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ACQUIRED IMMUNE DEFICIENCY SYNDROME IN ENGLAND AND WALES TO END 1993 PROJECTIONS USING DATA TO END SEPTEMBER 1989

Report of a Working Group convened by the
Director of the Public Health Laboratory Service

Summary

The Working Group projected that in 1993 there will be between 1175 and 4825 new cases of AIDS in England and Wales, of which between 875 and 1500 will be in the homosexual/bisexual male exposure category. For planning purposes, a figure of 1300 new cases is proposed for 1990 and 2700 for 1993. The predicted number of AIDS deaths is 750 for 1990 and 1540 for 1993, with a total by the end of 1993 of 6380 AIDS deaths since the start of the epidemic. The number of prevalent AIDS cases in England and Wales is projected to be 2350 at the end of 1990, and 4980 at the end of 1993.

The projected number of new AIDS cases is lower than in the 1988 Cox Report, indicating the value of annual updates, and is mainly due to a reduction in predictions for cases acquired by homosexual transmission. This reduction resulted from an apparently major change in behaviour in the homosexual population in the mid 1980s. There is great uncertainty in predictions of future cases due to transmission of HIV through heterosexual contact and injecting drug use; by 1993 over half the cases in England and Wales could be in these exposure categories, compared with only 7% of reports in the first nine months of 1989. This uncertainty would be much reduced if reliable estimates of HIV prevalence in different sections of the population were available. Unlinked anonymous surveys, introduced early in 1990, should form the basis for such estimates, and are of the highest importance for the precision of future predictions.

Membership of Working Group:

Professor NE Day (Chairman)¹

Prof RM Anderson²

Mr CD Daykin³

Dr SM Gore¹

Dr ON Gill⁴

Dr G Greenberg⁵

Mrs HC Hillier⁵

Dr V Isham⁶

Dr AM Johnson⁷

Dr A McCormick^{8,9}

Dr GM Medley²

Dr HE Tillet⁴

Prof AD Wilkie¹⁰

¹MRC Biostatistics Unit, Cambridge; ²Dept of Pure & Applied Biology, Imperial College of Science and Technology; ³Government Actuary's Department; ⁴PHLS AIDS centre at CDSC; ⁵Department of Health; ⁶Dept of Statistical Science, University College, London; ⁷Academic Dept of Genito-Urinary Medicine, University College and Middlesex Hospital School of Medicine; ⁸Office of Population Censuses & Surveys; ⁹PHLS CDSC; ¹⁰R Watson & Sons, Consultant Actuaries.

1. Introduction

In March 1988, the Chief Medical Officers of England and Wales established a Working Group, under the Chairmanship of Sir David Cox, to report on short term predictions of acquired immune deficiency syndrome (AIDS) and human immunodeficiency virus type-1 (HIV-1) infection in England and Wales. The Report of the Working Party¹ (the Cox Report), was published in November 1988, and was based on AIDS reports to the end of June 1988. Subsequently, extended versions of many of the appendices contained in this Report were published in the Philosophical Transactions of the Royal Society², for which AIDS data to the end of December 1988 were available.

Because of the rapidly changing nature of the epidemic, and the paucity of knowledge about the factors determining its spread, the Cox Group recommended that the forecasts should be updated at least annually, under the auspices of the Public Health Laboratory Service (PHLS) Communicable Disease Surveillance Centre (CDSC). This paper, the Report of a Working Group established by the Director of the PHLS, therefore presents AIDS projections on the basis of case reports to the end of September 1989. The models and methodology which form the basis for the projections were discussed at length in the two previous publications and are not repeated here.

1.1 The Cox Report:

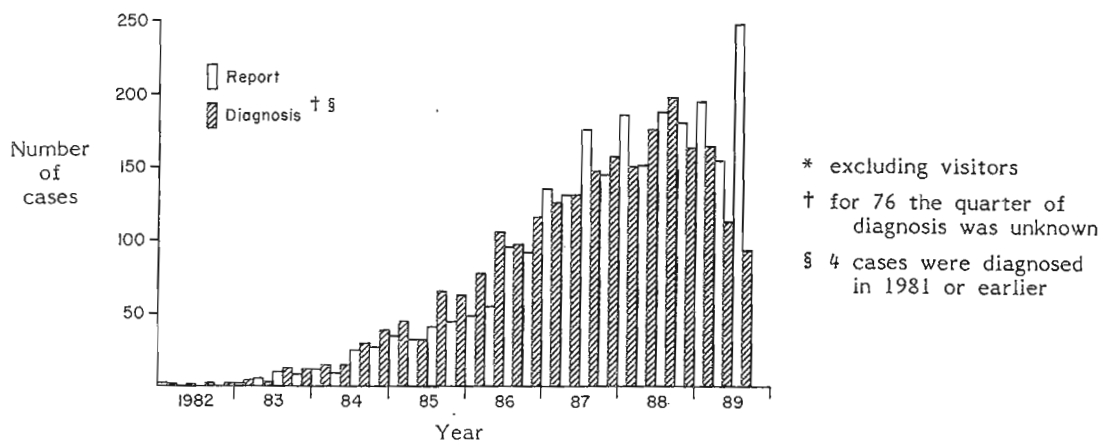
- i) Presented a range of projections for the annual numbers of new AIDS cases in England and Wales up to the end of 1992, undifferentiated by exposure category or age. There were in fact too few AIDS cases in any but the homosexual/bisexual male category for exposure category specific projections to be worth attempting.
- ii) Presented a range within which the number of people infected with HIV-1 in the population of England and Wales was likely to have been at the end of 1987, by estimating the number within each exposure category and the likely proportion infected on the basis of the limited data available.
- iii) Forecast the number of deaths from AIDS to the end of 1992, and the number of AIDS cases in the population in each year to the end of 1992.

