

Murray G D, Lawrence A E and Boyd J (2000) Linkage of Hospital Episode Statistics (HES) data to Office for National Statistics (ONS) mortality records, *Bristol Royal Infirmary Inquiry*, INQ 0032.

Spiegelhalter D J (1999) An initial synthesis of statistical sources concerning the nature and outcomes of paediatric cardiac surgical services at Bristol relative to other specialist centres from 1984 to 1995. *Bristol Royal Infirmary Inquiry*, INQ 0015, November 1999.

Spiegelhalter D J (2000) An investigation into the relationship between mortality and volume of cases in surgery for congenital heart disease from 1984 to 1995. *Bristol Royal Infirmary Inquiry*, INQ 0031.

Spiegelhalter D J, Evans S, Aylin P and Murray G D (2000) A response to 'Submissions on behalf of Mr J D Wisheart: Appendix 2. The Inquiry's Statistical Analysis'. *Bristol Royal Infirmary Inquiry*, INQ 0034.

Stark J (2000a) Comments on statistical analysis and review of outcomes of paediatric cardiac services at Bristol and other specialist centres. Part 1 *Bristol Royal Infirmary Inquiry*, WIT 0567.

Stark J (2000b) Comments on statistical analysis and review of outcomes of paediatric cardiac services at Bristol and other specialist centres, Part 2. *Bristol Royal Infirmary Inquiry*, WIT 0567.

Vardulaki K A, Bennett-Lloyd B D, O'Riordan P A, Reeves B C, Tsang V T C and Black N A (2000) A systematic review of the outcomes of paediatric open-heart surgery, *Bristol Royal Infirmary Inquiry*, INQ 0039.

Wisheart J (2000a) Submissions on behalf of Mr J D Wisheart: Appendix 2. The Inquiry's Statistical Analysis. *Bristol Royal Infirmary Inquiry*, SUB0009.

Wisheart J (2000b) Response of Mr J D Wisheart to a group of statistical papers. *Bristol Royal Infirmary Inquiry*, WIT 0120 0468-0499.

Yates J (1997) A case study exploring the early identification of performance failure in an acute hospital, *Bristol Royal Infirmary Inquiry*, WIT 0568.

Technical Appendix

The full analysis is described in the Appendices of Aylin *et al* (1999, INQ 0013) and Spiegelhalter (1999, INQ 0015). This involved a logistic regression model for each stratum defined by epoch, age-group and procedure group, in which a random effect was associated with each non-Bristol centre. The variance component within each stratum were assumed to be drawn from a hierarchical prior distribution, and this provided a predictive distribution over the effect in a new centre, and hence a predictive distribution over the number of deaths in a centre with Bristol's activity. The difference to the observed number of deaths gave both an estimate and interval for the excess mortality. This analysis is intended to allow for important sources of variation and so will be fairly conservative.

The full analysis is time consuming and unsuited for repeated sensitivity analyses. For this reason an intermediate analysis has been carried out, again based on a logistic regression but assuming independent fixed effects for each centre in each stratum defined by epoch and age-group, with main effects fitted for procedure group. The contrast between Bristol's effect and the average of the effects in the other centres was obtained using 'Helmert contrasts'. The natural way to report the results is by odds ratios and their 95% confidence intervals: the more restrictive assumptions in this simpler model tend to make the results somewhat less conservative than the full analysis.

The baseline analysis in the table below shows that for 1991-1995, both HES and CSR data, taken at face value, provide strong evidence for excess mortality in Bristol (odds ratio greater than 1). Stratifying for case-mix does not decrease this estimate. The CSR data from 1988-1990 provide some evidence for excess mortality. The results for the sensitivity analyses are given below and summarised in Section 6.4.3.

Appendix Table. Results of sensitivity analysis on open operations under one year of age.

Data	Epoch	Analysis	Unstratified		Stratified for case-mix				
			Odds ratio	95% interval	p-value	Odds ratio	95% interval	p-value	
CSR	1988-1990	Baseline							
		a) Without centres 3,4,5 b) Without groups 2,3,5	1.54 1.73 2.38	1.03 to 2.30 1.01 to 2.98 1.44 to 3.94	.02 .03 .001	1.62 1.86 2.88	0.96 to 2.72 0.93 to 3.73 1.5 to 5.53	.04 .04 .001	
CSR	1991-1995	Baseline							
		a) Without centres 3,4,5 b) Without groups 2,3,5	1.95 1.98 1.96	1.40 to 2.72 1.27 to 3.10 1.28 to 3.01	.0001 .001 .001	1.90 1.97 1.90	1.22 to 2.95 1.09 to 3.56 0.95 to 3.82	.002 .01 .04	
HES	1991-1995	Baseline							
		a) Without centres 3,4,5 b) Without groups 2,3,5	2.72 2.74 1.80	1.92 to 3.86 1.71 to 4.38 1.10 to 2.95	.0001 .0001 .01	3.43 3.46 2.58	2.21 to 5.32 1.85 to 6.48 1.46 to 4.58	.0001 .0001 .001	
		c) Compensating for deaths missed by HES	2.67	1.71 to 4.17	.0001	3.2	1.47 to 6.95	.002	
HES + CSR	1991-1995	d) "Extreme" choice of HES and CSR	1.83	1.31 to 2.54	.0001	1.46	0.97 to 2.21	.04	

a) Removes centres with higher discrepancies between HES and CSR data

b) Removes procedures for TGA (Groups 2 and 3) and AVSD (Group 5).

c) Increases mortality rates in each centre by apparent undercount indicated in Table 3.2

d) For each procedure group, selects HES or CSR data depending on which has the **lower** mortality (if Bristol), or whichever has the **higher** mortality (if elsewhere).

'Odds ratio' is the estimated ratio of the odds of dying in Bristol compared to the average odds of dying in other centres. P-values are 1-sided.

