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## The changing epidemiology of diagnosed prevalent HIV infections in England: greatest impact on the London environs

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### SUMMARY

Data from the 1997–2004 Surveys of Prevalent HIV Infections Diagnosed were analysed by three geographical areas of residence and treatment to describe the heterogeneous growth of the HIV epidemic in England and provide projections to 2007. Between 1997 and 2004, the number of diagnosed HIV-infected adults resident in England increased by 163% (14 223 to 37 459). Within the ‘London environs’ the increase was 360% (742 to 3411), within the rest of England 219% (4417 to 14 088) and within London 120% (9064 to 19 960). By 2004, the London environs had the largest proportion of infections acquired through heterosexual sex (and in particular women) and the most recently diagnosed population. Projections indicate over half of diagnosed HIV-infected adults will live outside London by 2007. The epidemiology of diagnosed HIV infection within the London environs is likely to be a predictor of future trends in England overall.

### INTRODUCTION

Established in 1995, the annual cross-sectional Survey of Prevalent HIV Infections Diagnosed (SOPHID) provides a residence-based measure of individuals with diagnosed HIV infection [1–3]. The survey aims to include every individual in England, Wales and Northern Ireland with diagnosed HIV infection who has attended for HIV-related care at National Health Service (NHS) sites of treatment within a calendar year.

Historically London has been the focus of HIV in the United Kingdom and although London continues to have the largest numbers of resident and treated individuals, recent increases in prevalence have been proportionally greater outside the capital

[1]. Analyses of the 1997–2003 SOPHID data [1] found the four strategic health authorities with the largest observed increases in the number of adults seen for HIV-related care or treatment, were outside London (Bedfordshire and Hertfordshire; Essex; Leicestershire, Northamptonshire and Rutland; Thames Valley) [1]. Of these, three bordered London (Bedfordshire and Hertfordshire; Essex; Thames Valley). Much of the increase in the number of adults seen for HIV-related care in the United Kingdom since 1997 is a result of continuing new diagnoses of HIV, particularly among those migrating from countries with high HIV prevalence, and the impact of highly active antiretroviral therapy, which has substantially reduced HIV-related mortality [4, 5].

To inform the planning and financing of HIV services in England, we investigate the heterogeneous growth of the HIV epidemic by focusing on the changes in the epidemiology of diagnosed HIV infection between 1997 and 2004 within the health authorities in close proximity to London [the London environs (LE)] and comparing these to London and

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the Rest of England (RoE). We also investigate what implications current and future trends of diagnosed HIV infection in the LE may have for the other areas.

## METHODS

The Survey of Prevalent HIV Infections Diagnosed (SOPHID) was established in 1995 as an annual cross-sectional survey of all individuals accessing HIV-related treatment and care services in England, Wales and Northern Ireland. The SOPHID database is held at the Health Protection Agency's Centre for Infections and strict attention to confidentiality is maintained at every stage of data collection, analysis and storage.

Eight consecutive annual cross-sectional SOPHID surveys (1997–2004) each providing a 'census' of individuals with diagnosed HIV in England were used for these analyses. Methods of data collection, de-duplication and dissemination have been described elsewhere [1–3]. This study was restricted to adults aged  $\geq 15$  years. The following variables from SOPHID were included in these descriptive analyses: area of residence, area of treatment, probable route of infection, sex and ethnicity. Where an individual was reported by more than one site to an annual survey, they were assigned to the site at which they were last seen in the calendar year, and the place of residence is as reported by that site.

Information on the time of diagnosis and the world region where HIV infection occurred were available by linking SOPHID data to the national surveillance database for new diagnoses of HIV [6, 7]. Record linkage was based on soundex code [3], date of birth and sex. World region of infection is only presented for adults infected through heterosexual sex as this information is not investigated further for other groups (warranted because the majority of adults infected through sex between men (SBM) probably acquire their infection within the United Kingdom whereas the majority of adults infected through heterosexual sex probably acquire their infection outside the United Kingdom [6]).