Some attention was paid to the way in which similar projections might be made on a regional basis.

1.2 The changing form of the epidemic

In the second half of 1987 and the first half of 1988, the number of new reports of AIDS cases each quarter began to depart from the approximate pattern of exponential growth shown by the epidemic until mid-1987 (figure 1), introducing great uncertainty into projections of future trends. Many widely differing scenarios for temporal trends in HIV-1 transmission were consistent with the observed pattern of AIDS diagnoses to mid-1988, varying from a continuation of almost exponential growth to a major fall in the annual incidence of HIV-1 infection occurring between 1984 and 1985, and continuing thereafter. These uncertainties resulted in the wide range of numbers of new AIDS cases projected for 1992 in the Cox Report. The AIDS data that have accumulated since mid-1988 now clearly indicate that, in the major exposure category (homosexual/bisexual males), transmission declined markedly in the mid-1980s, and the more pessimistic projections of the Cox Report are no longer tenable (as seen even in the projections based on reports to the end of 1988²). The implications of the changes in behaviour that reduced HIV transmission in the mid-1980s were considered in the scientific papers published in the Philosophical Transactions of the Royal Society². Other factors could have contributed to the reduction in the rate of increase of AIDS incidence in the second half of 1988 and in 1989. These include the slow spread of the epidemic from male homosexuals with high risk behaviours to homosexual and bisexual men with lower risk behaviours (eg lower rates of sexual partner change) and/or the influence of zidovudine in lengthening the incubation period of AIDS (discussed in section 2.1).

Figure 1
AIDS* in England and Wales
cases by quarter of report and diagnosis



More generally, the epidemic in the United Kingdom is entering a more complex phase where the overall total of AIDS case reports is made up from a series of separate but interlinked epidemics in other exposure categories such as injecting drug users and heterosexual contacts (the so called 'second' and 'third' waves of the epidemic). At present the patterns of increase in AIDS case reports in injecting drug users and heterosexual contacts are consistent with exponential growth (similar to the early phase of growth (pre-1987) in homosexual and bisexual men). Since the future effect of a currently small but rapidly growing epidemic in a particular sub-population might be concealed if projection methods were applied to the total population, this latter approach was considered unsafe. The Working Group therefore decided to consider different exposure categories separately.

2. Scope and methods of the present report

This Report considers the epidemic among each of the following exposure categories:

- i) homosexual/ bisexual male
- ii) injecting drug user (including those who are also homosexual/bisexual male)
- iii) heterosexual contact
- iv) haemophiliac and blood/components recipient
- v) child of at risk/infected parent.

2.1 Projection of the number of future AIDS diagnoses

For each exposure category, the Working Group attempted to define upper and lower bounds on projections for the annual number of new AIDS cases to the end of 1993, together with a preferred estimate which it felt to be most reasonable for planning purposes. The basis for these projections was the quarterly number of AIDS reports to the end of September 1989, and whatever data were available on HIV infection.

The main methods of approach used by the Working Group were transmission models³, specifically for the homosexual/bisexual male population, back projection methods^{4,5} and direct extrapolation, using mainly the linear logistic function (see section 3.5 of the Cox Report¹). The first two require an assumption for the incubation period distribution. The basic distribution, derived from data from AIDS cases infected by contaminated blood products⁶, was taken to be Weibull with mean 10 years and index two. Some data indicate that the incubation period may vary with age⁶, and the effect of this variation has been explored (see section 4.6).

2.2 The effect on the incubation period of the introduction of zidovudine and other improvements in patient management

The use of zidovudine is widespread for those with clinical manifestations of HIV-1 disease, including those with severe HIV-1 disease which is not AIDS (other CDC group IV). Delaying progression of HIV-1 disease to AIDS will lengthen the incubation period (defined in terms of the diagnosis of AIDS). It is possible that some of the change in the rate of increase of the quarterly number of AIDS reports may be due to this use of zidovudine. More general improvements have also taken place in the management of symptomatic patients before the diagnosis of AIDS, which may produce an additional lengthening of the incubation period. Preliminary investigations in one of the main London clinics (Johnson AM, personal communication) suggest that, in the year to the end of March 1989, only some 15% of new AIDS diagnoses had been treated with zidovudine in a symptomatic, pre-AIDS condition.

Use of zidovudine for asymptomatic patients has been uncommon in England and Wales up to September 1989. In the future, such use may become increasingly widespread. To investigate the effect on the number of new AIDS cases of possible improvements in treatment, both for symptomatic and asymptomatic HIV-1 infected individuals, transmission model and back projection calculations were performed with an elongation of the incubation period distribution assumed to have taken place in 1988 (the elongation was taken as an increase of one year in the mean of the distribution, taken as Weibull with the value of the index remaining at two). Only minor changes resulted and these were incorporated within the projections.

2.3 Estimation of the number of HIV-1 infected individuals in the population

Data were presented in the Cox Report¹, and in the subsequent publication of the Royal Society², on the proportion with HIV-1 antibody in a number of population subgroups, including genitourinary medicine (GUM) clinic attenders by exposure category and some samples of injecting drug users. These data were combined with estimates of the size of the populations in each exposure category, to provide estimates of the number infected with HIV-1 in the population at the end of 1987.