**Table 2.1. Paediatric Cardiac Surgical Procedures by Group:
OPCS4 Codes mapped by UKCSR Categories**

Group	OPCS4 Procedure Code	Description	Map to UKCSR
G1	K04	Tetralogy of Fallot	Yes
G2	K05	Interatrial TGA	Yes
G3	K06	Other TGAs (- switch)	Yes
G4	K07	Repair of TAPVD	Yes
G5	K09 excluding K09.4	Repair of CAVSD (complete not partial)	Yes
G6	K10, K20 and K09.4	Closure of secundum and sinus venosus ASD	Yes
G7	K11 (only on its own or with K10 or +/- L02; K11 is superior code to K10)	Closure of VSD	Yes
G8	L01.1	Truncus arteriosus	Yes
G9	K19.1, K19.2, K19.4 + L09	Fontan type operations	Yes
G10	K26, K28, K31.2, K31.4, K37	Aortic, pulmonary valve and paravalve procedures	Yes
G11	K25, K31.1, K34.1, K38	Mitral valve procedures	Yes
G12	L05, L06, L07, L08	Closed shunts	No
G13	L23.1, 2 or 3 [- if K code with it, code as KCoarctation procedures not L]	Coarctation procedures	Yes (simple coarctation)

Table 2.2. Synthesis of Statistical Sources: Primary Procedure Ranking

Rank	Group	Description
1	G 8	Truncus Arteriosus
2	G 9	Fontan type operations
3	G4	TAPVD
4	G 3	Other TGA
5	G 2	Interatrial TGA
6	G 5	AVSD
7	G 11	Mitral valve procedures
8	G 10	Aortic and pulmonary valve procedures
9	G 1	Tetralogy of Fallot
10	G 7	Closure of VSD
11	G 6	Closure of ASD
12	G 12	Closed Shunts
13	G 13	Simple Coarctation

(Note: If any operation features procedures falling into more than one of the consensus groups G1 to G13, the operation is assigned to the highest ranking Group. This table draws on expert clinical advice on the most common combinations of procedures and mortality rates.

Table 2.3. Centres included in the comparative exercise

Code	Centre	Hospital
1	Bristol	Bristol Royal Infirmary
2	Leicester	Glenfield Hospital
3	Leeds	Killingbeck Hospital
4	Oxford	The John Radcliffe Hospital
5	Guys	Guys Hospital
6	Liverpool	Royal Liverpool Children's Hospital
7	Southampton	Southampton General Hospital
8	Great Ormond Street	Great Ormond St Hospital
9	Newcastle	Freeman Hospital
10	Harefield	Harefield Hospital
11	Birmingham	Birmingham Children's Hospital
12	Brompton	Brompton Hospital

(Note: Centres were assigned Inquiry codes 2-12 at random. Centres were identified at the BRI Inquiry on November 3rd 1999.)

Table 3.1 Outline comparison of six available sources of data on Bristol's activity and outcomes.

	PAS Patient Administration System	CCR Coded Clinical Records	SL Surgeons' Logs	CHR South West Congenital Heart Register	HES Hospital Episode Statistics	CSR UK Cardiac Surgical Register
<i>Purpose</i>	Hospital administration and returns to HES.	Medical records.	Personal record for audit and constructing CSR returns	Epidemiological information and clinical back-up.	National administration system. Now used for DoH performance indicators.	Professional register for comparative anonymous audit.
<i>Completed by:</i>	Coders.	Medical personnel.	Surgeons.	Cardiologists.	Derived from PAS.	Surgical team in Bristol.
<i>'Activity'</i>	Episodes linked to form admissions/spells.	Operations.	Operations.	Operations.	Episodes linked to form admissions/spells.	Diagnostic group subdivided by 'corrective' and palliative' operations.
<i>Grouping for synthesis.</i>	Existing OPCS4 codes.	Coded into OPCS4 by expert team.	Coded into OPCS4 by expert team.	Mapped by expert consensus.	Existing OPCS4 codes.	Mapped by expert consensus in 13 groups. Open/closed provided on report.
<i>Epochs available</i>	2: 1988 - 1990 3: 1991 - Mar 95 4: Apr 95 - Dec 95	1: 1984 - 1987 2: 1988 - 1990 3: 1991 - Mar 95 4: Apr 95 - Dec 95	1: 1984 - 1987 2: 1988 - 1990 3: 1991 - Mar 95 4: Apr 95 - Dec 95	1: 1984 - 1987 2: 1988 - 1990 3: 1991 - Mar 95 4: Apr 95 - Dec 95	3: Mar 1991 - Mar 95 4: Apr 95 - Dec 95	1: 1985 - 1987 2: 1988 - 1990 3: 1991 - Mar 95 (not Jan - Mar 93) 4: Apr 95 - Mar 96
<i>Age groups</i>	1: 0 - 90 days 2: 90 days - 1 year 3: 1 year +	1: 0 - 90 days 2: 90 days - 1 year 3: 1 year +	1: 0 - 90 days 2: 90 days - 1 year 3: 1 year +	1: 0 - 90 days 2: 90 days - 1 year 3: 1 year +	1: 0 - 90 days 2: 90 days - 1 year 3: 1 year +	1+2: 0 - 1 year 3: 1 year +
<i>Comments.</i>	Considered to be of good quality. Late deaths may be missed.	Usual problems with incomplete medical records. Not all relevant records identified.	Only covers 'open' surgery at BRI.	'Child' is basis for records. Stable team.	Quality depends on local PAS systems. Missing outcomes on some admissions.	Completed by a range of staff. No validation. Missing years for some centres.

Table 3.2 Deaths identified by linkage within 30 days of procedures but NOT captured by HES

Centre	All cases		Open procedures in children under one	
	'Missed' deaths *	%	'Missed' deaths *	%
1	3 / 74	4	2 / 43	5
2	3 / 41	7	0 / 25	0
3	13 / 67	19	3 / 27	11
4	6 / 40	15	2 / 24	8
5	2 / 42	5	0 / 24	0
6	3 / 91	3	2 / 43	5
7	1 / 32	3	0 / 20	0
8	12 / 108	11	7 / 59	12
9	6 / 54	11	0 / 25	0
10	2 / 73	3	2 / 27	7
11	8 / 91	9	2 / 57	4
12	8 / 72	11	1 / 32	3
Elsewhere	1 / 21	5	0 / 1	0
Total	68 / 806	8.4	21 / 407	5.2

* 'Missed' in inverted commas since HES is not designed to capture 30-day mortality.

