0.00	0.00	0.00	0.00
	1983	0.98	0.96	0.91	0.79	0.52	0.13	0.00	0.00	0.00	0.00
	1984	0.98	0.96	0.92	0.81	0.56	0.17	0.01	0.00	0.00	0.00
	1985	0.98	0.96	0.93	0.82	0.59	0.21	0.01	0.00	0.00	0.00
	1986	0.98	0.97	0.93	0.84	0.63	0.25	0.02	0.00	0.00	0.00
	1987	0.98	0.97	0.94	0.85	0.66	0.30	0.03	0.00	0.00	0.00
	1988	0.98	0.97	0.95	0.87	0.70	0.35	0.04	0.00	0.00	0.00
	1989	0.99	0.97	0.95	0.88	0.73	0.40	0.06	0.00	0.00	0.00
	1990	0.99	0.98	0.95	0.89	0.75	0.45	0.08	0.00	0.00	0.00
	1991	0.99	0.98	0.96	0.90	0.78	0.49	0.11	0.00	0.00	0.00

Appendix Table 4.21 Probability of a male in England in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.96	0.90	0.79	0.50	0.09	0.00	0.00	0.00	0.00	0.00
	1971	0.97	0.91	0.81	0.54	0.13	0.00	0.00	0.00	0.00	0.00
	1972	0.97	0.92	0.82	0.57	0.16	0.00	0.00	0.00	0.00	0.00
	1973	0.97	0.93	0.84	0.61	0.20	0.00	0.00	0.00	0.00	0.00
	1974	0.97	0.94	0.85	0.64	0.24	0.01	0.00	0.00	0.00	0.00
	1975	0.97	0.94	0.86	0.68	0.28	0.02	0.00	0.00	0.00	0.00
	1976	0.98	0.95	0.88	0.71	0.32	0.03	0.00	0.00	0.00	0.00
	1977	0.98	0.95	0.89	0.73	0.37	0.04	0.00	0.00	0.00	0.00
	1978	0.98	0.96	0.89	0.75	0.42	0.06	0.00	0.00	0.00	0.00
	1979	0.98	0.96	0.90	0.77	0.47	0.08	0.00	0.00	0.00	0.00
	1980	0.99	0.97	0.91	0.80	0.52	0.10	0.00	0.00	0.00	0.00
	1981	0.99	0.97	0.92	0.82	0.56	0.14	0.00	0.00	0.00	0.00
	1982	0.99	0.97	0.93	0.83	0.59	0.17	0.00	0.00	0.00	0.00
	1983	0.99	0.97	0.93	0.85	0.63	0.22	0.00	0.00	0.00	0.00
	1984	0.99	0.98	0.94	0.86	0.66	0.26	0.02	0.00	0.00	0.00
	1985	0.99	0.98	0.94	0.87	0.70	0.31	0.02	0.00	0.00	0.00
	1986	0.99	0.98	0.95	0.88	0.73	0.36	0.03	0.00	0.00	0.00
	1987	0.99	0.98	0.96	0.90	0.75	0.41	0.05	0.00	0.00	0.00
	1988	0.99	0.98	0.96	0.90	0.77	0.46	0.07	0.00	0.00	0.00
	1989	0.99	0.99	0.97	0.91	0.80	0.51	0.10	0.00	0.00	0.00
	1990	0.99	0.99	0.97	0.92	0.82	0.56	0.13	0.00	0.00	0.00
	1991	0.99	0.99	0.97	0.93	0.84	0.60	0.17	0.00	0.00	0.00

Appendix Table 4.22 Probability of a female in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.93	0.86	0.69	0.34	0.04	0.00	0.00	0.00	0.00	0.00
	1971	0.93	0.87	0.72	0.39	0.05	0.00	0.00	0.00	0.00	0.00
	1972	0.94	0.89	0.74	0.43	0.07	0.00	0.00	0.00	0.00	0.00
	1973	0.94	0.89	0.76	0.47	0.10	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.90	0.79	0.51	0.12	0.00	0.00	0.00	0.00	0.00
	1975	0.95	0.91	0.80	0.55	0.16	0.01	0.00	0.00	0.00	0.00
	1976	0.95	0.92	0.82	0.58	0.19	0.01	0.00	0.00	0.00	0.00
	1977	0.96	0.92	0.83	0.62	0.24	0.01	0.00	0.00	0.00	0.00
	1978	0.96	0.93	0.85	0.64	0.28	0.02	0.00	0.00	0.00	0.00
	1979	0.96	0.94	0.86	0.67	0.32	0.03	0.00	0.00	0.00	0.00
	1980	0.96	0.94	0.87	0.70	0.36	0.05	0.00	0.00	0.00	0.00
	1981	0.97	0.94	0.88	0.73	0.41	0.06	0.00	0.00	0.00	0.00
	1982	0.97	0.95	0.90	0.76	0.45	0.09	0.00	0.00	0.00	0.00
	1983	0.97	0.95	0.91	0.78	0.50	0.12	0.00	0.00	0.00	0.00
	1984	0.97	0.96	0.91	0.80	0.54	0.15	0.01	0.00	0.00	0.00
	1985	0.97	0.96	0.92	0.82	0.58	0.18	0.01	0.00	0.00	0.00
	1986	0.98	0.96	0.93	0.83	0.61	0.22	0.01	0.00	0.00	0.00
	1987	0.98	0.97	0.93	0.85	0.65	0.28	0.02	0.00	0.00	0.00
	1988	0.98	0.97	0.94	0.86	0.67	0.32	0.03	0.00	0.00	0.00
	1989	0.98	0.97	0.95	0.87	0.70	0.37	0.05	0.00	0.00	0.00
	1990	0.98	0.97	0.95	0.89	0.73	0.42	0.07	0.00	0.00	0.00
	1991	0.98	0.98	0.95	0.90	0.77	0.47	0.09	0.00	0.00	0.00

Appendix Table 4.23 Probability of a male in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.95	0.89	0.75	0.44	0.08	0.00	0.00	0.00	0.00	0.00
	1971	0.96	0.90	0.77	0.48	0.10	0.00	0.00	0.00	0.00	0.00
	1972	0.96	0.91	0.79	0.52	0.13	0.00	0.00	0.00	0.00	0.00
	1973	0.96	0.92	0.81	0.55	0.16	0.00	0.00	0.00	0.00	0.00
	1974	0.97	0.93	0.83	0.59	0.20	0.01	0.00	0.00	0.00	0.00
	1975	0.97	0.93	0.84	0.62	0.24	0.02	0.00	0.00	0.00	0.00
	1976	0.97	0.94	0.85	0.65	0.28	0.02	0.00	0.00	0.00	0.00
	1977	0.97	0.94	0.87	0.68	0.33	0.03	0.00	0.00	0.00	0.00
	1978	0.98	0.95	0.88	0.71	0.37	0.05	0.00	0.00	0.00	0.00
	1979	0.98	0.95	0.89	0.74	0.42	0.06	0.00	0.00	0.00	0.00
	1980	0.98	0.96	0.90	0.76	0.46	0.09	0.00	0.00	0.00	0.00
	1981	0.98	0.96	0.91	0.79	0.50	0.11	0.00	0.00	0.00	0.00
	1982	0.98	0.96	0.91	0.81	0.54	0.14	0.00	0.00	0.00	0.00
	1983	0.98	0.97	0.92	0.82	0.58	0.18	0.00	0.00	0.00	0.00
	1984	0.98	0.97	0.93	0.84	0.61	0.22	0.01	0.00	0.00	0.00
	1985	0.99	0.97	0.94	0.85	0.64	0.26	0.02	0.00	0.00	0.00
	1986	0.99	0.97	0.94	0.87	0.68	0.31	0.03	0.00	0.00	0.00
	1987	0.99	0.98	0.95	0.88	0.71	0.36	0.04	0.00	0.00	0.00
	1988	0.99	0.98	0.95	0.89	0.74	0.41	0.06	0.00	0.00	0.00
	1989	0.99	0.98	0.96	0.90	0.76	0.46	0.08	0.00	0.00	0.00
	1990	0.99	0.98	0.96	0.91	0.79	0.51	0.11	0.00	0.00	0.00
	1991	0.99	0.98	0.97	0.92	0.81	0.55	0.15	0.00	0.00	0.00

Appendix Table 4.24 Probability of a female in Scotland in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.92	0.84	0.64	0.30	0.03	0.00	0.00	0.00	0.00	0.00
	1971	0.92	0.85	0.68	0.34	0.05	0.00	0.00	0.00	0.00	0.00
	1972	0.92	0.86	0.70	0.38	0.06	0.00	0.00	0.00	0.00	0.00
	1973	0.93	0.87	0.73	0.41	0.08	0.00	0.00	0.00	0.00	0.00
	1974	0.93	0.88	0.75	0.45	0.11	0.00	0.00	0.00	0.00	0.00
	1975	0.94	0.89	0.77	0.48	0.14	0.01	0.00	0.00	0.00	0.00
	1976	0.94	0.90	0.79	0.52	0.17	0.01	0.00	0.00	0.00	0.00
	1977	0.94	0.91	0.80	0.55	0.21	0.01	0.00	0.00	0.00	0.00
	1978	0.95	0.91	0.82	0.59	0.24	0.02	0.00	0.00	0.00	0.00
	1979	0.95	0.92	0.83	0.62	0.28	0.03	0.00	0.00	0.00	0.00
	1980	0.95	0.92	0.85	0.66	0.32	0.04	0.00	0.00	0.00	0.00
	1981	0.95	0.93	0.86	0.69	0.36	0.06	0.00	0.00	0.00	0.00
	1982	0.96	0.93	0.87	0.72	0.40	0.07	0.00	0.00	0.00	0.00
	1983	0.96	0.94	0.88	0.75	0.44	0.10	0.00	0.00	0.00	0.00
	1984	0.96	0.94	0.89	0.76	0.48	0.13	0.01	0.00	0.00	0.00
	1985	0.97	0.94	0.90	0.78	0.51	0.16	0.01	0.00	0.00	0.00
	1986	0.97	0.95	0.91	0.80	0.55	0.20	0.01	0.00	0.00	0.00
	1987	0.97	0.95	0.92	0.82	0.59	0.25	0.02	0.00	0.00	0.00
	1988	0.97	0.95	0.93	0.84	0.63	0.29	0.03	0.00	0.00	0.00
	1989	0.98	0.96	0.93	0.85	0.66	0.33	0.05	0.00	0.00	0.00
	1990	0.98	0.96	0.94	0.87	0.70	0.38	0.06	0.00	0.00	0.00
	1991	0.98	0.96	0.94	0.88	0.73	0.42	0.09	0.00	0.00	0.00

Appendix Table 4.25 Probability of a male in Scotland in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.96	0.90	0.78	0.49	0.10	0.00	0.00	0.00	0.00	0.00
	1971	0.96	0.91	0.80	0.53	0.12	0.00	0.00	0.00	0.00	0.00
	1972	0.97	0.92	0.82	0.57	0.16	0.00	0.00	0.00	0.00	0.00
	1973	0.97	0.93	0.84	0.61	0.19	0.00	0.00	0.00	0.00	0.00
	1974	0.97	0.93	0.85	0.64	0.23	0.01	0.00	0.00	0.00	0.00
	1975	0.97	0.94	0.86	0.67	0.28	0.02	0.00	0.00	0.00	0.00
	1976	0.98	0.95	0.87	0.70	0.33	0.03	0.00	0.00	0.00	0.00
	1977	0.98	0.95	0.88	0.73	0.37	0.04	0.00	0.00	0.00	0.00
	1978	0.98	0.95	0.89	0.75	0.42	0.06	0.00	0.00	0.00	0.00
	1979	0.98	0.96	0.90	0.77	0.47	0.08	0.00	0.00	0.00	0.00
	1980	0.98	0.96	0.91	0.79	0.51	0.11	0.00	0.00	0.00	0.00
	1981	0.98	0.97	0.92	0.81	0.55	0.14	0.00	0.00	0.00	0.00
	1982	0.98	0.97	0.92	0.83	0.59	0.17	0.00	0.00	0.00	0.00
	1983	0.99	0.97	0.93	0.85	0.63	0.21	0.00	0.00	0.00	0.00
	1984	0.99	0.97	0.94	0.86	0.66	0.26	0.02	0.00	0.00	0.00
	1985	0.99	0.98	0.94	0.87	0.69	0.30	0.02	0.00	0.00	0.00
	1986	0.99	0.98	0.95	0.88	0.72	0.36	0.04	0.00	0.00	0.00
	1987	0.99	0.98	0.95	0.89	0.75	0.41	0.05	0.00	0.00	0.00
	1988	0.99	0.98	0.96	0.90	0.77	0.46	0.07	0.00	0.00	0.00
	1989	0.99	0.98	0.96	0.91	0.79	0.51	0.10	0.00	0.00	0.00
	1990	0.99	0.99	0.97	0.92	0.81	0.55	0.13	0.00	0.00	0.00
	1991	0.99	0.99	0.97	0.93	0.84	0.60	0.17	0.00	0.00	0.00