The Working Group adopted a different approach, since it felt that the sizes of the populations to which the seroprevalence figures applied were clouded in great uncertainty. Estimation of the number of HIV-1 infected individuals was based, for the homosexual/bisexual male population, on transmission models and back projection. For the other exposure categories, back projection was used. For homosexuals and injecting drug users, two additional approaches were also considered (Ellam GA and Gill ON, paper in preparation). The first is based on the proportion of individuals with a new AIDS diagnosis who had previously been tested in an asymptomatic state and found to be infected. The approach is based on the assumption (which is at best a crude approximation) that, among asymptomatic persons infected with HIV-1, the mechanism which leads to a future diagnosis of AIDS is independent of the mechanisms which lead to a positive test for HIV-1. If the number of

persons known to be infected is N, and the proportion of new AIDS cases with a prior positive test when asymptomatic is P, then the total number infected can be estimated by N/P. The second is based on survey data estimating the proportion of samples of the homosexual/bisexual male population and of injecting drug users who have been tested for HIV-1 antibodies. If this proportion is Q, then an estimate of the total number infected is given by N/Q. Both procedures are clearly prone to bias but, in the absence of good seroprevalence data, it is useful to consider a number of independent approaches.

The Working Group has followed the Cox Report in providing upper and lower estimates of the number of HIV-1 infected individuals in the population by exposure category at the end of the year preceding the preparation of the Report; in this case 1988. The Cox Report did not attempt to project future levels of HIV-1 infection, since future prevalence is entirely dependent on future patterns of behaviour. The Working Group fully supports this reasoning, but felt it would be instructive to indicate how the pattern of HIV-1 prevalence might be changing if trends generating the upper 1988 estimate continued. For this reason, the Working Group has given projections of upper limits to the prevalence of HIV-1 infection at the end of 1990, by exposure category.

2.4 Projection of future AIDS deaths and future AIDS prevalence

From the projections of the numbers of new AIDS cases and from data on survival, the Working Group also considered the number of AIDS deaths likely to occur each year to 1993, and the number of people alive with AIDS in the population at the end of each year (the yearly prevalence).

3. Data on AIDS reports and diagnoses and on the prevalence of HIV-1 infection in adults

3.1 AIDS reports and diagnoses

Figure 1 displays the number of new AIDS cases reported up to 30 September 1989, by quarter of report and of diagnosis. For two years, July 1987 to June 1989, there was little change in the number of quarterly reports. Three factors may have contributed to the marked increase in the third quarter of 1989: the expected increase in AIDS incidence, the wide dissemination of a new clinical report form in July 1989, and an ongoing review of information and reporting in one London District. Table 1 cross-tabulates the AIDS cases by year of diagnosis and year of report.

Table 1 Comparison of year of diagnosis with year of report:
AIDS cases, excluding visitors, in England and Wales

Year of report	Year of diagnosis									Total
	1982	1983	1984	1985	1986	1987	1988	1989*	Unknown	
1982	2	-	-	-	-	-	-	-	0	2
1983	4	19	-	-	-	-	-	-	0	26†
1984	2	9	59	-	-	-	-	-	2	73‡
1985	1	1	27	114	-	-	-	-	8	151
1986	1	0	10	63	209	-	-	-	8	291
1987	0	3	1	36	164	382	-	-	1	587
1988	0	0	1	3	39	155	498	-	8	704
1989*	0	0	1	1	3	26	190	371	5	597
Total	10	32	99	217	415	563	688	371	32	2431

* reports to end September 1989

‡ includes 1 case diagnosed in 1979

† includes 3 cases diagnosed in 1981

Table 2 gives the delay distribution from diagnosis to report for cases diagnosed in each year to the end of September 1989. There is no indication of a lengthening in the delay time.

Table 2 The delay distribution from diagnosis to report of AIDS cases*,
excluding visitors, in England and Wales

Period of diagnosis	Diagnosis to report (interval in months)										Month of diagnosis unknown
	0	1	2	3	4-6	7-9	10-12	13-18	19-24	≥25	
1984 or earlier	21	36	25	5	11	9	6	5	9	11	7
1985	25	41	23	15	25	16	9	19	19	12	13
1986	36	81	44	33	62	43	18	35	28	16	19
1987	101	148	62	48	88	49	21	27	12	5	2
1988	125	195	93	64	92	53	37	25	2	0	2
1989†	85	147	69	29	33	7	-	-	-	-	1

* excludes 32 cases for which neither year nor month of diagnosis was known

† reports to end September 1989

Table 3 gives the number of yearly reports up to the end of September 1989 for each exposure category. The slowing of the increase in reports from 1987 seen in table 1 is reflected in the reports for homosexual/bisexual males, but is less marked in both the injecting drug user and the heterosexual contact exposure categories. An allowance for the possible incompleteness of these data is discussed in section 4.7.