Table 3.3 Comparison of UKCSR returns with HES data for 1991-1994.
Admissions are grouped by Surgery, Age, Centre, Consensus Group and Year.

	Number of Cases			Number of Deaths			Ratio of Death Rates
	UKCSR	HES	Ratio	UKCSR	HES	Ratio	
Surgery							
Open	8227	7544	1.09	698	577	1.21	1.10
Closed	2898	2817	1.03	86	100	0.86	0.83
Total	11125	10361	1.07	784	677	1.16	1.07
Age							
Under 1	5360	5078	1.06	500	461	1.08	1.01
Over 1	5765	5283	1.09	284	216	1.31	1.20
Centre							
1	830	750	1.11	79	69	1.14	0.96
2	758	603	1.26	43	37	1.16	0.92
3	556	1068	0.52	50	54	0.93	1.78
4	295	481	0.61	27	35	0.77	1.24
5	664	557	1.19	61	39	1.56	1.30
6	1372	1460	0.94	96	86	1.12	1.19
7	819	639	1.28	40	32	1.25	0.98
8	1187	965	1.23	82	64	1.28	1.04
9	805	609	1.32	49	46	1.07	0.81
10	709	574	1.24	87	70	1.24	1.01
11	1921	1492	1.29	95	84	1.13	0.86
12	1209	1163	1.04	75	61	1.23	1.15
Group							
G1	921	837	1.10	57	45	1.27	1.10
G2	76	158	0.48	15	17	0.88	1.76
G3	685	644	1.06	89	67	1.33	1.13
G4	203	217	0.94	28	27	1.04	1.01
G5	553	749	0.74	65	68	0.96	1.25
G6	1525	1182	1.29	11	18	0.61	0.46
G7	1141	1280	0.89	26	56	0.46	0.50
G8	123	97	1.27	30	30	1.00	0.76
G9	340	620	0.55	42	65	0.65	1.16
G10	827	893	0.93	42	43	0.98	1.03
G11	160	247	0.65	15	27	0.56	0.82
G13	757	632	1.20	12	17	0.71	0.59
Year							
1991	3255	2710	1.20	254	191	1.33	1.09
1992	3403	2944	1.16	245	203	1.21	1.03
1993	2352	2311	1.02	142	142	1.00	0.97
1994	2115	2396	0.88	143	141	1.01	1.14
1995	3509	2178	1.61	195	125	1.56	0.84

For 1991 and 1992 the UKCSR data cover calendar years but the HES data cover financial years.

The HES data for 1995 cover only the nine month period April 1995 to December 1995.

Centre 8 was dropped from the HES data for 1993/4 and 1994/5, as there were no corresponding UKCSR returns for those years.

HES figures include cases where outcome is unknown.

Comparison of mortality rates use a denominator which excludes these cases.

Data for 1995 are only included in the tabulation by year.

Some sub-totals for HES data may disagree slightly with other tables due to small differences in definition.

Table 5.1 UBHT activity and outcomes in Epoch 3 (1991-1995) - all ages, comparison of six different data sources

	Number of operations										No of deaths										Mortality rates (%)									
	CCR	SL	PL	CSR	PAS	HES*	SW	CHR	CV		CCR	SL	CSR	PAS	HES	SW	CHR	CV		CCR	SL	CSR	PAS	HES	SW	CHR	CV			
G1 Tetralogy of Fallot	55	61	62	58	54	51	45	11%		7	6	6	7	5	6	6	12%		13	10	10	13	11	13	13	15%				
G2 Interatrial TGA	25	27	25	4	29	24	26	37%		2	2	0	4	3	2	2	61%		8	7	0	14	17	8	8	59%				
G3 Other TGAs (- switch)	28	27	27	45	29	27	25	23%		11	12	10	12	11	11	7%			39	44	22	41	58	44	21%					
G4 Repair of TAPVD	24	24	23	19	20	18	21	11%		6	6	6	7	5	9	21%			25	25	32	35	36	43	22%					
G5 Repair of CAVSD (complete not partial)	47	56	17	41	39	36		33%		14	15	11	13	12		12%		30	27	27	33	35			11%					
G6 Closure of secundum and sinus venosus ASD	89	89	91	126	92	92	92	14%		1	2	2	4	5	12	93%		1	2	2	4	6	6	13	96%					
G7 Closure of VSD	101	101	114	90	115	105	72	15%		4	4	0	4	1	3	66%		4	4	0	3	1	4	4	66%					
G8 Truncus arteriosus	8	10	10	8	9	8		11%		5	4	2	4	3		32%		63	40	25	44	60			32%					
G9 Fontan type operations	57	45	47	39	43	42	30	19%		7	8	7	5	5	4	26%		12	18	18	12	13	13	13	21%					
G10 Aortic, pulmonary valve and paravalve procedures	55	45	71	34	57	51	42	24%		3	2	1	4	5	3	47%		5	4	3	7	10	7	7	39%					
G11 Mitral valve procedures	19	6	7	9	23	23	18	50%		3	1	0	3	3	2	63%		16	17	0	13	13	11	11	52%					
G12 Closed shunts	57			66	65			8%		10		7	7	7		22%		18			11	11			31%					
G13 Coarctation procedures	92			61	101	92	80	18%		2		0	2	2	3	61%		2		0	2	2	2	4	66%					
Total	657	491	534	494	677	634	451			75	75	62	76	67	55			11	11	13	7	10	7							
Total of Groups 1-4, 6, 7, 9-11	453	425	424	467	462	433	371	8%		42	44	43	50	43	52	16%		9	10	10	11	10	14	14	20%					
G88 Open	476	454	530	563	501	505		8%		68	61	71	65	62		6%		14	13	13	13	14			4%					
G99 Closed	136			267	160	245		32%		5	8	7	7	7		19%		4		3	4	3			16%					
Total	612			830	661	750		22%		73	79	72	69	69		9%		12	10	11	10	10	10	12	12%					

* Based on all admissions, whether outcome known or not

† Based only on admissions where outcome known

CV: Coefficient of Variation, defined to be mean / standard deviation.