Appendix Table 4.26 Probability of a female in Wales in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.93	0.86	0.69	0.35	0.04	0.00	0.00	0.00	0.00	0.00
	1971	0.93	0.87	0.72	0.39	0.06	0.00	0.00	0.00	0.00	0.00
	1972	0.94	0.88	0.75	0.43	0.08	0.00	0.00	0.00	0.00	0.00
	1973	0.94	0.90	0.77	0.47	0.10	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.90	0.78	0.51	0.13	0.00	0.00	0.00	0.00	0.00
	1975	0.95	0.91	0.80	0.54	0.16	0.01	0.00	0.00	0.00	0.00
	1976	0.95	0.92	0.82	0.58	0.20	0.01	0.00	0.00	0.00	0.00
	1977	0.95	0.92	0.83	0.62	0.24	0.01	0.00	0.00	0.00	0.00
	1978	0.96	0.93	0.85	0.65	0.28	0.02	0.00	0.00	0.00	0.00
	1979	0.96	0.93	0.86	0.68	0.33	0.03	0.00	0.00	0.00	0.00
	1980	0.96	0.94	0.87	0.70	0.37	0.05	0.00	0.00	0.00	0.00
	1981	0.96	0.94	0.88	0.74	0.41	0.07	0.00	0.00	0.00	0.00
	1982	0.97	0.95	0.89	0.76	0.45	0.09	0.00	0.00	0.00	0.00
	1983	0.97	0.95	0.90	0.78	0.49	0.12	0.00	0.00	0.00	0.00
	1984	0.97	0.95	0.91	0.80	0.53	0.15	0.01	0.00	0.00	0.00
	1985	0.97	0.96	0.92	0.81	0.57	0.19	0.01	0.00	0.00	0.00
	1986	0.98	0.96	0.93	0.83	0.61	0.23	0.01	0.00	0.00	0.00
	1987	0.98	0.96	0.93	0.84	0.64	0.28	0.02	0.00	0.00	0.00
	1988	0.98	0.96	0.94	0.86	0.68	0.32	0.04	0.00	0.00	0.00
	1989	0.98	0.97	0.94	0.87	0.71	0.37	0.05	0.00	0.00	0.00
	1990	0.98	0.97	0.95	0.88	0.73	0.42	0.07	0.00	0.00	0.00
	1991	0.99	0.97	0.95	0.89	0.77	0.47	0.10	0.00	0.00	0.00

Appendix Table 4.27 Probability of a male in Wales in each age band (in years) and transfusion year surviving to 2019 without assuming excess post-transfusion hazard.

Scotland's National Blood Transfusion Service (SNBTS) record-linkage study

A.38 The SNBTS's suite of record-linkage studies was approved by Scotland's Public Benefit and Privacy Panel for Health and Social Care (PBPP-HSC) in 2021. Approval was necessary because individual consent for establishing survival status was not being sought.

A.39 Minimal information about cohort-members includes age in completed years at 1st RBC-transfusion in their cohort-year, sex and International Classification of Diseases 2010 (ICD-10) disease-chapter for the underlying condition at hospital-discharge that aligned with the patient's RBC-transfusion-date.

A.40 The 1999-RBC-cohort comprised 13,260 persons with known sex (7,431 females; 5,829 males) and age-band (2,064 aged under 40 years (15.6%) of whom 1,286 (62%) were female; but 8,836 aged 60 years or older (66.6%) at their first RBC-transfusion in 1999, of whom 4,970 (56%) were female).

A.41 The 2004-RBC-cohort comprised 13,274 persons with known sex (7,438 females; 5,836 males) and age-band (1,565 aged under 40 years (11.8%) of whom 970 (62%) were female; but 9,520 aged 60 years or older (66.6%) at their first RBC-transfusion in 1999, of whom 5,345 (56%) were female).

Accounting for additional hazards at 11 - 20 years post-transfusion

A.42 The SNBTS record-linkage study followed individuals transfused in 1999 and 2004 to study survival in 5-year epochs post-transfusion. As the first 10-years of post-transfusion survival were already accounted for, these data were used to model the additional risk encountered by individuals between i) 11 - 15 and ii) 16 - 20 years post-transfusion.

A.43 The data included the number of transfusion-recipients alive at the beginning of each 5-year epoch of follow-up, and the subsequent number of deaths and emigrations observed in each transfusion age-group and sex per 5-year epoch of follow-up. It was then possible to estimate the expected number of deaths within each age-group and sex per epoch using a methodology analogous to that set out above. However, in this instance, there were only 5 relevant hazards contributing to the probability of surviving the epoch, one per year of the epoch under consideration. The expected number of survivors was estimated as the estimated number of people susceptible at the beginning of the epoch (e.g. the end of the previous epoch or in the case of the first epoch, the number of people transfused) multiplied by the probability of surviving that epoch. The number of people susceptible at the beginning of each epoch was taken as the observed number of individuals surviving to that time minus the observed number of emigration. The expected deaths were then the differences between the number of non-emigres who began the epoch and expected survivors. It is possible that some people who emigrated earlier in the follow-up then returned to Scotland to die - which was not accounted for here. However, this applied to a very small number of individuals and thus is unlikely to have any substantial effect on the resulting post-transfusion hazards.

A.44 The additional post-transfusion hazard was derived by considering the ratio of observed to expected deaths. Two scenarios were considered. First, hazards were pooled over age-groups and sex to give one estimated hazard ratio for 11 - 15 years post-transfusion and another for 16 - 20 years post-transfusion (with the exception of the 70 - 79 age-band which showed an anomalous reduced risk 16 - 20 years post-transfusion). In the case of 11 - 15 years post-transfusion, data were pooled over the 1999 and 2004 cohorts. This was not possible for the 16 - 20 years post-transfusion epoch due to lack of time elapsed since 2004, and so the hazard ratio for this epoch comes only from the 1999 cohort.

A.45 Second, the hazards were then stratified by age-group per epoch by pooling across sex and cohort years as applicable. Values for age-groups 0, 1 - 9 in the study were pooled as the 0 - 9 group in accordance with our model structure. Similarly, the study's final age group is 80+, and so the hazards for this category were applied to both the 80 - 89 and 90+ age groups in the model.

A.46 The resulting hazards are shown in Appendix Tables 4.28 and 4.29. The original hazards extracted from the life-tables were then multiplied by the relevant post-transfusion hazard ratio in any year, that is 11 - 15 or 16 - 20 years post-transfusion. The resulting probabilities of survival were then determined as above. The probabilities using the age-stratified hazards are shown in Appendix Tables 4.30 - 4.37 for females and males in each nation, respectively.

Additional hazard 11 - 15 years post-transfusion	Additional hazard 16 - 20 years post transfusion
1.72	1.32

Appendix Table 4.28 Additional hazards from transfusion for 11-15 and 16-20 years post-transfusion by pooling across age band, sex and, where applicable, cohort year.

Age at transfusion	Additional hazard 11 - 15 years post-transfusion	Additional hazard 16 - 20 years post transfusion
0 - 9	9.30	5.20
10 - 19	5.80	6.30
20 - 29	4.10	2.00
30 - 39	3.10	1.20
40 - 49	3.40	2.30
50 - 59	2.00	1.50
60 - 69	1.42	1.13
70 - 79	1.04	0.81
80 - 89	1.31	1.08
90+	1.31	1.08

Appendix Table 4.29 Additional hazards from transfusion by age band (in years) for 11-15 and 16-20 years post-transfusion by pooling across sex and, where applicable, cohort year.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.95	0.89	0.78	0.50	0.09	0.00	0.00	0.00	0.00	0.00
	1971	0.95	0.90	0.80	0.54	0.12	0.00	0.00	0.00	0.00	0.00
	1972	0.95	0.91	0.82	0.58	0.14	0.00	0.00	0.00	0.00	0.00
	1973	0.95	0.91	0.83	0.61	0.18	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.92	0.84	0.64	0.22	0.01	0.00	0.00	0.00	0.00
	1975	0.96	0.92	0.85	0.67	0.26	0.02	0.00	0.00	0.00	0.00
	1976	0.96	0.93	0.86	0.70	0.30	0.03	0.00	0.00	0.00	0.00
	1977	0.96	0.93	0.87	0.72	0.34	0.04	0.00	0.00	0.00	0.00
	1978	0.96	0.94	0.88	0.75	0.38	0.06	0.00	0.00	0.00	0.00
	1979	0.96	0.94	0.89	0.77	0.43	0.08	0.00	0.00	0.00	0.00
	1980	0.97	0.94	0.90	0.79	0.47	0.10	0.00	0.00	0.00	0.00
	1981	0.97	0.95	0.91	0.81	0.51	0.13	0.00	0.00	0.00	0.00
	1982	0.97	0.95	0.91	0.82	0.54	0.16	0.00	0.00	0.00	0.00
	1983	0.97	0.95	0.92	0.84	0.57	0.20	0.00	0.00	0.00	0.00
	1984	0.97	0.95	0.93	0.85	0.60	0.24	0.02	0.00	0.00	0.00
	1985	0.97	0.96	0.93	0.86	0.63	0.28	0.02	0.00	0.00	0.00
	1986	0.97	0.96	0.94	0.87	0.66	0.33	0.04	0.00	0.00	0.00
	1987	0.97	0.96	0.94	0.88	0.68	0.38	0.05	0.00	0.00	0.00
	1988	0.98	0.96	0.95	0.89	0.71	0.42	0.07	0.00	0.00	0.00
	1989	0.98	0.96	0.95	0.90	0.73	0.47	0.10	0.00	0.00	0.00
	1990	0.98	0.97	0.95	0.90	0.75	0.51	0.13	0.00	0.00	0.00
	1991	0.98	0.97	0.96	0.91	0.77	0.55	0.16	0.00	0.00	0.00

Appendix Table 4.30 Probability of a female in England in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.89	0.83	0.69	0.36	0.03	0.00	0.00	0.00	0.00	0.00
	1971	0.89	0.84	0.72	0.40	0.05	0.00	0.00	0.00	0.00	0.00
	1972	0.90	0.85	0.74	0.44	0.07	0.00	0.00	0.00	0.00	0.00
	1973	0.90	0.86	0.76	0.47	0.09	0.00	0.00	0.00	0.00	0.00
	1974	0.90	0.87	0.77	0.51	0.11	0.00	0.00	0.00	0.00	0.00
	1975	0.91	0.87	0.79	0.54	0.14	0.01	0.00	0.00	0.00	0.00
	1976	0.91	0.88	0.80	0.57	0.17	0.01	0.00	0.00	0.00	0.00
	1977	0.91	0.89	0.81	0.61	0.20	0.01	0.00	0.00	0.00	0.00
	1978	0.92	0.89	0.82	0.64	0.24	0.02	0.00	0.00	0.00	0.00
	1979	0.92	0.89	0.84	0.67	0.28	0.03	0.00	0.00	0.00	0.00
	1980	0.92	0.90	0.85	0.69	0.31	0.04	0.00	0.00	0.00	0.00
	1981	0.93	0.90	0.86	0.72	0.35	0.06	0.00	0.00	0.00	0.00
	1982	0.93	0.90	0.87	0.75	0.39	0.08	0.00	0.00	0.00	0.00
	1983	0.93	0.91	0.88	0.76	0.42	0.10	0.00	0.00	0.00	0.00
	1984	0.94	0.91	0.89	0.78	0.45	0.13	0.01	0.00	0.00	0.00
	1985	0.94	0.92	0.90	0.79	0.48	0.17	0.01	0.00	0.00	0.00
	1986	0.94	0.92	0.90	0.81	0.52	0.20	0.01	0.00	0.00	0.00
	1987	0.94	0.92	0.91	0.82	0.55	0.24	0.02	0.00	0.00	0.00
	1988	0.94	0.92	0.92	0.83	0.58	0.28	0.03	0.00	0.00	0.00
	1989	0.95	0.93	0.92	0.85	0.61	0.33	0.05	0.00	0.00	0.00
	1990	0.95	0.93	0.93	0.86	0.63	0.37	0.07	0.00	0.00	0.00
	1991	0.95	0.94	0.93	0.87	0.66	0.41	0.09	0.00	0.00	0.00