Table 3 AIDS cases by year of report, excluding visitors, in England and Wales:
trends in exposure category distribution

Exposure category	Sex	1982	1983	1984	1985	1986	1987	1988	1989*	Total
Homosexual/bisexual male	M	2	21	66	134	257	493	574	482	2029
Injecting drug user (IDU)	M	-	-	1	2	3	6	10	12	34
	F	-	-	-	-	1	1	5	3	10
Homosexual/bisexual male & IDU Haemophilic	M	-	1	1	2	5	11	11	6	37
	F	-	2	-	6	15	40	55	31	149
Blood/components recipient: abroad	M	-	-	-	1	1	4	1	1	8
	F	-	-	-	1	1	1	2	2	7
UK	M	-	-	-	2	-	2	3	2	9
	F	-	-	-	-	1	1	3	1	6
Heterosexual contact: partner(s) with above risk factor(s)	M	-	-	-	-	-	1	3	-	4
	F	-	-	-	1	-	5	2	1	9
others†: known exposure abroad‡	M	-	-	-	-	4	8	10	18	40
	F	-	1	5	-	-	2	4	10	22
no evidence of exposure abroad	M	-	-	-	1	-	1	2	5	9
	F	-	1	-	-	1	-	-	1	3
Child of at-risk/infected parent	M	-	-	-	-	-	4	4	-	8
	F	-	-	-	-	2	2	1	1	6
Other	M	-	-	-	-	-	-	1	1	2
	F	-	-	-	1	-	-	-	-	1
Undetermined	M	-	-	-	-	-	4	13	15	32
	F	-	-	-	-	-	-	-	4	4
Totals		2	26	73	151	291	587	704	597	2431

*, †, ‡ : see table 4 below

Table 4 New HIV-1 antibody positive reports in England and Wales:
trends in exposure category distribution

Exposure category	Sex	1985 or earlier	1986	1987	1988	1989*	Cumulative total
Homosexual/bisexual male	M	770	1261	1340	904	816	5091
Injecting drug user (IDU)	M	29	122	156	116	89	512
	F	15	62	92	54	29	252
Homosexual/bisexual male & IDU Haemophilic†	M	6	16	33	20	11	86
	F	478	370	75	42	31	996
Blood/components recipient	M	1	1	1	1	3	7
	F	4	12	18	9	11	54
Heterosexual contact: partner(s) with above risk factor(s)	M	1	12	14	8	5	40
	F	-	1	4	3	2	10
others†: known exposure abroad‡	M	6	19	28	20	22	95
	F	13	36	62	43	49	203
no evidence of exposure abroad	M	5	17	40	28	31	121
	F	2	5	4	4	3	18
undetermined	M	-	2	5	3	2	12
	F	1	2	16	21	23	63
Child of at-risk/infected parent	M	-	3	18	17	15	53
	F	-	2	2	9	6	19
Multiple risks	M	2	4	1	-	-	7
	F	494	327	254	307	152	1534
Other/undetermined	M	8	17	25	47	35	132
	F	1799	2162	1969	1479	1192	8601
Totals	M	36	135	225	187	148	731
	F	37	41	18	14	7	117

* reports to end September 1989

† partner(s) not known to have above risk factor(s)

‡ includes persons without other identified risks from, or who have lived in, WHO transmission pattern II countries

+, Δ : see text

3.2 Data on the number of HIV-1 infections

The annual number of new HIV-1 antibody positive reports by exposure category is given in table 4. The actual number of known HIV-1 infected haemophiliacs is greater. A number of persons in the 'other/undetermined' category are thought to be haemophiliacs who were tested in 1985. Of the 117 reports in which sex was not specified, six were IDUs, one was a haemophiliac, one was a blood components recipient, seven were heterosexual contacts with known exposure abroad, two were heterosexual contacts with no evidence of exposure abroad, three were children of at-risk/infected parents and for 97 the exposure category was undetermined.

Data by exposure category on the proportion of AIDS cases known to have been infected with HIV-1 while asymptomatic and on the proportion of subjects in lifestyle surveys reported to have had an HIV-1 test are given in table 5, together with the respective estimates of the number of HIV-1 infected persons which these proportions might imply.

Table 5 Indirect estimates* of total number of HIV-1 infected homosexual/bisexual males and injecting drug users in England and Wales at end 1988

Method	Proportion ($\pm 95\%$ ci) for dividing known infections to estimate total	Known HIV-1 infections cumulative number [†] (range [§]) at end 1988	Estimated total (range) HIV-1 infections at end 1988
Interval from first positive HIV-1 test to AIDS diagnosis	Proportion (P) HIV-1 antibody positive ≥ 4 months before AIDS diagnosis		
	Homosexual/bisexual males (n = 882) 54% ($\pm 3\%$)	5250 (5000-7000)	9700 (8750-13900)
	Injecting drug users (n = 36) 65% ($\pm 16\%$)	950 (900-1250)	1450 (1100- 2550)
HIV-1 test history from lifestyle surveys	Proportion (Q) reported to have had an HIV-1 test		
	Homosexual/bisexual males		
	Fitzpatrick Δ (n = 497) 49% ($\pm 4\%$)	5250 (5000-7000)	10700 (9450-15550)
	Project Sigma** (n = 790) 43% ($\pm 3\%$)		12200 (10850-17500)
	Injecting drug users		
	Stimson \times (n = 900) 53% ($\pm 3\%$)	950 (900-1250)	1800 (1600-2500)

* see text - Ellam GA and Gill ON paper in preparation

[†] cumulative number at end 1988 to nearest 50, see table 4, with undetermined group distributed proportionately to other exposure categories after regional standardisation

[§] information from soundex codes and dates of birth suggests about 5% of reports may be duplicates; therefore lower bound set at 95% of cumulative number, rounded to nearest 50

⁺ under-reporting is known to occur, therefore upper bound set at cumulative number multiplied by 1.33 to allow for 25% under-reporting, rounded to nearest 50

Δ Fitzpatrick R, personal communication;⁷

** Davies P, personal communication;⁸

\times Stimson GV, personal communication;⁹

The data on the prevalence of HIV-1 infection, particularly among homosexual/bisexual male GUM clinic attenders, indicate a substantial fall in the number of new HIV-1 infections after 1984 as reviewed previously^{1,2}. Estimates of the number of new HIV-1 infections, based on the AIDS data using back projection methods, also support a fall in transmission after 1984.