‡The 530 operations in PL are the total of all those occurring in Epoch 3, not just those classified as open using OPCS-4 code

PAS: Patient Administration system, CCR: Coded Clinical Records, SL: Surgeons' Logs, PL: Perfusionists' logs

SWCHR: South West Congenital Heart Register, HES: Hospital Episode Statistics, CSR: UK Cardiac Surgical Register.

(NB Further examination of data has resulted in small changes from a previous version of this table.)

Table 5.2 Comparison of annual admissions, deaths and mortality rates in Bristol derived from local data sources open operations on under-ones.

Year	No. of admissions					No. of deaths					Mortality rates (%)						
	CCR	PAS	SL	HES	CSR	CCR	PAS	SL	HES	CSR	HES/ONS	CCR	PAS	SL	HES	CSR	HES/ONS
1984	11	-	9	-	-	4	-	3	-	-	-	36	-	33	-	-	-
1985	14	-	15	-	14	2	-	2	-	3	-	14	-	13	-	21	-
1986	28	-	28	-	24	9	-	6	-	6	-	32	-	21	-	25	-
1987	25	-	35	-	25	5	-	7	-	7	-	20	-	20	-	28	-
1988	29	29	36	-	29	10	8	9	-	11	-	34	28	25	-	38	-
1989	40	41	46	-	40	14	14	15	-	15	-	35	34	33	-	37	-
1990	38	33	46	-	39	4	3	7	-	5	-	11	9	15	-	13	-
1991	43	41	48	(32) ¹	46	12	12	16	(7)	14	(8)	28	29	33	25	30	24
1992	45	49	58	50 ²	53	12	12	11	12	8	11	27	24	19	30	15	22
1993	50	54	55	50 ³	(50)	11	12	11	11	(14)	12	22	22	20	29	28	23
1994	32	31	40	32 ⁴	(32)	11	10	9	10	(7)	10	34	32	23	32	22	31
1995	25	28	14	(8) ⁵	(50)	3	3	1	(1)	(3)	(1)	12	11	7	17	6	12

Notes:

1. Brackets indicate figures which are not directly comparable for the following reasons:
HES : figures for 1991 do not include January to March; figures for 1995 include only January to March
CSR : figures for 1993 to 1995 are financial years, so exclude January to March of the current year and include January to March of the following year
2. HES figures include cases where outcome is unknown, as follows:
1:4 2:10 3:12 4:1 5:2
Corresponding mortality rates use a denominator which excludes these cases.
3. HES/ONS figures are HES records confirmed as 30-day deaths by linkage with ONS register of deaths

**Table 6.1 Summary of analyses comparing Bristol and elsewhere:
all open, case-mix stratified open, and closed operations.**

Source	Epoch	Under 1s					Over 1s				
		Mort else.	Mort Bris	Obs	Exp	Excs	Mort else.	Mort Bris	Obs	Exp	Excs
All open operations											
CSR	1: 1984-1987	21%	25%	16	14.0	2.0	8%	8%	24	23.3	.7
	2: 1988-1990	18%	29%	31	22.3	8.7	7%	12%	37	22.4	14.6
	3: 1991-1995	12%	24%	43	24.0	*19.0	5%	7%	28	22.8	5.2
	4: 1995-1996	12%	6%	3	6	-3.0	3%	1%	2	4.4	-2.4
HES	3: 1991-1995	12%	29%	41	16.9	*24.1	5%	7%	21	15.0	6.0
	4: 1995	12%	4%	1	2.8	-1.8	4%	0%	0	3.7	-3.7
Open operations – case-mix stratified											
CSR	1: 1984-1987			15	13.0	2.0			16	13.7	2.3
	2: 1988-1990			26	19.0	7.0			24	12.7	*11.3
	3: 1991-1995			30	17.1	*12.9			15	12.2	2.8
	4: 1995-1996			2	2.4	-.4			0	1.7	-1.7
HES	3: 1991-1995			42	14.8	*27.2			16	12.0	4.0
	4: 1995			1	2.7	-1.7			0	1.7	-1.7
All closed operations											
CSR	1: 1984-1987	6%	12%	18	9.4	8.6	2%	2%	3	2.0	1.0
	2: 1988-1990	5%	8%	12	7.9	4.1	2%	3%	4	2.6	1.4
	3: 1991-1995	3%	3%	5	6.2	-1.2	3%	3%	3	2.5	0.5
	4: 1995-1996	3%	0%	0	1.5	-1.5	1%	4%	1	.3	.7
HES	3: 1991-1995	4%	5%	7	6.9	0.1	2%	0%	0	1.7	-1.7
	4: 1995	9%	0%	0	2.8	-2.8	0%	4%	1	0.0	1.0

Epoch 4 (1995) based on simplified analysis.