Appendix Table 4.31 Probability of a male in England in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.95	0.88	0.77	0.48	0.08	0.00	0.00	0.00	0.00	0.00
	1971	0.95	0.89	0.79	0.52	0.10	0.00	0.00	0.00	0.00	0.00
	1972	0.95	0.90	0.80	0.55	0.13	0.00	0.00	0.00	0.00	0.00
	1973	0.95	0.90	0.82	0.59	0.16	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.91	0.83	0.62	0.20	0.01	0.00	0.00	0.00	0.00
	1975	0.96	0.92	0.84	0.65	0.23	0.02	0.00	0.00	0.00	0.00
	1976	0.96	0.93	0.86	0.68	0.27	0.02	0.00	0.00	0.00	0.00
	1977	0.96	0.93	0.87	0.71	0.32	0.03	0.00	0.00	0.00	0.00
	1978	0.97	0.93	0.88	0.73	0.36	0.05	0.00	0.00	0.00	0.00
	1979	0.97	0.94	0.88	0.75	0.40	0.07	0.00	0.00	0.00	0.00
	1980	0.97	0.95	0.89	0.77	0.44	0.09	0.00	0.00	0.00	0.00
	1981	0.97	0.95	0.90	0.79	0.48	0.12	0.00	0.00	0.00	0.00
	1982	0.97	0.95	0.91	0.81	0.52	0.15	0.00	0.00	0.00	0.00
	1983	0.97	0.95	0.91	0.82	0.55	0.18	0.00	0.00	0.00	0.00
	1984	0.97	0.96	0.92	0.84	0.58	0.22	0.01	0.00	0.00	0.00
	1985	0.97	0.96	0.93	0.85	0.61	0.27	0.02	0.00	0.00	0.00
	1986	0.97	0.96	0.93	0.86	0.64	0.31	0.03	0.00	0.00	0.00
	1987	0.97	0.96	0.94	0.87	0.67	0.35	0.04	0.00	0.00	0.00
	1988	0.97	0.96	0.94	0.88	0.68	0.40	0.06	0.00	0.00	0.00
	1989	0.98	0.96	0.95	0.89	0.71	0.45	0.09	0.00	0.00	0.00
	1990	0.98	0.97	0.95	0.89	0.73	0.49	0.11	0.00	0.00	0.00
	1991	0.98	0.97	0.96	0.90	0.75	0.53	0.15	0.00	0.00	0.00

Appendix Table 4.32 Probability of a female in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.86	0.81	0.66	0.32	0.03	0.00	0.00	0.00	0.00	0.00
	1971	0.87	0.82	0.69	0.36	0.04	0.00	0.00	0.00	0.00	0.00
	1972	0.87	0.84	0.71	0.40	0.05	0.00	0.00	0.00	0.00	0.00
	1973	0.88	0.84	0.74	0.45	0.07	0.00	0.00	0.00	0.00	0.00
	1974	0.88	0.85	0.76	0.48	0.09	0.00	0.00	0.00	0.00	0.00
	1975	0.89	0.86	0.78	0.52	0.11	0.00	0.00	0.00	0.00	0.00
	1976	0.89	0.86	0.79	0.55	0.14	0.01	0.00	0.00	0.00	0.00
	1977	0.90	0.87	0.80	0.58	0.18	0.01	0.00	0.00	0.00	0.00
	1978	0.90	0.88	0.82	0.61	0.21	0.02	0.00	0.00	0.00	0.00
	1979	0.90	0.88	0.83	0.64	0.24	0.02	0.00	0.00	0.00	0.00
	1980	0.91	0.89	0.84	0.67	0.28	0.03	0.00	0.00	0.00	0.00
	1981	0.91	0.90	0.86	0.70	0.32	0.05	0.00	0.00	0.00	0.00
	1982	0.91	0.90	0.87	0.72	0.36	0.06	0.00	0.00	0.00	0.00
	1983	0.91	0.90	0.88	0.74	0.40	0.09	0.00	0.00	0.00	0.00
	1984	0.91	0.91	0.88	0.76	0.43	0.11	0.00	0.00	0.00	0.00
	1985	0.92	0.92	0.89	0.79	0.46	0.14	0.01	0.00	0.00	0.00
	1986	0.92	0.92	0.90	0.80	0.49	0.18	0.01	0.00	0.00	0.00
	1987	0.92	0.92	0.90	0.81	0.52	0.22	0.02	0.00	0.00	0.00
	1988	0.92	0.92	0.91	0.83	0.55	0.26	0.03	0.00	0.00	0.00
	1989	0.92	0.92	0.91	0.84	0.58	0.30	0.04	0.00	0.00	0.00
	1990	0.93	0.92	0.92	0.85	0.61	0.34	0.05	0.00	0.00	0.00
	1991	0.93	0.92	0.92	0.86	0.64	0.38	0.07	0.00	0.00	0.00

Appendix Table 4.33 Probability of a male in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.93	0.87	0.73	0.42	0.06	0.00	0.00	0.00	0.00	0.00
	1971	0.94	0.88	0.75	0.46	0.08	0.00	0.00	0.00	0.00	0.00
	1972	0.94	0.88	0.77	0.50	0.10	0.00	0.00	0.00	0.00	0.00
	1973	0.94	0.89	0.79	0.53	0.13	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.90	0.81	0.57	0.16	0.01	0.00	0.00	0.00	0.00
	1975	0.95	0.91	0.82	0.60	0.19	0.01	0.00	0.00	0.00	0.00
	1976	0.95	0.91	0.83	0.63	0.23	0.02	0.00	0.00	0.00	0.00
	1977	0.95	0.91	0.84	0.65	0.27	0.03	0.00	0.00	0.00	0.00
	1978	0.95	0.92	0.85	0.68	0.31	0.04	0.00	0.00	0.00	0.00
	1979	0.96	0.92	0.87	0.71	0.35	0.05	0.00	0.00	0.00	0.00
	1980	0.96	0.93	0.88	0.73	0.39	0.07	0.00	0.00	0.00	0.00
	1981	0.96	0.93	0.88	0.76	0.42	0.09	0.00	0.00	0.00	0.00
	1982	0.96	0.94	0.89	0.78	0.46	0.12	0.00	0.00	0.00	0.00
	1983	0.96	0.94	0.90	0.80	0.49	0.15	0.00	0.00	0.00	0.00
	1984	0.96	0.94	0.91	0.81	0.52	0.18	0.01	0.00	0.00	0.00
	1985	0.96	0.95	0.91	0.82	0.55	0.22	0.02	0.00	0.00	0.00
	1986	0.96	0.95	0.92	0.84	0.57	0.26	0.03	0.00	0.00	0.00
	1987	0.96	0.95	0.93	0.85	0.60	0.31	0.04	0.00	0.00	0.00
	1988	0.97	0.95	0.93	0.86	0.63	0.35	0.05	0.00	0.00	0.00
	1989	0.97	0.95	0.94	0.87	0.66	0.40	0.07	0.00	0.00	0.00
	1990	0.97	0.95	0.94	0.88	0.68	0.44	0.10	0.00	0.00	0.00
	1991	0.97	0.95	0.94	0.89	0.71	0.48	0.13	0.00	0.00	0.00

Appendix Table 4.34 Probability of a female in Scotland in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.86	0.79	0.61	0.28	0.02	0.00	0.00	0.00	0.00	0.00
	1971	0.87	0.80	0.65	0.31	0.03	0.00	0.00	0.00	0.00	0.00
	1972	0.87	0.81	0.67	0.35	0.04	0.00	0.00	0.00	0.00	0.00
	1973	0.87	0.82	0.70	0.39	0.06	0.00	0.00	0.00	0.00	0.00
	1974	0.87	0.83	0.71	0.42	0.07	0.00	0.00	0.00	0.00	0.00
	1975	0.88	0.84	0.73	0.45	0.09	0.00	0.00	0.00	0.00	0.00
	1976	0.88	0.85	0.75	0.48	0.12	0.01	0.00	0.00	0.00	0.00
	1977	0.89	0.85	0.77	0.52	0.15	0.01	0.00	0.00	0.00	0.00
	1978	0.89	0.85	0.79	0.55	0.17	0.01	0.00	0.00	0.00	0.00
	1979	0.89	0.86	0.80	0.59	0.21	0.02	0.00	0.00	0.00	0.00
	1980	0.89	0.86	0.81	0.62	0.24	0.03	0.00	0.00	0.00	0.00
	1981	0.89	0.86	0.82	0.66	0.27	0.04	0.00	0.00	0.00	0.00
	1982	0.89	0.87	0.84	0.68	0.30	0.05	0.00	0.00	0.00	0.00
	1983	0.90	0.87	0.85	0.71	0.33	0.07	0.00	0.00	0.00	0.00
	1984	0.90	0.87	0.86	0.72	0.36	0.09	0.00	0.00	0.00	0.00
	1985	0.91	0.87	0.86	0.74	0.39	0.12	0.01	0.00	0.00	0.00
	1986	0.91	0.88	0.87	0.76	0.42	0.15	0.01	0.00	0.00	0.00
	1987	0.91	0.88	0.88	0.78	0.45	0.19	0.02	0.00	0.00	0.00
	1988	0.92	0.88	0.88	0.79	0.48	0.22	0.02	0.00	0.00	0.00
	1989	0.92	0.88	0.89	0.81	0.52	0.26	0.04	0.00	0.00	0.00
	1990	0.92	0.88	0.89	0.82	0.55	0.30	0.05	0.00	0.00	0.00
	1991	0.93	0.89	0.90	0.83	0.59	0.33	0.07	0.00	0.00	0.00

Appendix Table 4.35 Probability of a male in Scotland in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.94	0.88	0.76	0.48	0.08	0.00	0.00	0.00	0.00	0.00
	1971	0.95	0.89	0.78	0.51	0.10	0.00	0.00	0.00	0.00	0.00
	1972	0.95	0.90	0.80	0.55	0.13	0.00	0.00	0.00	0.00	0.00
	1973	0.95	0.91	0.82	0.59	0.16	0.00	0.00	0.00	0.00	0.00
	1974	0.95	0.91	0.83	0.62	0.20	0.01	0.00	0.00	0.00	0.00
	1975	0.95	0.92	0.84	0.65	0.23	0.02	0.00	0.00	0.00	0.00
	1976	0.96	0.92	0.86	0.68	0.28	0.02	0.00	0.00	0.00	0.00
	1977	0.96	0.93	0.87	0.71	0.32	0.03	0.00	0.00	0.00	0.00
	1978	0.96	0.93	0.87	0.73	0.36	0.05	0.00	0.00	0.00	0.00
	1979	0.96	0.93	0.88	0.75	0.40	0.07	0.00	0.00	0.00	0.00
	1980	0.96	0.94	0.89	0.77	0.44	0.09	0.00	0.00	0.00	0.00
	1981	0.96	0.94	0.89	0.79	0.48	0.12	0.00	0.00	0.00	0.00
	1982	0.96	0.95	0.90	0.81	0.51	0.15	0.00	0.00	0.00	0.00
	1983	0.97	0.95	0.91	0.82	0.55	0.18	0.00	0.00	0.00	0.00
	1984	0.97	0.95	0.92	0.83	0.58	0.22	0.01	0.00	0.00	0.00
	1985	0.97	0.95	0.92	0.85	0.60	0.26	0.02	0.00	0.00	0.00
	1986	0.97	0.95	0.93	0.86	0.63	0.31	0.03	0.00	0.00	0.00
	1987	0.97	0.96	0.93	0.87	0.66	0.35	0.04	0.00	0.00	0.00
	1988	0.98	0.96	0.94	0.88	0.68	0.40	0.06	0.00	0.00	0.00
	1989	0.98	0.96	0.94	0.89	0.70	0.44	0.09	0.00	0.00	0.00
	1990	0.98	0.96	0.95	0.89	0.72	0.48	0.12	0.00	0.00	0.00
	1991	0.98	0.96	0.95	0.90	0.74	0.53	0.15	0.00	0.00	0.00