4. Projection of new AIDS diagnoses to 1993 and estimation of the current prevalence of HIV-1 infection

Projections are given by exposure category. We consider first the estimation of the number of persons infected with HIV-1 at the end of 1988, together with a projection for 1990 and projections for the number of new AIDS cases to 1993. The two are strongly dependent. We present what we feel are upper and lower scenarios for the epidemic and a preferred estimate for planning purposes. The preferred estimate was based on the linear logistic and back projection best fitting models.

4.1 Homosexual/bisexual males

We have included in this category those males classified in the 'other/undetermined' exposure category. We have excluded those cases reported to be both homosexual/bisexual male and an injecting drug user.

On the basis of seroprevalence data, together with other evidence previously reviewed¹⁰, transmission of HIV-1 in this exposure category appeared to reach a peak in 1984 to 1985, then decline. Thus, the upper scenario for the rate of new HIV-1 infections assumes that the rate rises to

a peak in late 1984 and early 1985, then reduces smoothly to a level at the end of 1987 which is 25% of the peak level, after which date the rate remains constant. The lower scenario assumes the rate of new infection continues to decline after the end of 1987 until a zero level is reached in 1989, at which level it subsequently remains.

The results were obtained from transmission models and back projection calculations for these two scenarios, and from extrapolation using a linear logistic function for projections of new AIDS diagnoses annually to the end of 1993. Table 6 gives the lower and upper projections, together with the preferred estimate.

Table 6 Homosexual/bisexual male exposure category:
projections of AIDS incidence* and HIV-1 prevalence
in England and Wales

Year	Lower projection	Upper projection	Preferred estimate
New AIDS diagnoses:			
1989	620	830	665
1990	645	960	770
1991	665	1070	855
1992	685	1140	910
1993	700	1200	960
HIV-1 prevalence:			
end 1988	7000	14000	-
end 1990	-	15500	-

* without adjustment for under-reporting

4.2 Injecting drug users

We have included in the group of injecting drug users men who were reported as both drug users and homosexual/ bisexual. The upper scenario assumed for this group is continuing exponential growth in the HIV-1 epidemic, an assumption consistent with the reported number of new AIDS diagnoses.

Table 7 Injecting drug user exposure category:
projections of AIDS incidence* and HIV-1 prevalence
in England and Wales

Year	Lower projection	Upper projection	Preferred estimate
New AIDS diagnoses:			
1989	40	95	55
1990	45	180	80
1991	50	320	135
1992	50	565	225
1993	50	1000	400
HIV-1 prevalence:			
end 1988	900	2800	-
end 1990	-	9000	-

* without adjustment for under-reporting

4.3 Heterosexual contact cases

We have not differentiated individuals infected from partners with a major risk factor other than heterosexual contact, those with known heterosexual contact abroad or those with no evidence of exposure abroad (see tables 3 & 4), since there are insufficient data to enable separate projections to be made for these groups. The upper scenario assumed for this category is that HIV-1 infection is continuing to increase exponentially. This assumption is consistent with the reported number of new AIDS diagnoses.

Table 8 Heterosexual contact exposure category:
projections of AIDS incidence* and HIV-1 prevalence
in England and Wales

Year	Lower projection	Upper projection	Preferred estimate
New AIDS diagnoses:			
1989	35	100	45
1990	41	200	90
1991	45	400	180
1992	47	780	335
1993	50	1500	650
HIV-1 prevalence:			
end 1988	600	3000	-
end 1990	-	11000	-

* without adjustment for under-reporting

Table 6 also gives the corresponding upper and lower estimates of the number of HIV-1 infections at the end of 1988 based on transmission models and back projection. The upper projection for 1990 is also given. The variation between the "best" and "worst" scenarios for new AIDS cases is not great over the time period considered.

The lower scenario, given limited credence by indirect data¹¹, is that the number of new HIV-1 infections reached a peak at the end of 1984, then declined linearly by 75% by the end of 1987, thereafter remaining at a constant level. Projection for new AIDS diagnoses and the estimates for the number of HIV-1 infections in the population, comparable to table 6, are given in table 7.

The lower scenario is that the number of new HIV-1 infections reached a peak at the end of 1984, then declined linearly by 75% by the end of 1987, thereafter remaining at a constant level.

Table 8 gives the projections of new AIDS diagnoses by year to 1993 and estimates of the number of HIV-1 infections in the population, corresponding to table 6.

4.4 Haemophiliac and blood/components related infection

The number of individuals infected by contaminated blood or blood products will not have changed to any extent since the Cox Report. It is estimated that there are 1250 infected haemophiliacs^{1,2} and up to 200 other individuals may be infected by blood products. The number of AIDS cases is expected to rise from approximately 80 in 1989 to 110 in 1993. (The numbers for the years 1990 to 1992 used in table 9 were obtained by linear interpolation).

4.5 Children of an at risk/infected parent

To the end of September 1989, there had been 14 reports of AIDS cases, and 46 vertically exposed children who were HIV-1 antibody positive. It was considered that the annual number of new AIDS cases in this category could rise from about 10 in 1989 to between 30 and 50 in 1993. (The numbers for years 1990, 1991 and 1992 used in table 9 were obtained by linear interpolation). The number of children infected was probably no more than 300 at the end of 1988, and likely to have been considerably less, and might rise to 500 at the end of 1990, as an upper limit.