Increases in numbers of adult residents with diagnosed HIV infection between 1997 and 2004 were ranked by strategic health authority of residence. Based on the rank order of these increases three geographical areas were defined for analyses using 2001 health authorities: London, LE and RoE. The LE area was defined as the eight health authorities (2001 definition) bordering London (Buckinghamshire,

Hertfordshire, North Essex, South Essex, West Kent, East Surrey, West Surrey and Berkshire) and Bedfordshire, which was included due to its proximity and links to London [1]. London was defined as for the current London government office region (2005 definition). RoE was defined as all other parts of England. Health authority boundaries provide more geographical definition than larger strategic health authorities (introduced in April 2002). Retrospective allocation of pre-2002 surveys to the 2002 NHS administrative boundaries of primary care trusts was not technically possible.

Results are presented by area of residence unless stated otherwise. Prevalence is shown per 100 000 population, based on the Office of National Statistics (ONS) mid-2001 resident population estimates (aged  $\geq 15$  years). Children were excluded as no soundex code is reported for these records and additional information could not be attributed from the new diagnoses database. Descriptive analyses of epidemiological variables concentrate on differences between the three areas of residence.

Data by probable route of infection and residence were extrapolated to provide an estimate of the number of adults with diagnosed HIV infection for the years 2005–2007. To reflect current trends, projections were based on 2001–2004 SOPHID data. A number of model diagnostic and fitting techniques were applied to the 2001–2004 data to find a model that yielded a good fit. The negative binomial model, previously used to provide extrapolation estimates [2], was shown to no longer adequately fit the data. A linear regression model was found to be the most appropriate to model the temporal trend for each of the exposure by residence groups. STATA 8.2 was used for statistical analysis (Stata Corp., College Station, TX, USA).

## RESULTS

### Area of residence and area of HIV treatment or care

Between 1997 and 2004, both the number of diagnosed HIV-infected adults resident in England and those receiving HIV-related treatment or care in England increased by 163% (14 223 to 37 459 and 14 451 to 38 064 respectively). These increases varied greatly across the three study areas (Table 1). In England in 2004, the rate of diagnosed HIV-infected adults per 100 000 adult population was 92, in LE it was 62, in RoE 48 and in London 335.

Table 1. Adults with diagnosed HIV infection by area of residence and area seen for HIV-related treatment or care, 1997–2004

Area	Year of survey										Increase 1997 to 2004 <i>n</i>	Increase (%)	% of all diagnosed individuals in England 1997	% of all diagnosed individuals in England 2004	
	1997	1998	1999	2000	2001	2002	2003	2004	2004	(%)					
<b>London environs</b>															
Resident	742	869	960	1132	1607	2240	2918	3411	2669	(360)	5	9			
Treated/seen for care	481	554	627	765	1166	1736	2292	2603	2122	(441)	3	7			
<b>Rest of England</b>															
Resident	4417	4786	5466	6177	7360	9192	11 591	14 088	9671	(219)	31	38			
Treated/seen for care	4152	4493	5181	5922	6968	8860	11 121	13 663	9511	(229)	29	36			
<b>London</b>															
Resident	9064	10 126	11 321	12 670	14 473	16 643	18 452	19 960	10 896	(120)	64	53			
Treated/seen for care	9818	11 020	12 348	13 769	15 715	18 141	20 127	21 798	11 980	(122)	68	57			
<b>England</b>															
Resident	14 223	15 781	17 747	19 979	23 440	28 075	32 961	37 459	23 236	(163)	—	—			
Treated/seen for care	14 451	16 067	18 156	20 456	23 849	28 737	33 540	38 064	23 613	(163)	—	—			

### Area of treatment and care in relation to area of residence

In 2004, 68% (2322/3411) of adults resident in LE also received their care within LE compared to 54% (401/742) in 1997. The proportion of adults both resident and treated in RoE increased slightly from 91% (4029/4417) in 1997 to 94% (10 812/11 591) in 2004 whereas in London the proportion was over 99% for all years [1997 (9020/9064), 2004 (19 786/19 960)].