* indicates > 95% confidence that excess mortality > 0

Obs = Observed deaths

Exp = Expected deaths

Excs = Estimated excess deaths

**Table 6.2 Summary of analyses for Epoch 3, April 1991 to Mar 1995.
Operations on under-ones.**

		HES					CSR				
		Mort. Else.	Mort Bris.	Obs	Exp	Excs	Mort. else.	Mort Bris.	Obs	Exp	Excs
G1	Fallot type	6%	0%	0	0.2	-0.2	8%	0%	0	0.2	-0.2
G2	Interatrial TGA	11%	13%	2	1.6	0.4	(28%)	(0%)	0	0.8	-0.8
G3	Other TGAs	10%	77%	10	1.5	*8.5	(13%)	(28%)	10	5.0	5.0
G4	TAPVD	14%	36%	5	2.0	3.0	14%	33%	6	2.6	3.4
G5	AVSD	12%	48%	11	3.0	*8.0	13%	25%	8	4.5	3.5
G6	ASD	7%	50%	5	0.7	*4.3	2%	40%	2	0.1	*1.9
G7	VSD	6%	0%	0	2.7	-2.7	3%	0%	0	1.4	-1.4
G8	Truncus	32%	75%	3	1.3	1.7	25%	29%	2	1.9	0.1
G9	Fontan type	17%	50%	2	0.7	1.3	33%	100%	1	0.4	0.6
G10	Aortic, pulm	10%	50%	2	0.4	1.6	13%	100%	1	0.2	0.8
G11	Mitral valve	24%	67%	2	0.7	1.3	14%	0%	0	0.2	-0.2
G12	Closed shunts	10%	8%	3	3.8	-0.8					
G13	Coarctation	4%	3%	2	2.6	-0.6	2%	0%	0	0.6	-0.6
G1-11	Stratified open	10%	30%	42	14.8	*27.2	10%	19%	30	17.1	*12.9
	Open	11%	29%	41	16.9	*24.1	12%	24%	43	24.0	*19.0
	Closed	4%	5%	7	6.9	0.1	3%	3%	5	6.2	-1.2

* indicates > 95% confidence that excess mortality > 0

Obs = Observed deaths,

Exp = Expected deaths,

Excs = Estimated excess deaths.

Figure 6.1 Mortality in all centres derived from both HES and R Open operations

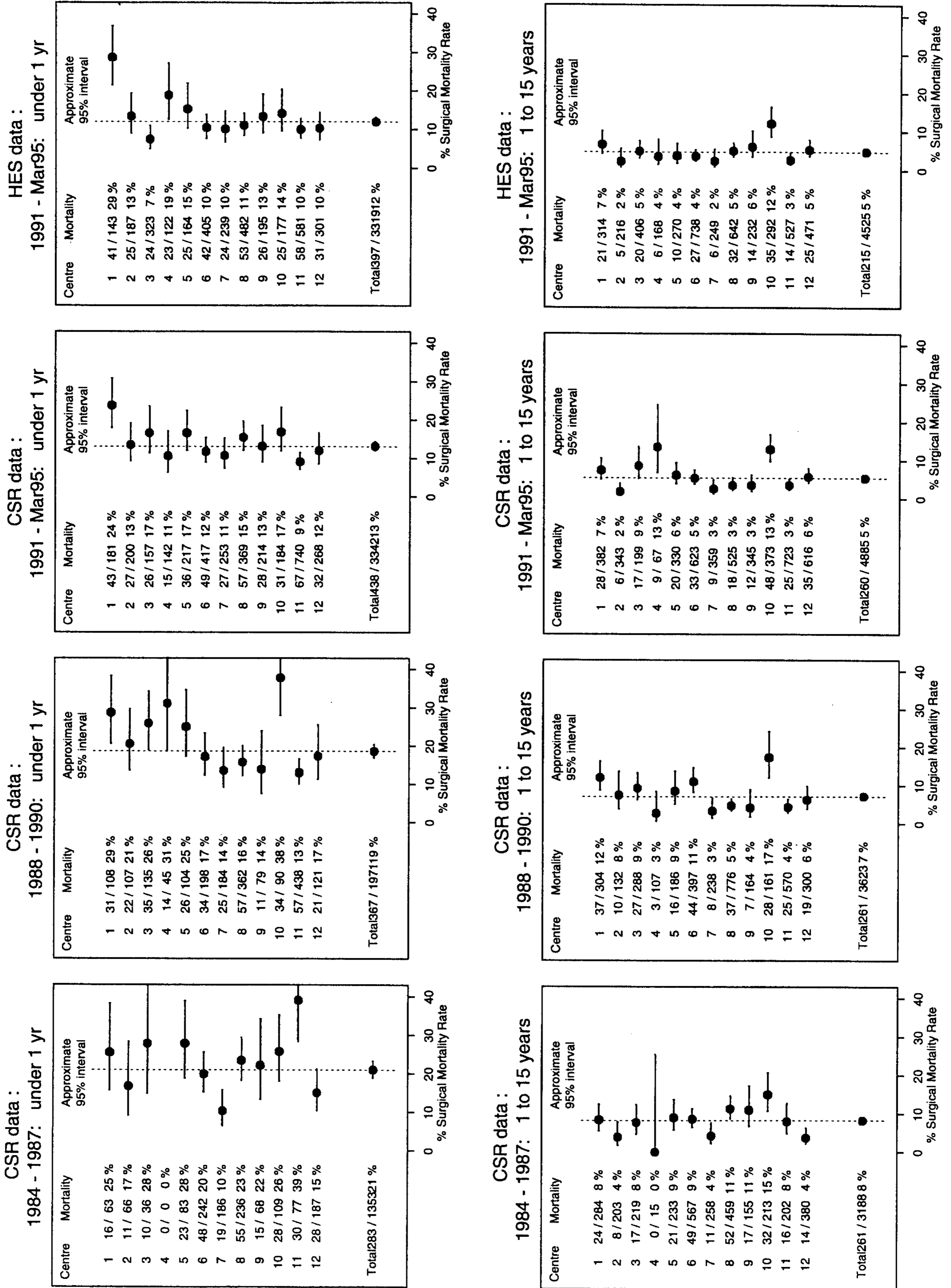


Table 6.4. Results for open operations, under one year of age, 1991-1995, excluding switch (group 3) and AVSD (group 5) operations.

Source	Mortality elsewhere	Mortality in Bristol	Estimated excess deaths	Simple p-value
HES	248/2201 = 11 %	21/130 = 16 %	6.4	.12
CSR	279/2257 = 12 %	25/111 = 22 %	11.3	0.003
Additionally excluding inter-atrial repairs (group 2)				
HES	237/2103 = 11 %	19/115 = 17 %	6.0	.12
CSR	265/2207 = 12 %	25/108 = 23 %	12.0	0.001

The full analysis has not been re-run for this particular subset of patients. A simple comparison has been made between the overall mortality rate elsewhere and that in Bristol. The 'p-value' is the chance of observing such a difference by chance alone, and is based on a standard 'chi-squared test'.