4.6 Age effect

The effect of allowing the incubation period to depend on age was investigated for the homosexual/bisexual male sub-population. Separate linear logistic functions were fitted to the observed AIDS cases in those under and over the age of 50. Then the back projection method was applied to each group assuming a Weibull distribution with index two for the incubation period, with mean 10 years for the under-50s and six years for the over-50s. The results were compared with those obtained by fitting a single linear logistic function to all the homosexual/bisexual male cases, using the Weibull distribution with mean 10 years.

With two groups, the total AIDS incidence in 1993 is slightly higher at 1210 as compared with 1190 for the single group; the fitted AIDS incidence among the over-50s contributes a decreasing proportion of the total incidence as the epidemic progresses. Cumulative HIV-1 incidence up to 1988 is 13,000 for the two groups combined as compared with 13,400 for the single group. Thus, as can be predicted intuitively, the effect of the shorter incubation period is to reduce the projected HIV-1 incidence; the effect is, however, relatively small.

4.7 Estimates and projections of the annual number of AIDS diagnoses and the number of HIV-1 infected individuals for the total population

The numbers given in the preceding section are combined in table 9 (AIDS diagnoses to 1993) and table 10 (estimated HIV-1 infected individuals for the end of 1988, and the upper projection for the end of 1990).

Table 9 has incorporated an adjustment for under-reporting. If known deceased cases of AIDS ascertained from reports to CDSC and death entries form the denominator, the degree of under-reporting of people with AIDS who have died is around 88%. This excludes from the denominator, however, deaths from AIDS not included in either of these reporting systems. We have therefore made an arbitrary estimate of 20% under-reporting of AIDS cases and accordingly multiplied the numbers in tables 6 to 8 and sections 4.4 and 4.5 by a factor of 1.25, to give the totals in table 9.

Table 9 Annual number of AIDS diagnoses observed to 1989, and projected to 1993: England and Wales; adjusted for under-reporting

Year	Cox Report ^{1*}		Observed [†]	Current forecasts (January 1990)		
	Planning projection	Linear logistic		Lower [§] projection	Upper [§] projection	Planning [§] projection
1984 or earlier	180	180	180	-	-	-
1985	270	270	270	-	-	-
1986	520	520	520	-	-	-
1987	1000	1000	730 ⁺	-	-	-
1988	1560	1515	990 ^Δ	-	-	-
1989	2250	1975	-	980	1400	1070
1990	2940	2340	-	1045	1800	1300
1991	3690	2650	-	1090	2400	1600
1992	4500	2900	-	1135	3275	2000
1993	-	-	-	1175	4825	2700

* recommended basis for planning and linear logistic projections from table 3.1 of the Cox Report, multiplied by 1.25 to adjust for 20% under-reporting

† numbers of table 1 multiplied by 1.25 to adjust for 20% under-reporting, rounded to nearest 10

§ tables 6 to 8, together with cases in haemophiliacs and blood recipients, and in children (see text), multiplied by 1.25 to adjust for 20% under-reporting and rounded to nearest 5

+ including 18 cases inferred from future reports

Δ including 100 cases inferred from future reports

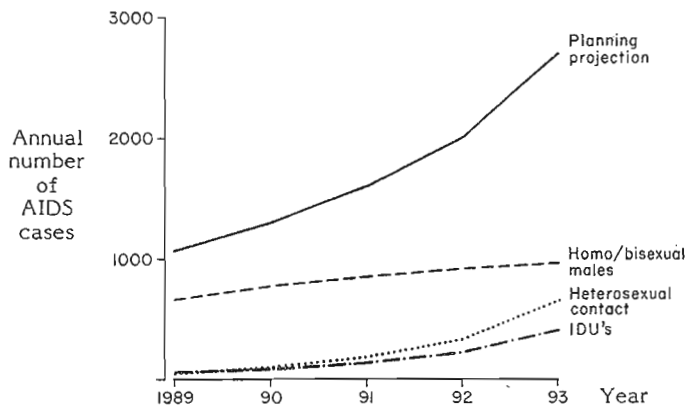
Table 10 Estimates of the number of HIV-1 infected individuals in the population at the end of 1988, and projections for the end of 1990

Exposure category	End 1988		End 1990
	Lower estimate	Upper estimate	Upper projection
(Tables 6, 7 and 8)*			
Homosexual/bisexual male	8750	17500	19500
Injecting drug user	1100	3500	11250
Haemophiliac/blood components recipient	1450	1450	1450
Heterosexual contact	750	3750	13750
Child of at-risk/infected parent	200	200	500
Total	12250	26400	46450
Indirect estimate (table 5)† for homosexual/bisexual males and injecting drug users for end 1988	11750	18100	-
Cox Report ¹ estimate for end 1987	20000	50000	-

* HIV-1 numbers from these tables, multiplied by 1.25 to adjust for 20% under-reporting of AIDS cases

† weighted combination of different estimates, rounded to nearest 50

Figure 2 Preferred estimate of annual number of AIDS cases for major exposure categories and planning projection*, 1989 to 1993

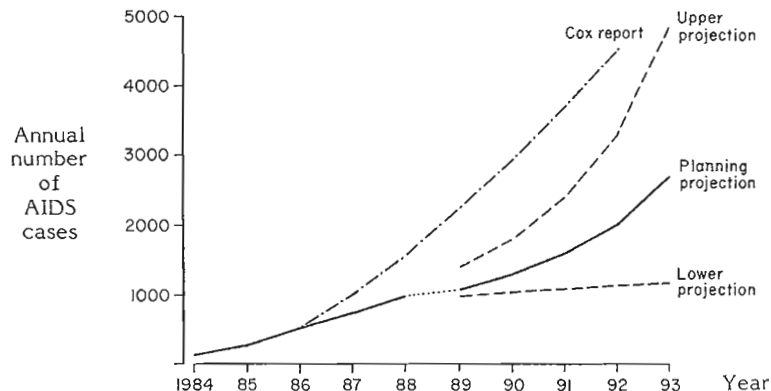


The preferred estimates of the annual number of AIDS cases, from tables 6, 7 and 8, and the planning projection to end 1993 are summarised in figure 2. Most of the increase in 1993 is from cases in the heterosexual contact and injecting drug use exposure categories.