Of the 32% (1089) LE residents receiving care elsewhere in 2004, 86% (933) were treated in London and 14% (156) in RoE. A higher proportion of LE residents infected through SBM received their care elsewhere (49%, 398/817) than LE residents infected through heterosexual sex (25%, 609/2459). Of the 6% (779) RoE residents receiving care elsewhere in 2004, 82% (736/899) were treated in London, 17% (150) in LE and 1% (13) in Wales or Northern Ireland.

### Sex, ethnicity and probable route of infection

While the number of men doubled between 1997 and 2004, the number of women increased almost five times such that the male:female ratio decreased in all areas, particularly in LE where in 2004 there was near parity (LE 4:1:1 to 1:1:1, RoE 6:1:1 to 2:1:1, London 4:2:1 to 2:2:1) (Table 2). In all three geographical areas, the largest proportional increases were seen in the number of individuals of black-African ethnicity. This rise was largest in LE, increasing from 9% of all resident diagnosed adults (69/729) in 1997 to 57% (1935/3371) in 2004 (Table 2).

Within LE the number of resident adults who acquired their infection through heterosexual sex (either within or outside the United Kingdom) outnumbered those reported as having acquired their infection through SBM (either within or outside the United Kingdom) in 2000. In RoE this epidemiological shift took place in 2004 whereas SBM remained the most probable route of infection reported in London in 2004 (Table 2).

In 2004, black-African women infected through heterosexual sex accounted for the highest proportion of residents within LE with diagnosed HIV infection (39%, 1322/3411), followed by white men infected through SBM (22%, 736). Within RoE and London, the two largest groups in 2004 were white men infected through SBM [42% (5851/14 088) and 39% (7818/19 960) respectively] and black-African females infected through heterosexual sex [21% (2960) and 22% (4479) respectively].

Table 2. Adults with diagnosed HIV infection by area of residence, sex, ethnicity, year of UK diagnosis and route and country of infection, 1997 and 2004

		Individuals with diagnosed HIV infection by area of residence											
		London environs			Rest of England			London			England		
		1997	2004	% of	1997	2004	% of	1997	2004	% of	1997	2004	% of
				2004			2004			2004			2004
Sex	Male	597	1751	51.3	3782	9568	67.9	7313	13 774	69.0	11 692	25 093	67.0
	Female	145	1660	48.7	622	4520	32.1	1750	6186	31.0	2517	12 366	33.0
	Not reported	0	0	—	13	0	—	1	0	—	14	0	—
Ethnicity	Black-African	69	1935	56.7	198	4634	32.9	1823	7131	35.7	2090	13 700	36.6
	Black-Caribbean	17	60	1.8	56	265	1.9	233	825	4.1	306	1150	3.1
	Black – Other/Black unspecified	5	32	0.9	12	93	0.7	193	418	2.1	210	543	1.4
	Indian/Pakistani/Bangladeshi	8	20	0.6	67	173	1.2	95	244	1.2	170	437	1.2
	Other/Mixed/Oriental	26	97	2.8	86	361	2.6	639	1042	5.2	751	1500	4.0
	White	604	1227	36.0	3746	8424	59.8	5802	9614	48.2	10 152	19 265	51.4
	Not reported	13	40	1.2	252	138	1.0	279	686	3.4	544	864	2.3
Probable route of infection	Sex between men	382	817	24.0	2792	6196	44.0	5782	9523	47.7	8956	16 536	44.1
	Sex between men & women	223	2459	72.1	891	6897	49.0	2495	9198	46.1	3609	18 554	49.5
	Other*	118	96	2.8	620	662	4.7	571	686	3.4	1309	1444	3.9
	Not reported	19	39	1.1	114	333	2.4	216	553	2.8	349	925	2.5
Year of first HIV diagnoses in the UK	1979–2001 (inclusive)	—	1045	30.6	—	5419	38.5	—	9900	49.6	—	16 364	43.7
	2002	—	440	12.9	—	1503	10.7	—	1717	8.6	—	3660	9.8
	2003	—	547	16.0	—	2025	14.4	—	2148	10.8	—	4720	12.6
	2004	—	609	17.9	—	2221	15.8	—	2355	11.8	—	5185	13.8
	Not linked to the database for new diagnoses of HIV	—	770	22.6	—	2920	20.7	—	3840	19.2	—	7530	20.1
Infections acquired through heterosexual sex – follow-up of probable country of infection	Africa	—	1452	59.0	—	3713	53.8	—	4863	52.9	—	10 028	54.0
	Asia	—	63	2.6	—	283	4.1	—	149	1.6	—	495	2.7
	Australasia /North America	—	4	0.2	—	16	0.2	—	35	0.4	—	55	0.3
	Europe	—	17	0.7	—	100	1.4	—	155	1.7	—	272	1.5
	Latin America/Caribbean	—	27	1.1	—	113	1.6	—	283	3.1	—	423	2.3
	UK – partners exposed through heterosexual sex outside Europe	—	124	5.0	—	339	4.9	—	525	5.7	—	988	5.3
	UK – partners exposed through heterosexual sex within Europe	—	28	1.1	—	151	2.2	—	78	0.8	—	257	1.4
	UK – partners with miscellaneous risk†	—	42	1.7	—	264	3.8	—	199	2.2	—	505	2.7
	Not linked to the database for new diagnoses of HIV	—	702	28.5	—	1918	27.8	—	2911	31.6	—	5531	29.8