Table 6.5. Impact of including all HES data for Bristol with missing outcomes, and assuming they all were survivors.

Age group	Number of missing outcomes in Bristol for open operations	Mortality elsewhere for open operations	Number of additional deaths expected if Bristol were 'typical'	Reduction in excess number of deaths
< 90 days	7	16%	1.1	1.1
90 days – 1 year	22	7%	1.5	1.5
> 1 year	19	5%	1.0	1.0
Total	48		3.6	3.6

Table 7.1 Comparison of mortality rates elsewhere and in Bristol with published literature for the period 1991- 1995.

% Mortality rates						
Procedure	Vardulaki <i>et al</i>	Hannan <i>et al</i>	HES elsewhere	CSR elsewhere	HES Bristol	CSR Bristol
Switch (G3)	8 – 12	10*	10	12	58	22
TAPVD (G4)	10 – 30	18	12	12	36	32
AVSD (G5)	8 – 12	10	8	11	35	27
Truncus (G8)	10 – 25	22	31	24	60	25
Fontan (G9)	10 – 20	14 (8**)	11	12	13	18
All surgery						
< 90 days		15	11		19	
90 days – 1 year		7	6		14	
< 1 year		11	9	9	16	13
> 1 year		3	4	5	5	7

* Includes Rastelli repair / intraventricular tunnel repair

** Including bidirectional Glenn

Table 8.1 Summary table of status at admission and comorbidity for open operations, epoch 3

	UBHT		Elsewhere	
	n	% Mortality*	n	% Mortality*
Age	under 90 days	37 7%	1,696 22%	16%
	90 days – 1 year	135 27%	1,641 21%	7%
	1 - 15 years	333 66%	4,408 57%	5%
Down's Syndrome	Mention of Down's syndrome in any diagnosis field	52 10%	539 7%	8%
	No mention of Down's syndrome	453 90%	7206 93%	7%
Transfers	Transfers from other units	32 6%	1707 22%	14%
	Non-transfers	473 94%	6038 78%	5%
Emergencies	Emergency admissions	36 7%	783 10%	12%
	Non-emergency admissions	469 93%	6962 90%	7%

*based on spells with known outcome

Figure 8.1 Mortality in relation to volume of cases. Open operations
 r = estimated change in risk per 10 extra case(s) per year (excluding Bristol)
 Bristol labelled 'o', other centres labelled '*'