The current planning projection, including upper and lower estimates, is compared in figure 3 with the earlier Cox Report recommended basis for planning. The difference between the projections is striking and is the upturn from 1991 to 1993 in the current planning projection.

* preferred estimates added together with infected cases in haemophiliacs and blood recipients, and in children, all multiplied by 1.25 for under-reporting

Figure 3 Incidence of AIDS in England and Wales : current 1989 projection compared with previous 1988 Cox Report projection



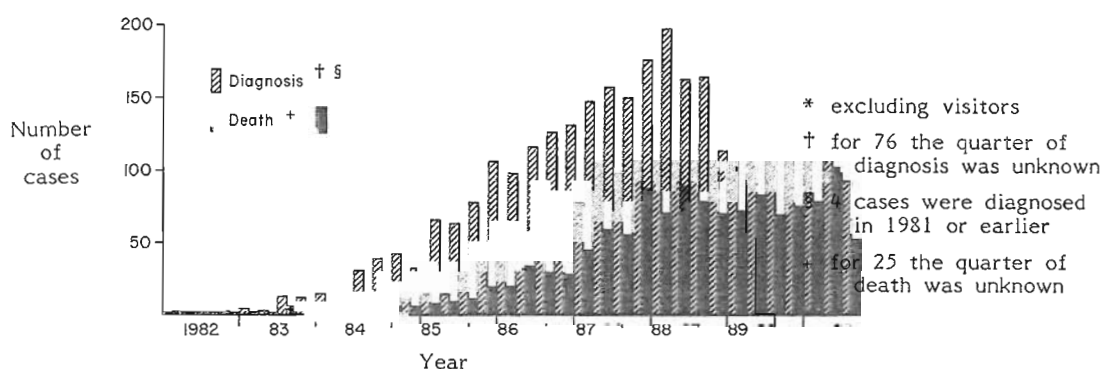
5. Projected deaths from AIDS and prevalence of AIDS, and the survival distribution

Projections of AIDS prevalence in future years have been based on projections of AIDS diagnoses and available information on survival.

Reports of AIDS deaths suffer from some delay, albeit to a lesser extent than the delay in reporting of diagnosis. Figure 4 gives the numbers of reported AIDS deaths, by quarter of death, together with the quarterly number of diagnoses. In the past year, 50% of reports in a given three-month period referred to deaths occurring in that quarter, 45% to deaths occurring in the preceding quarter and the remaining 5% mainly to deaths in the two quarters before that. By the end of December 1989, 1497 AIDS deaths had been reported in England and Wales residents; one could assume that an additional 70 will have occurred by the end of 1989 but not have been reported by that date.

Our projection of the cumulative number of new diagnoses that will have occurred by the end of 1989 is 3010, taken from table 9 but without adjustment for under-reporting. Our prevalence estimate, after rounding, for the end of 1989 is therefore 1440 without, and 1800 with, adjustment for under-reporting (see table 12).

Figure 4 Incidence of AIDS cases and deaths* : England and Wales



For years 1990 to 1993, projections of deaths and prevalence are based on an estimated survival function for AIDS, applied to incident cases of AIDS. In the Cox Report¹, the median survival of persons with AIDS was assumed to be 9.22 months, based on an analysis of cases reported to CDSC by September 1987, most of whom were diagnosed in 1986 or earlier. It is now clear that better management of patients and the advent of new treatments - notably zidovudine, but also aerosolised pentamidine and others - have significantly increased survival times in the last couple of years.

CDSC has produced a preliminary analysis based upon active follow-up (see table 11) of 1995 AIDS cases reported by the end of 1988, showing that the median survival time for patients diagnosed prior to 1987 was nine to 10 months, but for those diagnosed in 1987 the median is around 18 months. For cases diagnosed in 1988 (for whom only very truncated data are available) survival at 12 months showed a further improvement.

Table 11 Survival of adult* AIDS cases in England and Wales, excluding cases with missing dates and visitors; cumulative numbers known to have died by end December 1989

Interval from diagnosis to death (months)	Diagnosed 1979-1986 (n = 715)	Diagnosed 1987 (n = 551)	Diagnosed 1988 (n = 689)
	Deaths (%)	Deaths (%)	Deaths (%)
0†	79 (11)	57 (10)	47 (7)
1	137 (19)	84 (15)	88 (13)
2	159 (22)	103 (19)	104 (15)
3	187 (26)	119 (22)	119 (17)
4	217 (30)	128 (23)	138 (20)
5	246 (34)	134 (24)	147 (21)
6	266 (37)	154 (28)	156 (23)
7	297 (42)	164 (30)	166 (24)
8	319 (45)	180 (33)	176 (26)
9	339 (47)	189 (34)	188 (27)
10	368 (51)	201 (36)	198 (29)
11	392 (55)	208 (38)	210 (30)
12	408 (57)	222 (40)	221 (32)

* aged 15 years and over at diagnosis

† died in same calendar month

For the purposes of calculating the number of deaths, survival distributions were assumed to have the mathematical form discussed in the Cox Report¹.