\* Includes injecting drug use, mother-to-child transmission (>14 years of age) and blood/blood products.

† Includes partners exposed through heterosexual sex in an unknown country, and partners exposed within or outside the UK through injecting drug use, blood/blood products, and sex between men.

Table 3. *Adults with diagnosed HIV infection by area of residence and probable route of infection – observed data 2001–2004 and estimates using a linear regression model 2001–2007*

Probable route of infection	Survey year	Observed data Area of residence			Total (sum of the three areas of residence)	Linear regression model Area of residence			Total (sum of the three areas of residence)
		London environs	Rest of England	London		London environs	Rest of England	London	
Sex between men	2001	568	4196	7692	12 456	566	4120	7721	12 407
	2002	643	4714	8371	13 728	651	4784	8327	13 762
	2003	748	5359	8931	15 038	737	5449	8932	15 118
	2004	817	6196	9523	16 536	822	6113	9537	16 472
	2005	—	—	—	—	907	6778	10 143	17 828
	2006	—	—	—	—	992	7442	10 748	19 182
	2007	—	—	—	—	1077	8107	11 353	20 537
Sex between men and women	2001	911	2438	5852	9201	928	2314	5973	9215
	2002	1450	3643	7209	12 302	1449	3817	7088	12 354
	2003	2020	5296	8325	15 641	1971	5320	8204	15 495
	2004	2459	6897	9198	18 554	2492	6823	9319	18 634
	2005	—	—	—	—	3014	8326	10 435	21 775
	2006	—	—	—	—	3535	9829	11 550	24 914
	2007	—	—	—	—	4056	11 332	12 665	28 053
Other routes	2001	94	620	605	1319	103	609	612	1324
	2002	112	612	650	1374	104	624	637	1365
	2003	118	629	659	1406	106	638	663	1407
	2004	96	662	686	1444	107	652	688	1447
	2005	—	—	—	—	108	667	713	1488
	2006	—	—	—	—	109	681	738	1528
	2007	—	—	—	—	110	695	763	1568
Total (sum of the three routes of infection)	2001	1573	7254	14 149	22 976	1597	7043	14 306	22 946
	2002	2205	8969	16 230	27 404	2204	9225	16 052	27 481
	2003	2886	11 284	17 915	32 085	2814	11 407	17 799	32 020
	2004	3372	13 755	19 407	36 534	3421	13 588	19 544	36 553
	2005	—	—	—	—	4029	15 771	21 291	41 091
	2006	—	—	—	—	4636	17 952	23 036	45 624
	2007	—	—	—	—	5243	20 134	24 781	50 158