Appendix Table 4.36 Probability of a female in Wales in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.88	0.82	0.67	0.33	0.03	0.00	0.00	0.00	0.00	0.00
	1971	0.88	0.83	0.70	0.37	0.04	0.00	0.00	0.00	0.00	0.00
	1972	0.89	0.84	0.72	0.41	0.05	0.00	0.00	0.00	0.00	0.00
	1973	0.89	0.86	0.74	0.44	0.07	0.00	0.00	0.00	0.00	0.00
	1974	0.90	0.86	0.76	0.48	0.10	0.00	0.00	0.00	0.00	0.00
	1975	0.90	0.87	0.77	0.52	0.12	0.00	0.00	0.00	0.00	0.00
	1976	0.90	0.87	0.79	0.55	0.15	0.01	0.00	0.00	0.00	0.00
	1977	0.90	0.88	0.80	0.59	0.18	0.01	0.00	0.00	0.00	0.00
	1978	0.90	0.88	0.82	0.62	0.22	0.02	0.00	0.00	0.00	0.00
	1979	0.90	0.88	0.83	0.65	0.25	0.02	0.00	0.00	0.00	0.00
	1980	0.90	0.88	0.84	0.67	0.29	0.03	0.00	0.00	0.00	0.00
	1981	0.91	0.89	0.85	0.70	0.32	0.05	0.00	0.00	0.00	0.00
	1982	0.91	0.89	0.86	0.73	0.36	0.07	0.00	0.00	0.00	0.00
	1983	0.91	0.89	0.87	0.75	0.39	0.09	0.00	0.00	0.00	0.00
	1984	0.91	0.90	0.88	0.77	0.43	0.12	0.00	0.00	0.00	0.00
	1985	0.92	0.90	0.89	0.78	0.46	0.15	0.01	0.00	0.00	0.00
	1986	0.93	0.90	0.89	0.79	0.49	0.18	0.01	0.00	0.00	0.00
	1987	0.93	0.91	0.90	0.81	0.53	0.22	0.02	0.00	0.00	0.00
	1988	0.93	0.90	0.91	0.82	0.56	0.26	0.03	0.00	0.00	0.00
	1989	0.94	0.91	0.91	0.84	0.59	0.30	0.04	0.00	0.00	0.00
	1990	0.94	0.91	0.92	0.85	0.61	0.34	0.06	0.00	0.00	0.00
	1991	0.94	0.91	0.92	0.86	0.64	0.38	0.08	0.00	0.00	0.00

Appendix Table 4.37 Probability of a male in Wales in each age band (in years) and transfusion year surviving to 2019 assuming excess age-stratified post-transfusion hazard.

Chapter 4. Task 6. Of those infected with chronic HCV through transfusion between 1970 to 1991, how many died of HCV-related causes by 2019?

A.47 An additional hazard of 1.53 stemming from chronic HCV infection was also incorporated into the model, applied uniformly to all transfusion-adjusted hazards as set out in 4.5. The resulting chronic HCV infection hazards are shown for females and males for each nation in Appendix Tables 4.38 - 4.45.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.92	0.84	0.68	0.34	0.02	0.00	0.00	0.00	0.00	0.00
	1971	0.92	0.85	0.71	0.39	0.03	0.00	0.00	0.00	0.00	0.00
	1972	0.92	0.86	0.73	0.43	0.05	0.00	0.00	0.00	0.00	0.00
	1973	0.93	0.87	0.76	0.47	0.07	0.00	0.00	0.00	0.00	0.00
	1974	0.93	0.88	0.77	0.51	0.09	0.00	0.00	0.00	0.00	0.00
	1975	0.94	0.89	0.79	0.54	0.12	0.00	0.00	0.00	0.00	0.00
	1976	0.94	0.89	0.80	0.57	0.15	0.00	0.00	0.00	0.00	0.00
	1977	0.94	0.90	0.81	0.61	0.19	0.01	0.00	0.00	0.00	0.00
	1978	0.94	0.91	0.83	0.64	0.23	0.01	0.00	0.00	0.00	0.00
	1979	0.95	0.91	0.84	0.67	0.27	0.02	0.00	0.00	0.00	0.00
	1980	0.95	0.92	0.85	0.69	0.31	0.03	0.00	0.00	0.00	0.00
	1981	0.95	0.92	0.86	0.72	0.35	0.04	0.00	0.00	0.00	0.00
	1982	0.95	0.92	0.87	0.74	0.39	0.06	0.00	0.00	0.00	0.00
	1983	0.95	0.93	0.88	0.76	0.42	0.08	0.00	0.00	0.00	0.00
	1984	0.96	0.93	0.89	0.78	0.46	0.11	0.00	0.00	0.00	0.00
	1985	0.96	0.93	0.90	0.79	0.49	0.14	0.00	0.00	0.00	0.00
	1986	0.96	0.94	0.91	0.81	0.52	0.18	0.00	0.00	0.00	0.00
	1987	0.96	0.94	0.91	0.82	0.56	0.22	0.01	0.00	0.00	0.00
	1988	0.96	0.94	0.92	0.83	0.59	0.26	0.01	0.00	0.00	0.00
	1989	0.96	0.95	0.92	0.85	0.61	0.31	0.02	0.00	0.00	0.00
	1990	0.97	0.95	0.93	0.86	0.64	0.36	0.04	0.00	0.00	0.00
	1991	0.97	0.95	0.93	0.87	0.66	0.40	0.06	0.00	0.00	0.00

Appendix Table 4.38 Probability of a female in England in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.83	0.75	0.56	0.20	0.00	0.00	0.00	0.00	0.00	0.00
	1971	0.84	0.77	0.60	0.24	0.01	0.00	0.00	0.00	0.00	0.00
	1972	0.85	0.78	0.63	0.28	0.01	0.00	0.00	0.00	0.00	0.00
	1973	0.85	0.79	0.65	0.32	0.02	0.00	0.00	0.00	0.00	0.00
	1974	0.86	0.80	0.67	0.35	0.03	0.00	0.00	0.00	0.00	0.00
	1975	0.86	0.81	0.69	0.39	0.04	0.00	0.00	0.00	0.00	0.00
	1976	0.87	0.82	0.71	0.42	0.06	0.00	0.00	0.00	0.00	0.00
	1977	0.87	0.83	0.73	0.46	0.08	0.00	0.00	0.00	0.00	0.00
	1978	0.87	0.84	0.74	0.50	0.11	0.00	0.00	0.00	0.00	0.00
	1979	0.88	0.84	0.76	0.54	0.14	0.00	0.00	0.00	0.00	0.00
	1980	0.88	0.85	0.78	0.57	0.17	0.01	0.00	0.00	0.00	0.00
	1981	0.89	0.85	0.79	0.61	0.20	0.01	0.00	0.00	0.00	0.00
	1982	0.89	0.86	0.81	0.64	0.23	0.02	0.00	0.00	0.00	0.00
	1983	0.90	0.86	0.82	0.66	0.26	0.03	0.00	0.00	0.00	0.00
	1984	0.90	0.87	0.84	0.68	0.30	0.04	0.00	0.00	0.00	0.00
	1985	0.91	0.87	0.85	0.70	0.33	0.06	0.00	0.00	0.00	0.00
	1986	0.91	0.88	0.86	0.72	0.36	0.08	0.00	0.00	0.00	0.00
	1987	0.91	0.88	0.87	0.74	0.40	0.11	0.00	0.00	0.00	0.00
	1988	0.92	0.88	0.87	0.76	0.43	0.14	0.00	0.00	0.00	0.00
	1989	0.92	0.89	0.88	0.77	0.47	0.18	0.01	0.00	0.00	0.00
	1990	0.92	0.90	0.89	0.79	0.50	0.21	0.01	0.00	0.00	0.00
	1991	0.93	0.90	0.89	0.81	0.53	0.25	0.02	0.00	0.00	0.00

Appendix Table 4.39 Probability of a male in England in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.92	0.82	0.67	0.32	0.02	0.00	0.00	0.00	0.00	0.00
	1971	0.92	0.84	0.69	0.37	0.03	0.00	0.00	0.00	0.00	0.00
	1972	0.92	0.85	0.71	0.40	0.04	0.00	0.00	0.00	0.00	0.00
	1973	0.92	0.86	0.73	0.44	0.06	0.00	0.00	0.00	0.00	0.00
	1974	0.93	0.87	0.75	0.48	0.08	0.00	0.00	0.00	0.00	0.00
	1975	0.93	0.88	0.77	0.52	0.10	0.00	0.00	0.00	0.00	0.00
	1976	0.94	0.89	0.79	0.56	0.13	0.00	0.00	0.00	0.00	0.00
	1977	0.94	0.89	0.81	0.58	0.17	0.00	0.00	0.00	0.00	0.00
	1978	0.95	0.90	0.82	0.61	0.21	0.01	0.00	0.00	0.00	0.00
	1979	0.95	0.91	0.83	0.64	0.25	0.01	0.00	0.00	0.00	0.00
	1980	0.95	0.92	0.83	0.67	0.29	0.02	0.00	0.00	0.00	0.00
	1981	0.95	0.92	0.85	0.70	0.33	0.03	0.00	0.00	0.00	0.00
	1982	0.96	0.92	0.86	0.72	0.37	0.05	0.00	0.00	0.00	0.00
	1983	0.95	0.93	0.87	0.74	0.40	0.07	0.00	0.00	0.00	0.00
	1984	0.95	0.93	0.88	0.76	0.43	0.10	0.00	0.00	0.00	0.00
	1985	0.95	0.93	0.89	0.78	0.47	0.13	0.00	0.00	0.00	0.00
	1986	0.96	0.93	0.90	0.79	0.51	0.16	0.00	0.00	0.00	0.00
	1987	0.96	0.94	0.91	0.81	0.54	0.20	0.01	0.00	0.00	0.00
	1988	0.96	0.94	0.91	0.83	0.56	0.24	0.01	0.00	0.00	0.00
	1989	0.96	0.94	0.92	0.84	0.59	0.29	0.02	0.00	0.00	0.00
	1990	0.97	0.95	0.93	0.84	0.62	0.34	0.03	0.00	0.00	0.00
	1991	0.97	0.95	0.93	0.86	0.65	0.38	0.05	0.00	0.00	0.00

Appendix Table 4.40 Probability of a female in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.80	0.72	0.53	0.17	0.00	0.00	0.00	0.00	0.00	0.00
	1971	0.81	0.74	0.57	0.21	0.01	0.00	0.00	0.00	0.00	0.00
	1972	0.81	0.76	0.60	0.25	0.01	0.00	0.00	0.00	0.00	0.00
	1973	0.82	0.77	0.62	0.29	0.01	0.00	0.00	0.00	0.00	0.00
	1974	0.83	0.78	0.65	0.33	0.02	0.00	0.00	0.00	0.00	0.00
	1975	0.84	0.79	0.68	0.37	0.03	0.00	0.00	0.00	0.00	0.00
	1976	0.84	0.80	0.70	0.40	0.05	0.00	0.00	0.00	0.00	0.00
	1977	0.85	0.81	0.71	0.44	0.07	0.00	0.00	0.00	0.00	0.00
	1978	0.86	0.82	0.73	0.46	0.09	0.00	0.00	0.00	0.00	0.00
	1979	0.85	0.83	0.75	0.50	0.11	0.00	0.00	0.00	0.00	0.00
	1980	0.86	0.83	0.77	0.54	0.14	0.00	0.00	0.00	0.00	0.00
	1981	0.86	0.84	0.79	0.58	0.17	0.01	0.00	0.00	0.00	0.00
	1982	0.87	0.85	0.81	0.61	0.20	0.01	0.00	0.00	0.00	0.00
	1983	0.87	0.86	0.82	0.63	0.24	0.02	0.00	0.00	0.00	0.00
	1984	0.87	0.86	0.83	0.66	0.27	0.03	0.00	0.00	0.00	0.00
	1985	0.87	0.87	0.84	0.69	0.31	0.05	0.00	0.00	0.00	0.00
	1986	0.88	0.88	0.84	0.71	0.33	0.07	0.00	0.00	0.00	0.00
	1987	0.88	0.88	0.85	0.73	0.37	0.09	0.00	0.00	0.00	0.00
	1988	0.89	0.88	0.87	0.75	0.40	0.12	0.00	0.00	0.00	0.00
	1989	0.89	0.88	0.87	0.76	0.43	0.15	0.01	0.00	0.00	0.00
	1990	0.89	0.88	0.88	0.78	0.46	0.19	0.01	0.00	0.00	0.00
	1991	0.89	0.89	0.88	0.80	0.50	0.23	0.02	0.00	0.00	0.00