For cases diagnosed:

before 1987	probability of zero survival time	= 0.08;
	probability of surviving t months	= $0.92 \exp(-0.061t)$;
in 1987	probability of zero survival time	= 0.09;
	probability of surviving t months	= $0.91 \exp(-0.034t)$;
in 1988	probability of zero survival time	= 0.06;
	probability of surviving t months	= $0.94 \exp(-0.026t)$.

These above distributions were obtained by fitting the two distribution parameters to the observed probability of survival at 0 and 12 months from table 11.

Applying these survival distributions to the observed and projected number of AIDS diagnoses gives the number of AIDS deaths, by years, and hence the AIDS prevalence at year end. These projections are given in table 12.

Table 12 Projections of annual numbers of AIDS diagnoses and deaths, and numbers of AIDS cases alive

Year	No under-reporting adjustment*			Adjusted for under-reporting†		
	New diagnoses (incidence)	Deaths‡	Cases alive at year end (prevalence)	New diagnoses (incidence)	Deaths‡	Cases alive at year end (prevalence)
1989	860	455	1440	1070	570	1800
1990	1040	600	1880	1300	750	2350
1991	1280	750	2410	1600	940	3010
1992	1600	950	3060	2000	1190	3820
1993	2160	1230	3990	2700	1540	4980

* planning projection from table 9 multiplied by 0.8

† see table 9 and text

‡ based on the survival distribution described in the text

It should be noted that the projected prevalence figures incorporate not only the uncertainty of the projection for new diagnoses, but also uncertainty as to the evolution of survival with improving treatment. Further improvements in treatment will elongate the survival distribution described above, decrease the yearly number of deaths and increase the prevalence. Given the importance of the prevalence projections for planning purposes, this aspect needs to be kept under close review.

6. Conclusions

The projections in this report, as in the Cox Report, are subject to considerable uncertainty arising both from limited knowledge of key factors that determine transmission and disease progression, and from limitations in the epidemiological data. Under-reporting and delays in reporting are one aspect. In addition, the effect of medical developments in vaccines or therapy are difficult to predict. We have made some allowance for the possible effect that widespread use of zidovudine among those infected with HIV-1 and asymptomatic may have, but our assumptions are largely speculative. There is also a possibility that there may be considerably more HIV-1 related deaths than are currently ascribed to AIDS^{1,3}; longitudinal studies of different exposure category cohorts should throw light on this issue.

Bearing in mind these limitations, the projections in this report nevertheless differ appreciably from those of the Cox Report. Much of this difference derives from a changing perception of how the epidemic has evolved in the homosexual community. During the period in which the Cox Report Working Group was meeting, the quarterly number of AIDS reports were only just beginning to indicate that major changes in behaviour in the homosexual community might have been occurring in the mid-1980s. That such changes had occurred was supported by some independent evidence, both behavioural and seroepidemiological, available at the time. Since then, the evidence that transmission diminished markedly in the homosexual/bisexual section of the male community in the mid-1980s, coming from studies of behaviour, from the changing prevalence of HIV-1 infection and from the number of new AIDS cases, has strengthened. Future trends will depend on this reduction in high risk behaviour being maintained, which can certainly not be guaranteed. Only serial, unbiased seroprevalence monitoring can provide data on current rates of transmission. In addition, past trends emphasise the importance of acquiring longitudinal data on patterns of sexual behaviour in the total population and in specific exposure categories. The Working Group estimates that the number of infected homosexuals at the end of 1988 was in the range 8750 to 17,500, rather than the Cox estimate of 13,000-30,000 for the end of 1987. The projections for new AIDS cases among homosexuals in 1993 are in the range 875 to 1500, in contrast to roughly 2000 to 10,000 (the Cox Report did not give separate projections for AIDS cases by exposure category, but some 80% of all projected cases were assumed to be homosexual/bisexual males).

The second main conclusion of this Working Group is that major uncertainty exists in the direction the epidemic is taking among those infected by injecting drug use and through heterosexual contact. Continuing exponential growth in the number of new persons infected with HIV-1 in both populations is consistent with available data on AIDS diagnoses. In contrast to exponential spread, a lower scenario, also consistent with available data, is that little new transmission is taking place in either group, and that only minor increases will be seen in the next few years in the yearly number of cases due to injecting drug use or heterosexual contact. The incidence of acute hepatitis B among drug users fell markedly between 1985 and 1987¹¹, a fall which has been sustained in the last two years, giving support to the lower scenario. Although in both groups the current number of new cases is small, and the number of persons infected dominated by the number in homosexual/bisexual males, if exponential growth is occurring the situation will change rapidly so that, by 1993, two thirds or more of new AIDS cases would arise from these two exposure categories; in contrast, in 1988 nearly 90% of all reports were in homosexual/bisexual males. It is for this reason that the Working Group decided to include upper projections for the number infected with HIV-1 in the population at the end of 1990, to underline the possibility that injecting drug use and heterosexual contact transmission may provide the majority of persons infected in the population in the fairly immediate future. This range of uncertainty underlines the great importance of obtaining reliable data on the changing prevalence of HIV-1 infection by exposure category. If unlinked anonymous HIV-1 testing programmes¹⁴ had been started even two years ago, this uncertainty would have been largely reduced.

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