### Year of HIV diagnoses in the United Kingdom and probable country of infection

Across the three study areas approximately the same proportion of adults reported to SOPHID in 2004 were found to have a linked record in the national surveillance database for new diagnoses of HIV (Table 2). Of adults reported as resident within LE in 2004 and who had a linked record, 60.4% (1596/2641) were shown to have been diagnosed with HIV infection in the United Kingdom in 2002, 2003 or 2004 (Table 2). Of adults reported as resident within LE in 2004 who acquired their infection through heterosexual sex and had a linked record, 82.6% (1452/1757) acquired their infection in Africa (Table 2). Within RoE the figures were 51.5% (5749/11 168) and 74.6%

(3713/4979) respectively and within London 38.8% (6220/16 120) and 77.4% (4863/6287) respectively.

### Projected estimates of diagnosed HIV infection for 2005–2007

The linear regression model predicted an increase of 55% (3372 to 5243) between 2004 and 2007 in the overall number of diagnosed adults resident within LE (Table 3). In RoE it predicted an increase of 46% (13 755 to 20 134) and within London an increase of 28% (19 407 to 24 781). The model predicted that by 2007 over half of diagnosed HIV-infected adults will live outside London.

In all three areas the estimated increases are strongly influenced by new diagnoses in adults

infected through heterosexual sex. Within London it was predicted that the number of adults infected through heterosexual sex would exceed, for the first time, those infected through SBM in and after 2005 (Table 3). This epidemiological shift was observed within LE in 2000 and RoE in 2004. Within all three areas it is estimated that numbers of adults infected through SBM will gradually increase between 2004 and 2007 whereas, numbers infected through other (non-sexual) routes remain constant (Table 3).

## DISCUSSION

### Increase in number of diagnosed HIV infections

The large increase in numbers of adults living with diagnosed HIV infection in England between 1997 and 2004 is, in part, due to the success of anti-retroviral drugs in reducing mortality rates [4]. However, a stronger influence than reduced mortality on the figures is the large increase that has been seen in new HIV diagnoses, particularly since 2000–2001 [8]. A number of factors would appear to contribute to this increase including an increase in the uptake of voluntary confidential HIV testing, the continued transmission of HIV within the United Kingdom [particularly amongst men who have sex with men (MSM)], the increased diagnosis of infections acquired through heterosexual contact in countries with a high HIV prevalence and the introduction of the universal offer and recommendation of antenatal screening for HIV in 1999.

During the study period the largest increase in numbers of diagnosed individuals was in London. Proportionally, however, infections increased at a faster pace outside London and in particular within LE where the proportional increase of diagnosed infections was three times that seen within London and almost double that seen within RoE.

Overall new diagnoses in England among heterosexual men and women exceeded those in MSM in 1999 [9]. Whereas LE and RoE have already seen the prevalent number of diagnosed adults infected through heterosexual sex exceed the number of adults infected through SBM, the linear regression model predicts that this epidemiological shift will not take place within London until 2005 (observed data not available until late 2006).

In 1999, when new diagnoses of heterosexually acquired infections exceeded those acquired through

SBM, 61% of the population in England seen for HIV-related treatment or care were infected through SBM compared to half in LE. This reflects that the epidemiology of diagnosed HIV infection within LE is shaped to a greater extent than elsewhere by more recently diagnosed infections. Also reflecting this is that only within LE has the number of HIV-infected black-African women exceeded that of all white adults (2002), and only within LE has the ratio of male:female adults (including all ethnicities and routes of infection) almost reached parity.

### Service providers

The number of individuals receiving HIV-related care at services within LE has increased because of the growth in the resident diagnosed population and the increase in the proportion of the current resident population seeking care locally. Interestingly, the data show a difference by probable route of infection between those LE residents receiving care locally and those receiving care in the capital, with a large proportion of those infected through SBM receiving HIV care in London.