Appendix Table 4.41 Probability of a male in Northern Ireland in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.90	0.80	0.61	0.27	0.01	0.00	0.00	0.00	0.00	0.00
	1971	0.90	0.82	0.65	0.31	0.02	0.00	0.00	0.00	0.00	0.00
	1972	0.91	0.83	0.67	0.34	0.03	0.00	0.00	0.00	0.00	0.00
	1973	0.91	0.84	0.70	0.38	0.04	0.00	0.00	0.00	0.00	0.00
	1974	0.92	0.85	0.72	0.42	0.06	0.00	0.00	0.00	0.00	0.00
	1975	0.92	0.86	0.74	0.45	0.08	0.00	0.00	0.00	0.00	0.00
	1976	0.92	0.87	0.75	0.49	0.10	0.00	0.00	0.00	0.00	0.00
	1977	0.93	0.87	0.77	0.52	0.13	0.00	0.00	0.00	0.00	0.00
	1978	0.93	0.88	0.79	0.56	0.16	0.01	0.00	0.00	0.00	0.00
	1979	0.94	0.89	0.80	0.59	0.19	0.01	0.00	0.00	0.00	0.00
	1980	0.94	0.89	0.82	0.62	0.23	0.02	0.00	0.00	0.00	0.00
	1981	0.94	0.90	0.83	0.65	0.27	0.02	0.00	0.00	0.00	0.00
	1982	0.94	0.90	0.84	0.68	0.30	0.03	0.00	0.00	0.00	0.00
	1983	0.94	0.91	0.85	0.70	0.33	0.05	0.00	0.00	0.00	0.00
	1984	0.94	0.91	0.86	0.72	0.37	0.07	0.00	0.00	0.00	0.00
	1985	0.94	0.92	0.87	0.74	0.40	0.09	0.00	0.00	0.00	0.00
	1986	0.94	0.92	0.88	0.76	0.43	0.12	0.00	0.00	0.00	0.00
	1987	0.95	0.92	0.89	0.78	0.46	0.16	0.00	0.00	0.00	0.00
	1988	0.95	0.93	0.90	0.79	0.49	0.20	0.01	0.00	0.00	0.00
	1989	0.95	0.93	0.90	0.81	0.52	0.24	0.01	0.00	0.00	0.00
	1990	0.95	0.93	0.91	0.82	0.55	0.28	0.02	0.00	0.00	0.00
	1991	0.95	0.93	0.91	0.84	0.59	0.32	0.04	0.00	0.00	0.00

Appendix Table 4.42 Probability of a female in Scotland in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.80	0.69	0.47	0.14	0.00	0.00	0.00	0.00	0.00	0.00
	1971	0.80	0.71	0.51	0.17	0.00	0.00	0.00	0.00	0.00	0.00
	1972	0.80	0.73	0.55	0.20	0.01	0.00	0.00	0.00	0.00	0.00
	1973	0.81	0.74	0.57	0.23	0.01	0.00	0.00	0.00	0.00	0.00
	1974	0.81	0.76	0.60	0.26	0.02	0.00	0.00	0.00	0.00	0.00
	1975	0.82	0.77	0.62	0.29	0.02	0.00	0.00	0.00	0.00	0.00
	1976	0.82	0.78	0.64	0.33	0.04	0.00	0.00	0.00	0.00	0.00
	1977	0.83	0.78	0.67	0.36	0.05	0.00	0.00	0.00	0.00	0.00
	1978	0.83	0.78	0.69	0.40	0.07	0.00	0.00	0.00	0.00	0.00
	1979	0.83	0.79	0.71	0.44	0.09	0.00	0.00	0.00	0.00	0.00
	1980	0.83	0.79	0.73	0.48	0.11	0.00	0.00	0.00	0.00	0.00
	1981	0.84	0.80	0.74	0.52	0.13	0.01	0.00	0.00	0.00	0.00
	1982	0.84	0.80	0.76	0.55	0.16	0.01	0.00	0.00	0.00	0.00
	1983	0.84	0.81	0.78	0.59	0.18	0.02	0.00	0.00	0.00	0.00
	1984	0.85	0.81	0.79	0.61	0.21	0.02	0.00	0.00	0.00	0.00
	1985	0.86	0.81	0.80	0.63	0.23	0.04	0.00	0.00	0.00	0.00
	1986	0.87	0.82	0.81	0.66	0.26	0.05	0.00	0.00	0.00	0.00
	1987	0.87	0.82	0.82	0.68	0.29	0.07	0.00	0.00	0.00	0.00
	1988	0.87	0.82	0.83	0.70	0.33	0.09	0.00	0.00	0.00	0.00
	1989	0.88	0.82	0.83	0.72	0.36	0.12	0.00	0.00	0.00	0.00
	1990	0.89	0.83	0.84	0.74	0.40	0.15	0.01	0.00	0.00	0.00
	1991	0.90	0.84	0.85	0.76	0.44	0.18	0.01	0.00	0.00	0.00

Appendix Table 4.43 Probability of a male in Scotland in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	**1970**	0.91	0.82	0.66	0.32	0.02	0.00	0.00	0.00	0.00	0.00
	1971	0.92	0.84	0.69	0.36	0.03	0.00	0.00	0.00	0.00	0.00
	1972	0.92	0.85	0.71	0.40	0.04	0.00	0.00	0.00	0.00	0.00
	1973	0.93	0.86	0.74	0.44	0.06	0.00	0.00	0.00	0.00	0.00
	1974	0.93	0.87	0.75	0.48	0.08	0.00	0.00	0.00	0.00	0.00
	1975	0.93	0.88	0.77	0.51	0.10	0.00	0.00	0.00	0.00	0.00
	1976	0.93	0.88	0.79	0.55	0.14	0.00	0.00	0.00	0.00	0.00
	1977	0.94	0.89	0.80	0.58	0.17	0.00	0.00	0.00	0.00	0.00
	1978	0.94	0.90	0.81	0.62	0.21	0.01	0.00	0.00	0.00	0.00
	1979	0.94	0.90	0.82	0.64	0.25	0.01	0.00	0.00	0.00	0.00
	1980	0.94	0.91	0.83	0.66	0.28	0.02	0.00	0.00	0.00	0.00
	1981	0.94	0.91	0.84	0.69	0.32	0.03	0.00	0.00	0.00	0.00
	1982	0.94	0.92	0.86	0.72	0.36	0.05	0.00	0.00	0.00	0.00
	1983	0.95	0.92	0.87	0.74	0.39	0.07	0.00	0.00	0.00	0.00
	1984	0.95	0.92	0.88	0.76	0.43	0.09	0.00	0.00	0.00	0.00
	1985	0.96	0.93	0.89	0.77	0.46	0.12	0.00	0.00	0.00	0.00
	1986	0.96	0.93	0.89	0.79	0.49	0.16	0.00	0.00	0.00	0.00
	1987	0.96	0.93	0.90	0.81	0.52	0.20	0.01	0.00	0.00	0.00
	1988	0.97	0.93	0.91	0.82	0.55	0.24	0.01	0.00	0.00	0.00
	1989	0.97	0.94	0.92	0.83	0.58	0.28	0.02	0.00	0.00	0.00
	1990	0.97	0.94	0.92	0.84	0.61	0.33	0.03	0.00	0.00	0.00
	1991	0.97	0.94	0.93	0.85	0.64	0.37	0.05	0.00	0.00	0.00

Appendix Table 4.44 Probability of a female in Wales in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

Age band at transfusion		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Midpoint age		5	15	25	35	45	55	65	75	85	95
Midpoint age after surviving 10 years		15	25	35	45	55	65	75	85	95	105
Transfusion year	***1970***	0.82	0.74	0.54	0.18	0.00	0.00	0.00	0.00	0.00	0.00
	1971	0.83	0.76	0.57	0.21	0.01	0.00	0.00	0.00	0.00	0.00
	1972	0.84	0.77	0.60	0.25	0.01	0.00	0.00	0.00	0.00	0.00
	1973	0.84	0.79	0.63	0.29	0.02	0.00	0.00	0.00	0.00	0.00
	1974	0.85	0.80	0.65	0.32	0.03	0.00	0.00	0.00	0.00	0.00
	1975	0.85	0.80	0.67	0.36	0.04	0.00	0.00	0.00	0.00	0.00
	1976	0.85	0.81	0.70	0.40	0.05	0.00	0.00	0.00	0.00	0.00
	1977	0.85	0.82	0.72	0.44	0.07	0.00	0.00	0.00	0.00	0.00
	1978	0.85	0.82	0.73	0.48	0.09	0.00	0.00	0.00	0.00	0.00
	1979	0.86	0.82	0.75	0.52	0.12	0.00	0.00	0.00	0.00	0.00
	1980	0.86	0.83	0.76	0.55	0.14	0.00	0.00	0.00	0.00	0.00
	1981	0.86	0.83	0.78	0.58	0.17	0.01	0.00	0.00	0.00	0.00
	1982	0.86	0.84	0.80	0.62	0.20	0.01	0.00	0.00	0.00	0.00
	1983	0.86	0.84	0.81	0.64	0.23	0.02	0.00	0.00	0.00	0.00
	1984	0.87	0.84	0.82	0.66	0.27	0.03	0.00	0.00	0.00	0.00
	1985	0.88	0.85	0.83	0.68	0.30	0.05	0.00	0.00	0.00	0.00
	1986	0.89	0.85	0.84	0.70	0.33	0.07	0.00	0.00	0.00	0.00
	1987	0.89	0.86	0.85	0.72	0.37	0.09	0.00	0.00	0.00	0.00
	1988	0.90	0.86	0.86	0.74	0.41	0.12	0.00	0.00	0.00	0.00
	1989	0.91	0.86	0.87	0.76	0.44	0.16	0.01	0.00	0.00	0.00
	1990	0.91	0.86	0.87	0.77	0.47	0.19	0.01	0.00	0.00	0.00
	1991	0.92	0.87	0.88	0.79	0.51	0.23	0.02	0.00	0.00	0.00

Appendix Table 4.45 Probability of a male in Wales in each age band (in years) and transfusion year surviving to 2019 assuming excess chronic HCV infection and excess post-transfusion hazard.

A.48 Appendix Tables 4.46 - 4.48 present the number of people surviving to 2019 under the different hazard scenarios for Northern Ireland, Scotland and Wales, respectively.

Year of transfusion	Year 10-years post-transfusion	(a) Estimated number chronically infected surviving 10 years post-transfusion (from Task 4)	(b) Estimated number chronically infected surviving to 2019, assuming no post-transfusion excess risk	(c) Estimated number surviving to 2019, assuming post-transfusion excess risk	(d) Estimated number surviving to 2019, assuming both post-transfusion and chronic HCV-infection excess risk
1970	1980	4 (1 - 9)	1 (0 - 3)	1 (0 - 3)	1 (0 -3)
1971	1981	4 (1 - 10)	1 (0 - 4)	1 (0 - 4)	1 (0 -3)
1972	1982	5 (1 - 11)	1 (0 - 4)	1 (0 - 4)	1 (0 - 4)
1973	1983	5 (1 - 12)	2 (0 - 5)	2 (0 - 5)	1 (0 - 4)
1974	1984	6 (2 - 13)	2 (0 - 6)	2 (0 - 5)	2 (0 - 5)
1975	1985	7 (2 - 14)	2 (0 - 6)	2 (0 - 6)	2 (0 - 5)
1976	1986	8 (3 - 17)	3 (0 - 7)	3 (0 - 7)	2 (0 - 6)
1977	1987	9 (4 - 19)	3 (0 - 8)	3 (0 - 8)	3 (0 - 7)
1978	1988	11 (5 - 21)	4 (1 - 9)	4 (1 - 9)	3 (0 - 8)
1979	1989	12 (5 - 24)	4 (1 - 10)	4 (1 - 9)	4 (1 - 9)
1980	1990	14 (6 - 26)	5 (1 - 11)	5 (1 - 11)	4 (1 - 10)
1981	1991	14 (6 - 26)	5 (1 - 11)	5 (1 - 11)	5 (1 - 10)
1982	1992	15 (6 - 28)	6 (2 - 13)	6 (2 - 12)	5 (1 - 11)
1983	1993	17 (8 - 32)	7 (2 - 15)	7 (2 - 14)	6 (2 - 12)
1984	1994	19 (9 - 36)	8 (3 - 17)	8 (3 - 16)	7 (2 - 14)
1985	1995	8 (3 - 15)	4 (1 - 8)	3 (0 - 8)	3 (0 - 7)
1986	1996	9 (4 - 16)	4 (1 - 9)	4 (1 - 8)	3 (0 - 8)
1987	1997	10 (4 - 17)	4 (1 - 9)	4 (1 - 9)	4 (1 - 8)
1988	1998	11 (5 - 18)	5 (1 - 10)	5 (1 - 10)	4 (1 - 9)
1989	1999	12 (6 - 20)	6 (2 - 12)	5 (2 - 11)	5 (1 - 10)
1990	2000	12 (6 - 20)	6 (2 - 12)	6 (2 - 11)	5 (1 - 10)
1991	2001	8 (3 - 15)	4 (1 - 9)	4 (1 - 9)	4 (0 - 8)
Total		**220** (160 - 330)	**92** (65 - 140)	**87** (62 - 130)	**76** (53 - 110)
Total for 1970-1979		**73** (48 - 120)	**25** (14 - 43)	**24** (13 - 42)	**21** (11 - 36)
Total for 1980-1991		**150** (110 - 210)	**67** (47 - 96)	**63** (44 - 91)	**56** (38 - 82)

Appendix Table 4.46 Estimated annual number of individuals infected with chronic HCV by transfusion in Northern Ireland, 1970-1991, and surviving to 2019, both without and with allowing for any effect of chronic HCV infection.

Year of transfusion	Year 10-years post-transfusion	(a) Estimated number chronically infected surviving }10 years post-transfusion (from Task 4)	(b) Estimated number chronically infected surviving to 2019, assuming no post-transfusion excess risk	(c) Estimated number surviving to 2019, assuming post-transfusion excess risk	(d) Estimated number surviving to 2019, assuming both post-transfusion and chronic HCV-infection excess risk
1970	1980	12 (6 - 21)	3 (0 - 7)	3 (0 - 7)	2 (0 - 6)
1971	1981	13 (6 - 22)	3 (0 - 7)	3 (0 -7)	3 (0 - 6)
1972	1982	14 (7 - 23)	4 (1 - 8)	4 (1 - 8)	3 (0 - 7)
1973	1983	15 (8 - 24)	4 (1 - 9)	4 (1 - 8)	3 (1 - 7)
1974	1984	16 (8 - 26)	5 (1 - 9)	5 (1 - 9)	4 (1 - 8)
1975	1985	16 (8 - 26)	5 (1 - 10)	5 (1 - 9)	4 (1 - 8)
1976	1986	18 (9 - 29)	6 (2 - 11)	5 (1 -10)	4 (1 - 9)
1977	1987	21 (12 - 34)	7 (3 -13)	7 (3 - 13)	6 (2 - 11)
1978	1988	24 (14 - 39)	8 (3 - 15)	8 (3 - 15)	7 (3 - 12)
1979	1989	29 (17 -46)	10 (4 - 18)	10 (4 -17)	8 (3 - 15)
1980	1990	33 (20 - 54)	12 (6 - 21)	11 (5 - 20)	9 (4 - 17)
1981	1991	39 (24 - 64)	15 (8 - 26)	14 (7 - 24)	12 (6 - 21)
1982	1992	49 (30 - 82)	19 (10 - 33)	17 (9 - 31)	15 (8 - 27)
1983	1993	63 (39 - 110)	24 (14 - 44)	23 (12 - 41)	20 (11 - 36)
1984	1994	37 (24 - 52)	15 (8 - 24)	14 (8 - 22)	12 (6 - 19)
1985	1995	44 (30 - 61)	19 (11 - 28)	17 (10 - 26)	15 (8 - 23)
1986	1996	53 (36 - 72)	23 (14 - 33)	21 (13 - 31)	18 (11 - 27)
1987	1997	54 (38 - 74)	24 (15 - 35)	23 (14 - 32)	19 (11 - 29)
1988	1998	64 (46 - 86)	30 (19 - 42)	27 (18 - 38)	24 (15 - 34)
1989	1999	72 (51 - 96)	34 (23 - 48)	32 (21 - 44)	27 (17 - 39)
1990	2000	79 (58 - 100)	39 (27 - 54)	36 (25 - 49)	31 (20 - 44)
1991	2001	59 (42 - 80)	31 (20 - 43)	28 (18 - 40)	24 (15 - 35)
Total		**830** (660 - 1,100)	**340** (270 - 440)	**320** (250 - 410)	**270** (210 - 360)
Total for 1970-1979		**180** (130 - 25)	**56** (38 - 80)	**54** (37 - 77)	**45** (29 - 66)
Total for 1980-1991		**650** (520 - 820)	**290** (220 - 360)	**270** (210 - 340)	**230** (180 - 300)

Appendix Table 4.47 Estimated annual number of individuals infected with chronic HCV by transfusion in Scotland, 1970-1991, and surviving to 2019, both without and with allowing for any effect of chronic HCV infection.

Year of transfusion	Year 10-years post-transfusion	(a) Estimated number chronically infected surviving 10 years post-transfusion (from Task 4)	(b) Estimated number chronically infected surviving to 2019, assuming no post-transfusion excess risk	(c) Estimated number surviving to 2019, assuming post-transfusion excess risk	(d) Estimated number surviving to 2019, assuming both post-transfusion and chronic HCV-infection excess risk
1970	1980	7 (2 - 14)	2 (0 - 5)	2 (0 - 5)	1 (0 - 4)
1971	1981	8 (3 - 16)	2 (0 - 6)	2 (0 - 6)	2 (0 - 5)
1972	1982	9 (3 - 17)	3 (0 - 6)	3 (0 - 6)	2 (0 - 5)
1973	1983	10 (4 - 20)	3 (0 - 7)	3 (0 - 7)	2 (0 - 6)
1974	1984	11 (5 - 22)	4 (1 - 9)	3 (0 - 8)	3 (0 - 7)
1975	1985	13 (6 - 24)	4 (1 - 9)	4 (1 - 9)	3 (0 - 8)
1976	1986	15 (7 - 29)	5 (1 - 11)	5 (1 - 11)	4 (1 - 9)
1977	1987	17 (8 - 32)	6 (2 - 12)	6 (2 - 12)	5 (1 - 10)
1978	1988	20 (10 - 37)	7 (2 - 15)	7 (2 - 14)	6 (2 - 12)
1979	1989	22 (11 - 41)	8 (3 - 16)	8 (3 - 16)	7 (2 - 14)
1980	1990	25 (13 - 45)	9 (4 - 18)	9 (3 - 18)	8 (3 - 15)
1981	1991	25 (13 - 46)	10 (4 - 19)	9 (3 - 18)	8 (3 - 16)
1982	1992	26 (14 - 49)	11 (4 - 21)	10 (4 - 20)	9 (3 - 17)
1983	1993	30 (16 - 56)	12 (5 - 24)	12 (5 - 23)	10 (4 - 20)
1984	1994	33 (19 - 62)	15 (7 - 28)	13 (6 - 26)	12 (5 - 23)
1985	1995	15 (8 - 24)	7 (2 - 12)	6 (2 - 12)	5 (2 - 10)
1986	1996	16 (9 - 26)	7 (3 - 13)	7 (3 - 13)	6 (2 - 12)
1987	1997	18 (9 - 28)	8 (3 - 14)	8 (3 - 14)	7 (2 - 12)
1988	1998	20 (11 - 30)	9 (4 - 16)	9 (4 - 15)	8 (3 - 14)
1989	1999	22 (12 - 33)	11 (5 - 18)	10 (4 - 17)	9 (4 - 15)
1990	2000	22 (13 - 33)	11 (5 - 18)	10 (5 - 17)	9 (4 - 16)
1991	2001	15 (8 - 24)	8 (3 - 14)	7 (3 - 13)	7 (2 - 12)
Total		**400** (300 - 600)	**160** (120 - 240)	**160** (120 - 230)	**140** (98 - 200)
Total for 1970-1979		**130** (90 - 220)	**44** (27 - 76)	**43** (27 - 73)	**36** (22 - 62)
Total for 1980-1991		**270** (200 - 380)	**120** (88 - 170)	**110** (83 - 160)	**99** (72 - 140)

Appendix Table 4.48 Estimated annual number of individuals infected with chronic HCV by transfusion in Wales, 1970-1991, and surviving to 2019, both without and with allowing for any effect of chronic HCV infection.

A.49 Appendix Tables 4.49 - 4.51 present the age-sex distribution of people surviving to 2019 under the different hazard scenarios for Northern Ireland, Scotland and Wales, respectively.

A.50 Appendix Tables 4.52 - 4.54 present the age of those in 2019 and the number expected to have survived for Northern Ireland, Scotland and Wales, respectively.

Age band at transfusion	Females			Males		
	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths
0 – 9	9 (3 - 18)	6 (2 - 14)	0 (0 - 0)	16 (8 - 29)	13 (6 - 23)	0 (0 - 0)
10 – 19	5 (1 - 12)	4 (1 - 11)	0 (0 - 0)	5 (1 - 11)	3 (0 - 7)	0 (0 - 0)
20 – 29	22 (12 - 38)	20 (11 - 33)	0 (0 - 0)	7 (2 - 15)	6 (1 - 12)	0 (0 - 0)
30 – 39	20 (11 - 34)	12 (6 - 20)	0 (0 - 3)	11 (5 - 21)	5 (1 - 10)	0 (0 - 2)
40 – 49	27 (15 - 44)	5 (1 - 10)	1 (0 - 7)	18 (9 - 31)	1 (0 - 4)	1 (0 - 6)
50 – 59	32 (19 - 52)	0 (0 - 2)	2 (0 - 9)	31 (18 - 51)	0 (0 - 1)	2 (0 - 8)
60 – 69	53 (35 - 85)	0 (0 - 0)	5 (0 - 13)	68 (45 - 100)	0 (0 - 0)	6 (0 - 16)
70 – 79	87 (60 - 130)	0 (0 - 0)	8 (1 - 18)	73 (50 - 110)	0 (0 - 0)	2 (0 - 19)
80 – 89	65 (43 - 100)	0 (0 - 0)	1 (0 - 4)	33 (20 - 55)	0 (0 - 0)	0 (0 -1)
90+	12 (5 - 22)	0 (0 - 0)	0 (0 - 0)	3 (0 - 7)	0 (0 - 0)	0 (0 - 0)
Total	**330** (250 - 500)	**49** (32 - 74)	**18** (1 - 54)	**260** (200 - 400)	**28** (16 - 44)	**13** (1 - 42)

Appendix Table 4.49 Estimated number of chronic HCV infections, survivors until 2019, and number of HCV-related deaths – by age-sex band, pooled over years of transfusion 1970-1991 in Northern Ireland. Survival estimates take into account both additional risk from both transfusion and HCV.

Age band at transfusion	Females			Males		
	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths
0 – 9	35 (21 - 56)	24 (12 - 40)	0 (0 - 0)	61 (39 - 88)	44 (28 - 64)	0 (0 - 4)
10 – 19	21 (10 - 36)	17 (7 - 30)	0 (0 - 0)	18 (8 - 32)	10 (3 - 19)	0 (0 - 0)
20 – 29	82 (56 - 120)	68 (47 - 96)	0 (0 - 10)	28 (15 - 46)	19 (10 - 30)	0 (0 - 2)
30 – 39	76 (51 - 110)	40 (25 - 60)	2 (0 - 14)	42 (26 - 65)	16 (9 - 28)	1 (0 - 9)
40 – 49	100 (69 - 140)	18 (10 - 30)	11 (0 - 23)	67 (44 - 97)	7 (2 - 14)	8 (0 - 19)
50 – 59	120 (85 - 160)	5 (2 - 11)	15 (3 - 29)	120 (84 - 160)	2 (0 - 5)	14 (3 - 27)
60 – 69	200 (150 - 270)	0 (0 - 1)	25 (9 - 44)	250 (190 - 330)	0 (0 - 0)	30 (11 - 52)
70 – 79	320 (250 - 420)	0 (0 - 0)	35 (13 - 60)	280 (210 - 360)	0 (0 - 0)	16 (4 - 30)
80 – 89	240 (180 - 320)	0 (0 - 0)	7 (0 - 16)	120 (89 - 170)	0 (0 - 0)	0 (0 - 4)
90+	45 (27 - 67)	0 (0 - 0)	0 (0 - 1)	10 (3 - 20)	0 (0 - 0)	0 (0 - 0)
Total	**1,200** (1,000 - 1,600)	**170** (130 - 230)	**71** (20 - 140)	**1,000** (800 - 1,300)	**99** (70 - 130)	**71** (20 - 180)

Appendix Table 4.50 Estimated number of chronic HCV infections, survivors until 2019, and number of HCV-related deaths - by age-sex band, pooled over years of transfusion 1970-1991 in Scotland. Survival estimates take into account both additional risk from both transfusion and HCV.