These differences may be explained by: MSM having greater social ties with the capital; current treatment facilities locally not meeting the needs of certain groups; disparities in awareness of availability and open access of services; socioeconomic disparities. Further analyses are necessary to understand patterns of use of HIV-related services. However, it is inevitable that the increase in diagnosed HIV infections observed and predicted for LE will not only have implications for service providers within LE but also those within London.

### Limitations of this study

It is estimated that ~34% of adults aged between 15 and 59 years living with HIV infection in the United Kingdom are unaware of their status [10]. Therefore, the results presented reflect not the total number of adults living with HIV in England but the number resident within England aware of their HIV infection and accessing NHS sites of treatment for HIV-related care within a calendar year [1–3]. It is also worth noting that probable route of infection may not necessarily reflect an individual's risk of onward transmission of HIV infection and this should be considered when using SOPHID data to inform HIV prevention strategies.

With the three study areas being large there is obviously considerable heterogeneity within each area in terms of the rate of increase in numbers of diagnosed HIV infections and in the epidemiology of the resident populations, particularly for RoE [1]. However, extrapolations for these areas are likely to be more reliable than for smaller geographies.

The extrapolated estimates for 2005–2007, using a linear regression model, assume that current observed trends continue [2]. The model is particularly sensitive to changes in the pattern of in-migration of HIV-infected people from countries with a high prevalence of HIV to the United Kingdom (the majority of individuals resident in LE and reported as having been infected through heterosexual sex were probably infected in Africa) and changes in number of deaths among individuals with diagnosed HIV infection. However, a negative binomial model applied to the 1997–2001 SOPHID data accurately predicted the 2003 totals for LE (estimate 2918, observed 2918) and London (estimate 18 742, observed 18 452), although it underestimated the total for RoE (estimate 10 526, observed 11 591) [2].

Neither SOPHID nor the national database for new diagnoses of HIV collect information on an individual's residency status or reasons for migration within the United Kingdom. Therefore, it was not possible to comment on whether the National Asylum Support Service guidelines on dispersal [11] (as informed by section 97 of the Immigration and Asylum Act 1999) possibly explain some of the trends presented in this paper.

### Implications

Of the three study areas the trends seen within LE most closely follow those seen in new diagnoses in the United Kingdom as a whole [6]. If current trends continue it is probable that the diagnosed population resident within RoE will, in the next couple of years, present a similar epidemiology to that currently seen within LE. The increase in number of diagnosed HIV infections among heterosexual men and women from countries with a high HIV prevalence reinforces the need for sustained prevention activities within these communities to minimize the risk of ongoing transmission of HIV within the United Kingdom.

The increases described have serious implications for the planning and financing of HIV/AIDS services and the appropriate targeting of prevention programmes in the three study areas. As stated in the

Department of Health's national strategy for sexual health and HIV, local services should meet the needs of different populations [12]. Data presented in this study highlight the need for local HIV/AIDS services to be responsive to rapid increases and changes to the epidemiology and treatment access patterns of their diagnosed prevalent HIV-infected population.

### CONCLUSIONS

1. Between 1997 and 2004, the number of adults living with diagnosed HIV infection increased in all three study areas. However, the proportional increase of diagnosed adults resident within LE was three times that seen within London and nearly double that seen within RoE.
2. In 2004, of the three study areas, LE had the largest proportion of infections acquired through heterosexual sex, the largest proportional increase in numbers of diagnosed adults of black-African ethnicity, the most recently diagnosed population and the highest proportion of individuals receiving HIV-related care outside their area of residence.
3. While LE and RoE have already seen numbers of adults infected through heterosexual sex exceed those acquired through SBM the linear regression model predicts that this epidemiological shift will take place within London in 2005.
4. London continues to have the largest number of resident and treated adults with diagnosed HIV infection, however, using a linear regression model projections based on current figures show that over half of diagnosed HIV-infected adults will live outside London by 2007.
5. Based on current trends it is probable that the diagnosed population resident within RoE will, in the next couple of years, present a similar epidemiology to that currently seen within LE.

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**DECLARATION OF INTEREST**

None.

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