Age band at transfusion	Females			Males		
	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths	Estimated number chronically HCV-infected through transfusion 1970-1991	Estimated number alive in 2019	HCV-related deaths
0 – 9	17 (8 - 31)	12 (5 - 22)	0 (0 - 0)	29 (16 - 49)	23 (12 - 38)	0 (0 - 0)
10 – 19	10 (4 - 20)	8 (2 - 17)	0 (0 - 0)	9 (3 - 18)	5 (1 - 12)	0 (0 - 0)
20 – 29	40 (24 - 65)	35 (22 - 55)	0 (0 - 3)	13 (6 - 25)	10 (4 - 18)	0 (0 - 0)
30 – 39	37 (22 - 61)	20 (12 - 33)	0 (0 - 6)	21 (10 - 36)	9 (3 - 16)	0 (0 - 4)
40 – 49	48 (30 - 78)	8 (3 - 16)	4 (0 - 13)	32 (18 - 53)	2 (0 - 7)	3 (0 - 10)
50 – 59	57 (37 - 91)	1 (0 - 4)	6 (0 - 16)	57 (37 - 90)	0 (0 - 2)	6 (0 - 15)
60 – 69	97 (67 - 150)	0 (0 - 0)	11 (2 - 24)	120 (87 - 190)	0 (0 - 0)	14 (3 - 28)
70 – 79	160 (110 - 240)	0 (0 - 0)	16 (4 - 32)	130 (95 - 200)	0 (0 - 0)	6 (0 - 16)
80 – 89	120 (83 - 180)	0 (0 - 0)	2 (0 - 8)	60 (39 - 94)	0 (0 - 0)	0 (0 - 2)
90+	22 (11 - 38)	0 (0 - 0)	0 (0 - 0)	5 (1 - 12)	0 (0 - 0)	0 (0 - 0)
Total	**600** (460 - 900)	**86** (60 - 130)	**41** (8 - 100)	**480** (370 - 720)	**50** (32 - 76)	**30** (4 - 73)

Appendix Table 4.51 Estimated number of chronic HCV infections, survivors until 2019, and number of HCV-related deaths - by age-sex band, pooled over years of transfusion 1970-1991 in Wales. Survival estimates take into account both additional risk from both transfusion and HCV.

Age in December 2019	Females Estimated number alive in 2019	Males Estimated number alive in 2019
30 – 39	2 (0 - 6)	4 (1 - 9)
40 – 49	5 (1 - 11)	8 (3 - 16)
50 – 59	10 (4 - 18)	5 (1 - 11)
60 – 69	17 (9 - 28)	6 (2 - 11)
70 – 79	12 (6 - 20)	4 (1 - 9)
80 – 89	2 (0 - 7)	0 (0 - 2)
90+	0 (0 - 0)	0 (0 - 0)
Total	**49** (32 - 74)	**28** (16 - 44)

Appendix Table 4.52 Estimated age distribution (in years) of people with chronic-HCV-infection from transfusion between 1970 and 1991 in Northern Ireland, who are alive in December 2019.

Age in December 2019	Females Estimated number alive in 2019	Males Estimated number alive in 2019
30 – 39	12 (5 - 22)	23 (13 - 34)
40 – 49	18 (9 - 31)	22 (13 - 36)
50 – 59	46 (31 - 64)	18 (10 - 28)
60 – 69	52 (35 - 74)	19 (11 - 29)
70 – 79	33 (21 - 49)	13 (6 - 22)
80 – 89	11 (5 - 21)	3 (0 - 8)
90+	0 (0 - 2)	0 (0 - 0)
Total	**170** (130 - 230)	**99** (70 - 130)

Appendix Table 4.53 Estimated age distribution (in years) of people with chronic-HCV-infection from transfusion between 1970 and 1991 in Scotland, who are alive in December 2019.

Age in December 2019	Females Estimated number alive in 2019	Males Estimated number alive in 2019
30 – 39	4 (0 - 8)	7 (2 - 14)
40 – 49	9 (3 - 18)	14 (7 - 26)
50 – 59	18 (10 - 29)	9 (3 - 17)
60 – 69	28 (17 - 46)	10 (4 - 18)
70 – 79	20 (11 - 32)	7 (3 - 14)
80 – 89	6 (1 - 13)	1 (0 - 5)
90+	0 (0 - 1)	0 (0 - 0)
Total	**86** (60 - 130)	**50** (32 - 76)

Appendix Table 4.54 Estimated age distribution (in years) of people with chronic-HCV-infection from transfusion between 1970 and 1991 in Wales, who are alive in December 2019.

Chapter 4. Deterministic sensitivity analysis

A.51 Appendix Tables 4.55 - 4.57 present the results of deterministic sensitivity analyses for Northern Ireland, Scotland and Wales, respectively. Scenarios are as described in the main report.

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Estimates from deterministic model baseline scenario	730	599	221	72	527	52
Median estimates from stochastic baseline model, together with upper and lower 95% uncertainty limits.	1,080 **727** 566	888 **596** 460	333 **221** 164	114 **76** 53	784 **520** 400	97 **31** 2
Scenario A: past-IDUs with deferral effect year 1987 & 33% reduction	517	424	157	53	371	36
Scenario B: 0% contribution to prevalence from non-IDUs	752	617	228	74	543	53
Scenario C: 100% contribution to prevalence from non-IDUs (constant proportion of infectious donations)	664	544	201	65	479	47

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Scenario D: ever-IDUs deferral policy in 1986	769	631	233	76	555	55
Scenario E: ever-IDUs, deferral reduction of 33% with effect in 1985	530	434	161	54	381	37
Scenario F: 50% contribution to prevalence from non-IDUs	708	581	215	69	511	50
Scenario G: No additional transfusion hazards	730	599	221	78	521	50
Scenario H: Constant transfusion hazard for 11 - 15 and 16 - 20 years post-transfusion	730	599	221	76	523	50
Scenario I: No additional chronic HCV hazard	730	599	221	82	516	0

Appendix Table 4.55 Estimates for Northern Ireland from baseline deterministic model, baseline stochastic model with 95% confidence intervals and deterministic sensitivity analyses.

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Estimates from deterministic model baseline scenario	2,717	2,228	823	267	1961	193
Median estimates from stochastic baseline model, together with upper and lower 95% uncertainty limits.	3,440 **2,740** 2,250	2,850 **2,250** 1,820	1,060 **831** 663	357 **270** 209	2,510 **1,970** 1,600	323 **170** 50
Scenario B: 0% contribution to prevalence from non-IDUs	2,252	1,847	683	230	1617	157
Scenario C: 100% contribution to prevalence from non-IDus (constant proportion of infectious donations)	4,111	3,371	1,246	380	2,991	300
Scenario D: ever-IDUs deferral policy in 1985	2,859	2,344	867	281	2,063	203
Scenario E: ever-IDUs, deferral reduction of 33% with effect in 1984	2,402	1,970	728	240	1,730	169

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Scenario F: 50% contribution to prevalence from non-IDUs	3,182	2,609	964	305	2,304	228
Scenario G: No additional transfusion hazards	2,717	2,228	823	294	1,934	183
Scenario H: Constant transfusion hazard for 11 - 15 and 16 - 20 years post-transfusion	2,717	2,228	823	285	1,943	186
Scenario I: No additional chronic HCV hazard	2,717	2,228	823	310	1,918	0

Appendix Table 4.56 Estimates for Scotland from baseline deterministic model, baseline stochastic model with 95% confidence intervals and deterministic sensitivity analyses. As we do not have past-IDUs for Scotland, scenario (A) is omitted.

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Estimates from deterministic model baseline scenario	1,322	1,084	401	129	954	94
Median estimates from stochastic baseline model, together with upper and lower 95% uncertainty limits.	1,960 **1,320** 1,030	1,610 **1,080** 834	597 **401** 303	199 **140** 98	1,420 **945** 728	172 **71** 13
Scenario A: past-IDUs with deferral effect year 1987 & 33% reduction	936	768	284	95	673	65
Scenario B: 0% contribution to prevalence from non-IDUs	1,362	1,116	413	133	983	97
Scenario C: 100% contribution to prevalence from non-IDus (constant proportion of infectious donations)	1,202	986	364	118	868	86
Scenario D: ever-IDUs deferral policy in 1986	1,393	1,142	422	137	1,005	99

Scenario	Infected	Chronically infected, were they to survive 6 months	Chronically infected, survived to 10 years post-transfusion	Chronically infected, survived to 2019 (assuming extra HCV risk)	Chronically infected, died by 2019 (assuming extra HCV risk)	Chronically infected, died by 2019, extra deaths related to HCV
Scenario E: ever-IDUs, deferral reduction of 33% with effect in 1985	959	787	291	97	690	67
Scenario F: 50% contribution to prevalence from non-IDUs	1,282	1,051	389	125	926	91
Scenario G: No additional transfusion hazards	1,322	1,084	401	140	944	90
Scenario H: Constant transfusion hazard for 11 - 15 and 16 - 20 years post-transfusion	1,322	1,084	401	137	947	91
Scenario I: No additional chronic HCV hazard	1,322	1,084	401	149	935	0

Appendix Table 4.57 Estimates for Wales from baseline deterministic model, baseline stochastic model with 95% confidence intervals and deterministic sensitivity analyses.

Chapter 4. Probabilistic model

A.52 Appendix Table 4.58 presents the distributional assumptions of the probabilistic model.

Parameter	Distribution/value	Notes
HCV prevalence in 1991	Beta (532, 808938)	National Blood Authority/PHLS Infection Surveillance report tables
HCV clearance in donors	Normal (mean = 0.26, standard deviation = 0.018)	Micallef et al. (2006)*
HCV clearance in survivors	Normal (mean = 0.18, standard deviation = 0.028)	Micallef et al. (2006)*
Deferral effect	Normal (mean = 0.67, standard deviation = 0.0765)	Expert opinion - see Task 1.4 above
Number of IDUs	Randomly sample one set of figures from the 1000 estimates of the number of injecting drug users provided.	We have been provided with previously unpublished estimates for HCV-infectious current and past-IDUs and their sum (ever-IDUs) for the period 1971-1991 (see Appendix for estimation for 1970).
Units transfused from each donation	Normal (mean, standard, deviation). Estimates are different for each year.	Mean is taken from estimates from linear regression model. Standard deviation is estimated by treating the 95% prediction interval as the 95% uncertainty interval.*
Number antibody positive donations	Binomial (number of donations, antibody prevalence in donors)	
Number RNA positive donations	Binomial (number antibody positive donations, 1-HCV clearance in donors)	
Number RNA positive units transfused (number people acutely infected)	Number RNA positive donations * Units transfused from each donation	
Number of people chronically infected	Binomial (number of people acutely infected, 1-HCV clearance in survivors)	
Proportion of recipients of transfusions by age and sex	Dirichlet (Number of people in each age and sex)	
Number infected by age and sex in each year (1970-1990)	Multinomial (number infected per year, proportion of recipients by age and sex)	

Parameter	Distribution/value	Notes
HCV mortality hazard ratio	Exponential of value selected on log scale from Normal distribution (mean 0.425, standard deviation 0.137), matching estimated hazard ratio of 1.53 (95% interval 1.17 to 2.00)	From the UKHSA paper by Ross Harris et al. on record-linkage follow-up to end of 2019 of the case-control study last published by Harris HE et al. (2006) in *Epidemiology & Infection.*

** Where 95% confidence intervals/uncertainty intervals are extracted from published studies or model estimates, the standard deviation is estimated by dividing the width of the interval by 1.96*2.*

Appendix Table 4.58 Summary of assumptions and distributions for baseline scenario within probabilistic model.

Chapter 5

A.53 Our baseline stochastic scenario for England provides age-sex bands for survivors from chronic HCV infection by transfusion. We represent here our estimates for survivors at 31 December 2019; and also for survivors at 31 December 2014. In 2019, female survivors outnumbered males by 1.77 (uncertainty 1.45 - 2.17) and in 2014, female survivors outnumbered males by 1.77 (uncertainty 1.46 - 2.15); and are older than their male counterparts.

Age band in completed years at 31 December 2014	Male survivors	Female survivors	Age band in completed years at 31 December 2019	Male survivors	Female survivors
20-29	30 (20 - 50)	20 (20 - 30)	**20-29**	NA	NA
30-39	220 (150 - 330)	120 (80 - 190)	**30-39**	120 (80 - 160)	60 (40 - 90)
40-49	170 (120 - 280)	200 (140 - 290)	**40-49**	220 (150 - 380)	150 (100 - 240)
50-59	130 (90 - 210)	420 (310 - 630)	**50-59**	130 (90 - 200)	280 (220 - 380)
60-69	170 (110 - 260)	440 (320 - 680)	**60-69**	140 (100 - 220)	450 (330 - 700)
70-79	130 (80 - 200)	270 (190 - 420)	**70-79**	130 (90 - 210)	320 (230 - 500)
80+ years	60 (30 - 110)	140 (80 - 240)	**80+ years**	60 (30 - 110)	150 (90 - 270)
Total	**910** (670 - 1,350)	**1,600** (1,220 - 2,370)	**Total**	**800** (590 - 1,190)	**1,410** (1,070 - 2,090)

Appendix Table 5.1 Estimates from baseline stochastic model for England for the number, sex and age-distribution of survivors from chronic HCV infection by transfusion to 31 December 2014 (910 (uncertainty 670 - 1,350) males; 1,600 (uncertainty 1,220 - 2,370) females;) and to 31 December 2019 (800 (uncertainty 590 - 1,200) males; 1,410 (uncertainty 1,100 - 2,100) females). Estimates are rounded to the nearest 10.

A.54 From preliminary analysis of the well-documented cohort within the NHD, we present the age-sex bands for survivors from chronic mono HCV infection for people with bleeding disorders who are born and NHD-registered before 1992 and who are known to have tested HCV antibody positive or whose morbidity/cause of death revealed them to have been chronically HCV infected. We present here the age-sex distribution for survivors at 31 December 2019; and also for survivors at 31 December 2013. In both cases male survivors outnumber females by 9 to 1 (1,366/153; 1,513/163); and are younger than their female counterparts.

Age band in completed years at 31 December 2013	Male survivors	Female survivors	Age band in completed years at 31 December 2019	Male survivors	Female survivors
20-29	9	1	**20-29**	NA	NA
30-39	337	12	**30-39**	130	3
40-49	406	31	**40-49**	340	21
50-59	394	42	**50-59**	417	34
60-69	247	46	**60-69**	295	46
70-79	94	23	**70-79**	149	36
80+ years	26	8	**80+ years**	35	13
Total	**1,513**	**163**	**Total**	**1,366**	**153**

Appendix Table 5.2 From the well-documented cohort within the NHD, the age-sex bands for survivors from chronic mono HCV infection for people with bleeding disorders (PwBDs) who are born and NHD-registered before 1992 and known to have tested HCV antibody positive or whose morbidity/cause of death revealed them to have been chronically mono HCV infected. Sex and age-distribution of survivors from chronic HCV infection by transfusion to 31 December 2013 (1,513 males; 163 females) and to 31 December 2019 (1,366 males; 153 females).

A.55 For comparison with the above age-sex distributions, we very recently requested information about Skipton/EIBSS surviving mono chronically HCV infected claimants at 31 December 2014 from an analytical team at the Department of Health and Social Care who have familiarity with those data. We are grateful that this team was able to respond so promptly. First, we document the information provided on survival status at 31 December 2014 for male and female beneficiaries by exposure.

A.56 The sex distribution for DHSC/EIBSS surviving beneficiaries whose exposure was Other (mainly by transfusion, we assume) echoes our baseline scenario for survivors from chronic HCV infection by transfusion in that surviving female beneficiaries outnumber males by 1.5 to 1 (718/473); also for surviving people with a bleeding disorder among whom male beneficiaries outnumber females by 7.6 to 1.

A.57 From Table 5.3, notice that, among surviving beneficiaries, males with a bleeding disorder outnumber Other males by 2.1 to 1. By contrast, surviving female Other beneficiaries outnumber females with a bleeding disorder by 5.6 to 1.

Exposure	Male beneficiaries				Female beneficiaries			
	Total	Deceased	Alive	Unknown	Total	Deceased	Alive	Unknown
People with bleeding disorders*	1,310	197	978	135	170	26	129	15
Other	796	175	473	148	1,057	155	718	184
Total	2,106	372	1,451	283	1,227	181	847	199

**Labelled as "haemophiliac".*

Appendix Table 5.3 From DHSC/EIBSS, survival status at 31 December 2014 for chronically HCV infected (mono-infected) beneficiaries - by sex and exposure. We have interpreted the DHSS/EIBSS label "haemophiliac" to mean people with bleeding disorders.

A.58 From the DHSC/EIBSS, we also have the age-distribution at 31 December 2014 for:

- All surviving beneficiaries, denoted by A;
- Male surviving beneficiaries, denoted by M;
- Surviving Bleeding Disorder beneficiaries, denoted by BD.

A.59 Our goal is to compare the age-distributions at 31 December 2014 for male and female surviving DHSC/EIBSS beneficiaries who were HCV-infected by Other exposure (essentially by transfusion) with the age-distribution for transfusion-infected HCV infected survivors from our baseline stochastic scenario, as shown in Table 5.1.

A.60 We achieve our goal – the age distributions for DHSC/EIBSS male other beneficiaries, denoted MO, and for female other beneficiaries, denoted FO, at 31 December 2014 – by a series of subtractions which are detailed below together with one key assumption.

A.61 By subtraction, $A - M$, we easily obtain the age-distribution for female surviving beneficiaries, denoted as F.

A.62 To progress further, we shall assume, plausibly, that the age-distribution at 31 December 2013 for 163 females with a bleeding disorder in Table 5.2 applies to the 129 DHSC/ EIBSS female beneficiaries with a bleeding disorder who survived to 31 December 2014, denoted FBD.

A.63 By subtraction, $BD - FBD$, we easily obtain the age-distribution for males with a bleeding disorder who survived to 31 December 2014, denoted MBD.

A.64 Another subtraction, $M - MBD$, gives us the age-distribution for surviving male beneficiaries whose exposure was Other, denoted MO.

A.65 By yet another subtraction, $F - FBD$, we obtain the age-distribution also for surviving females whose exposure was Other (i.e. not on account of bleeding disorder), denoted FO.

A.66 Details are displayed in Appendix Table 5.4.

Mono HCV infected survivors' age band in completed years at 31 December 2014	All mono HCV infected *(A)*	Male mono HCV infected *(M)*	PwBD mono HCV infected *(BD)*	Female mono HCV infected *(F)*	Female with bleeding disorders *(FBD)*	Male with bleeding disorders *(MBD)*	Male Other: *(MO)*	Female Other: *(FO)*
10-19	3	3					3	
20-29	26	15		11			15	11
30-39	189	161	144	28	10	134	27	18
40-49	353	265	238	88	25	213	52	63
50-59	699	455	325	244	33	292	163	211
60-69	639	350	250	289	37	213	137	252
70-79	283	151	111	132	18	93	58	114
80+ years	105	51	39	54	6	33	18	48
unknown	1			1				1
Total	**2,298**	**1,451**	**1,107**	**847**	**129**	**978**	**473**	**718**

Appendix Table 5.4 By applying the age-distribution from Table 5.4 for 31 December 2013 surviving females with bleeding disorders who were born and NHD-registered before 1992 and had been HCV mono infected, we derive the age-distributions in the final two columns for male and female DHSC/ EIBSS surviving beneficiaries at 31 December 2014 whose exposure was Other.

A.67 Our goal is achieved in Appendix Table 5.5 - comparison between our baseline scenario's estimated age-sex distribution for survivors at 31 December 2014 who were chronically HCV infected by transfusion in England versus the corresponding age-sex distributions for DHSC/EIBSS surviving mono HCV infected beneficiaries whose exposure was Other than on account of a bleeding disorder.

Age band in completed years at 31 December 2014	Male survivors at 31 December 2014			Female survivors at December 2014		
	Estimated by baseline stochastic scenario for England	DHSS/EIBSS known alive beneficiaries	Known alive beneficiaries as proportion of estimated number	Estimated by baseline stochastic scenario for England	DHSS/EIBSS known alive beneficiaries	Known alive beneficiaries as proportion of estimated number
20-29 or younger	30 (20 - 50)	18	0.60 (0.36 - 0.90)	20 (10 - 30)	11	0.55 (0.37 - 1.10)
30-39	220 (150 - 330)	27	0.12 (0.08 - 0.18)	120 (80 - 190)	18	0.15 (0.09 - 0.23)
40-49	170 (120 - 280)	52	0.31 (0.19 - 0.43)	200 (140 - 290)	63	0.32 (0.22 - 0.45)
50-59	130 (90 - 210)	163	1.25 (0.78 - 1.81)	420 (310 - 630)	211	0.50 (0.33 - 0.68)
60-69	170 (110 - 260)	137	0.81 (0.53 - 1.25)	440 (320 - 680)	252	0.57 (0.37 - 0.79)
70-79	130 (80 - 200)	58	0.45 (0.29 - 0.73)	270 (190 - 420)	114	0.42 (0.27 - 0.60)
80+ years	60 (30 - 110)	18	0.30 (0.16 - 0.60)	140 (80 - 240)	48	0.34 (0.20 - 0.60)
unknown					1	
Totals	**910** (670 - 1,350)	**473**	**0.52** (0.35 - 0.71)	**1,600** (1,220 - 2,370)	**718**	**0.45** (0.30 - 0.59)

Appendix Table 5.5 Age-sex bands from our stochastic baseline scenario for survivors to 31 December 2014 who had been chronically HCV infected by transfusion in England prior to September 1991; and for known-alive surviving DHSC/EIBSS beneficiaries who were not persons with a bleeding disorder.

A.68 Our baseline stochastic scenario expected around 2,500 survivors at 31 December 2014 (95% uncertainty interval: 1,920 to 3,680) who have been chronically HCV infected by transfusion in England. DHSC/EIBSS has around 1,200 beneficiaries who were known to be alive at 31 December 2014.

A.69 Our baseline scenario expected 64% of survivors to be female. And indeed females represent 60% of the DHSC/EIBSS known-alive beneficiaries (95% CI: 57% to 63%).

A.70 In terms of age-bands, our baseline scenario and DHSC/EIBSS are in close agreement for male survivors aged 50-69 years (both – coincidentally – 300) but female beneficiaries aged 50-69 years at 31 December 2014 are around 460, noticeably below our baseline scenario estimate of around 860.

A.71 The age-band of 50-69 years is highlighted because, for males in particular, late liver sequelae from chronic HCV infection prior to September 1991 are likely to become apparent in this age-band as survivors have been HCV infected for at least 22 years. Moreover, HCV progression tends to be faster in males.

A.72 More males than females in the youngest age-group feature both in our baseline scenario and for DHSC/EIBSS beneficiaries.

A.73 We note that our baseline scenario had expected around 700 survivors at 31 December 2014 who were aged 39-40 years after having been chronically HCV-infected by transfusion prior to September 1991. DHSC/EIBSS has only 160 known-alive registered beneficiaries, about one-quarter of the number expected. Their youth at the time of HCV infection is likely to have delayed HCV progression to late liver sequelae. There may be other explanations too.

A.74 Survival status at 31 December 2014 was unknown at DHSS/EIBSS for 148/796 male Other-exposure beneficiaries (19%) and for 184/1057 female Other-exposure beneficiaries (17%) which may contribute to the difference in totals from our baseline scenario. But this cannot be the entire explanation. Even if almost all 332 were still alive, the DHSS/EIBSS surviving beneficiaries would increase from 1200 to 1500 but not to 2,500 (95% uncertainty interval: 1,920 to 3,680).

A.75 We do not have the corresponding age-distribution at 31 December 2014 for Scotland's 387 SIBSS beneficiaries (males and females) by transfusion but our baseline scenario estimated their number to be 310 (95% uncertainty interval: 240 to 410). Hence, our baseline scenario for Scotland is consistent with SIBSS's beneficiaries (all ages, both sexes) who were HCV infected with transfusion whereas our baseline scenario for England anticipates more surviving beneficiaries than DHSS/EIBSS is aware of. There are both age-related and sex-related aspects to the differences observed. There is robust agreement on male beneficiaries aged 50-69 years.