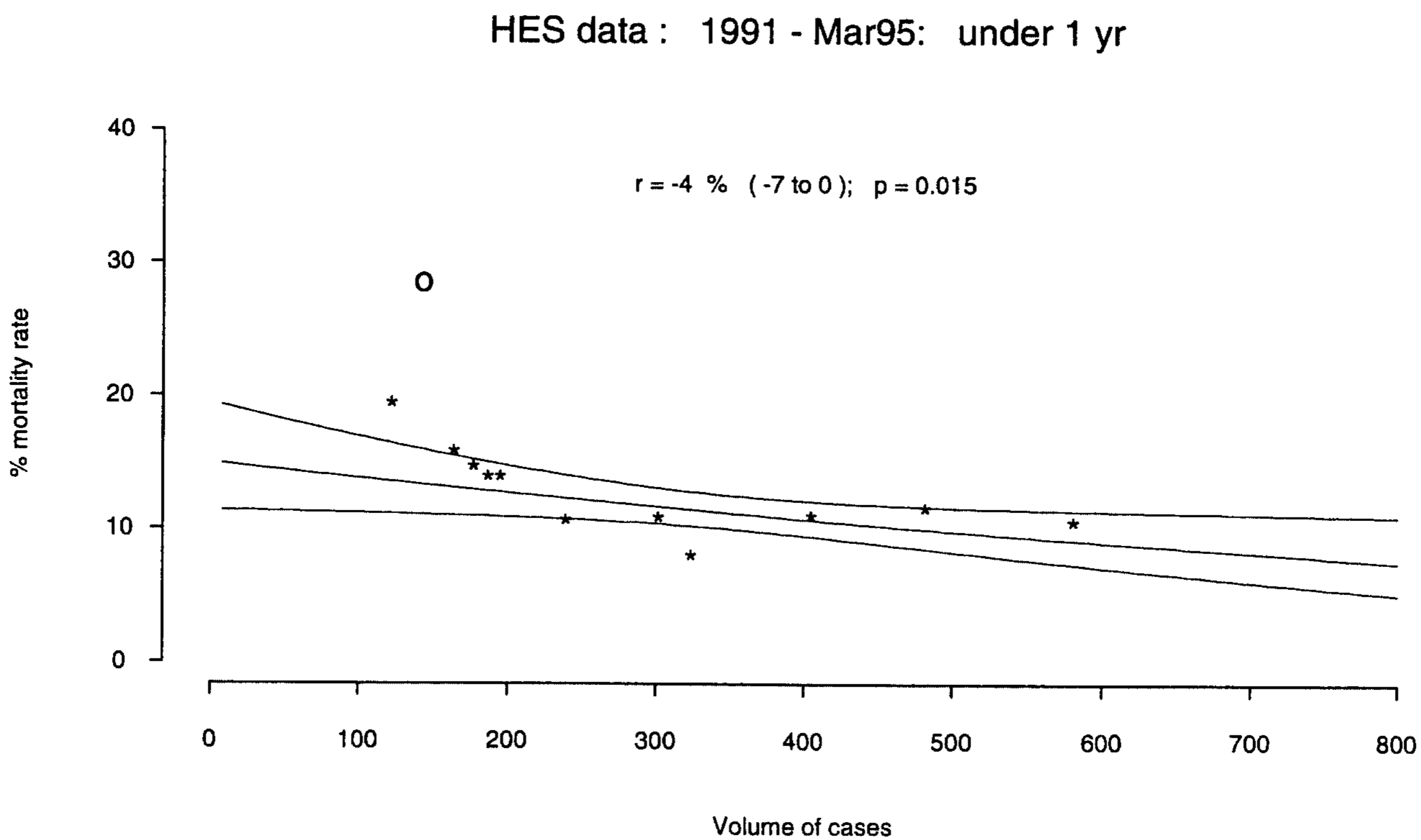
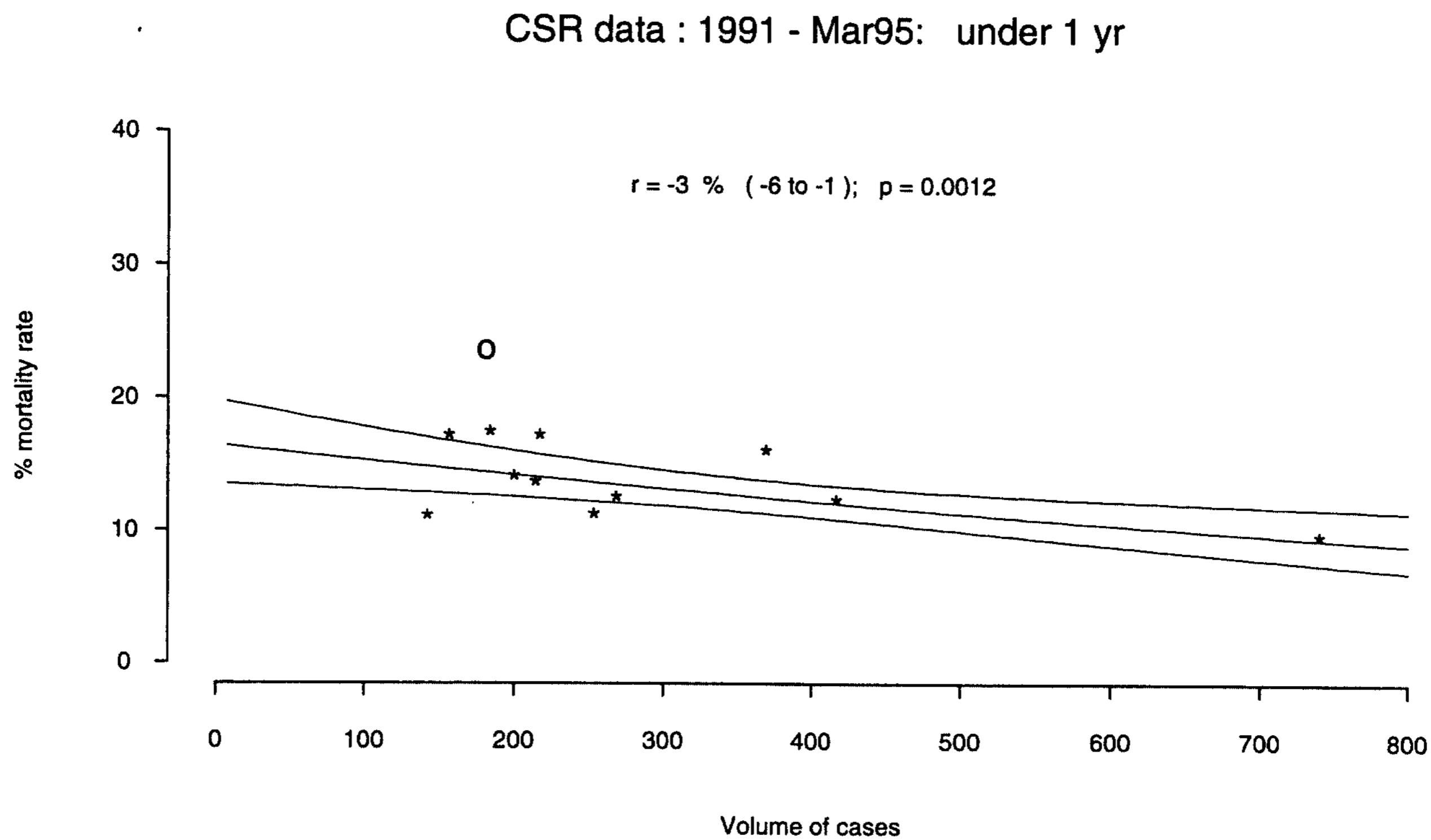
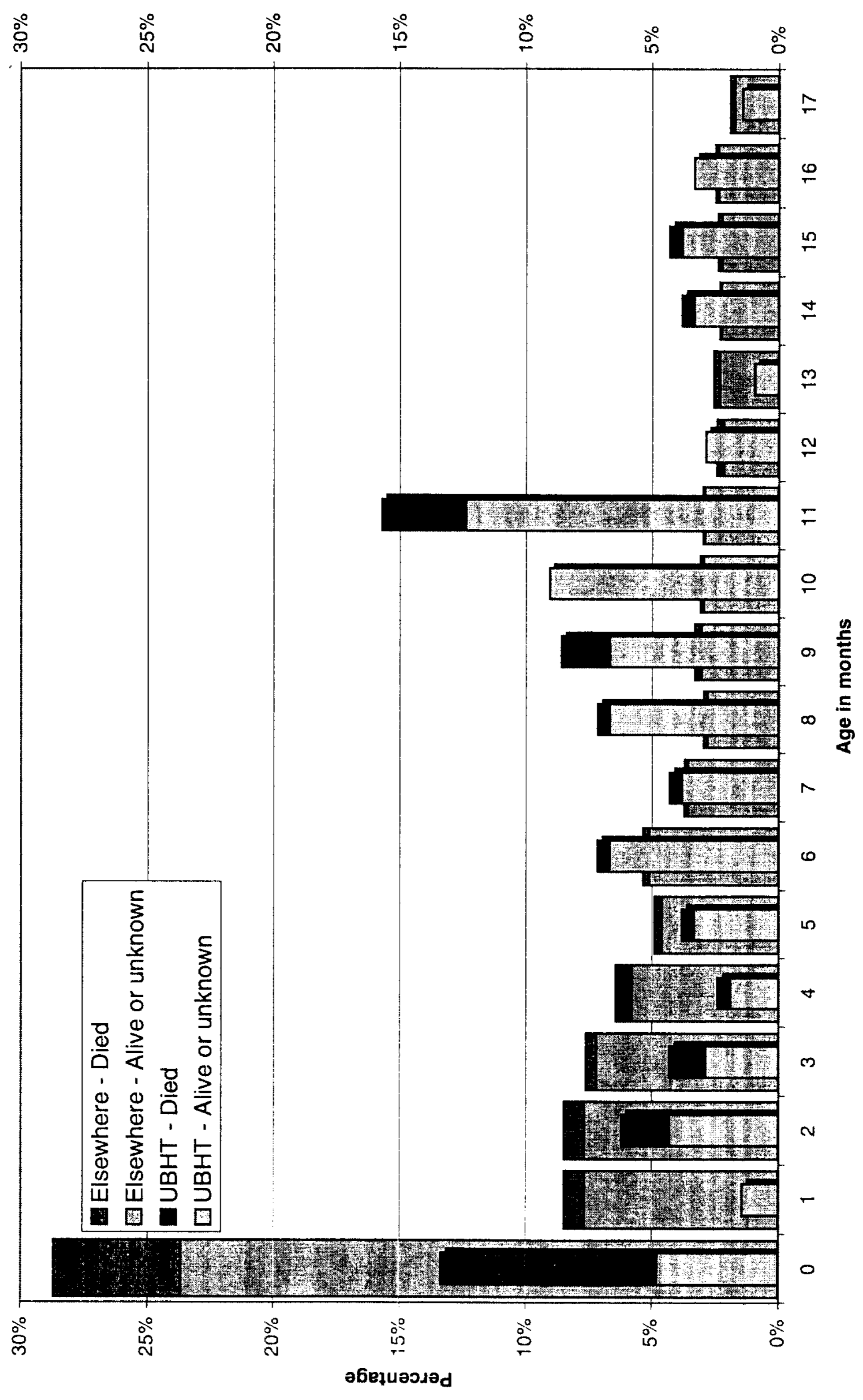
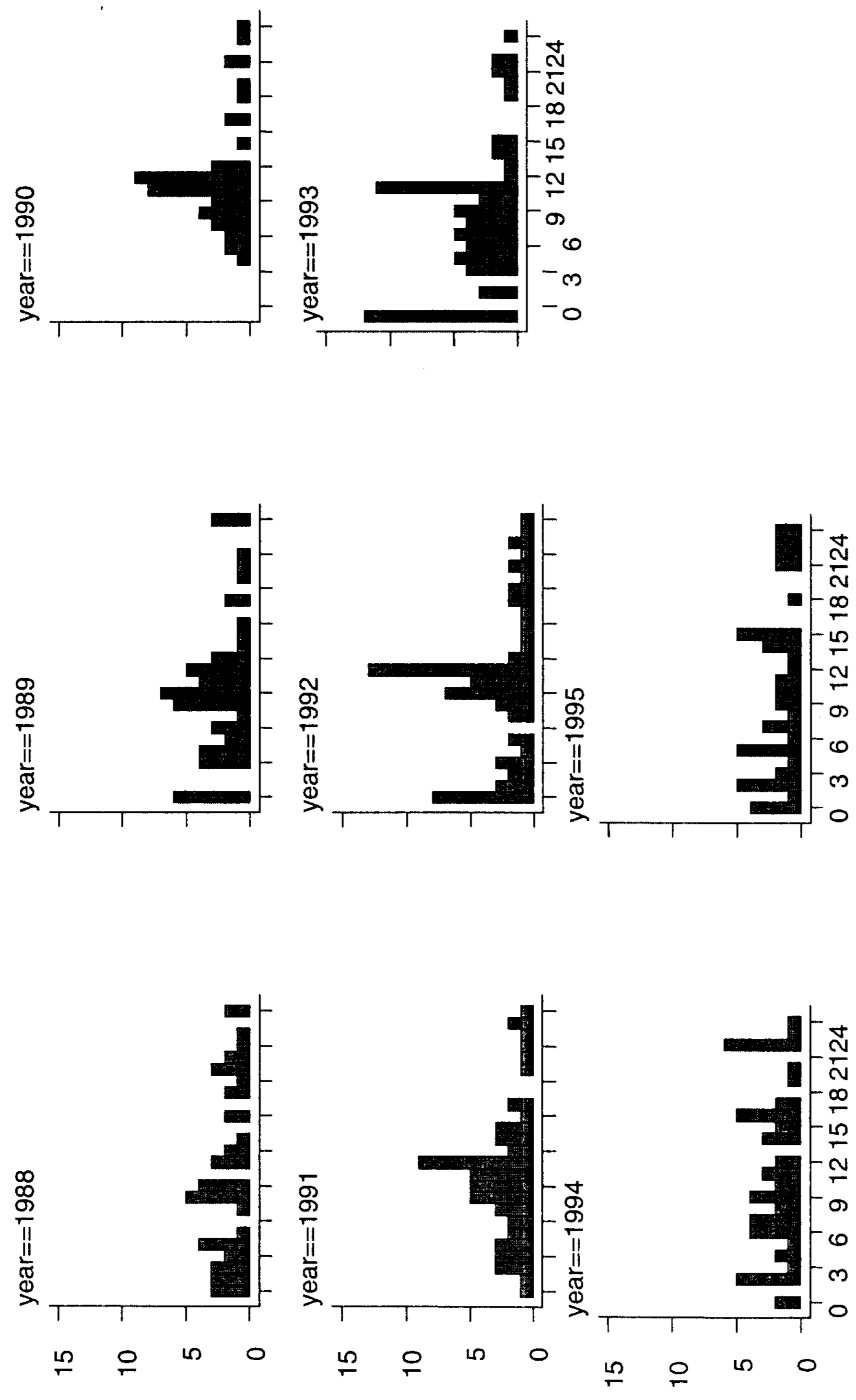


Figure 8.2 Comparison of percentage of Open operations including outcome (death, alive or unknown) by age at admission (in months) between UBHT and elsewhere in epoch 3 (HES 1 April 1991 to 31 March 1995) aged under 18 months.



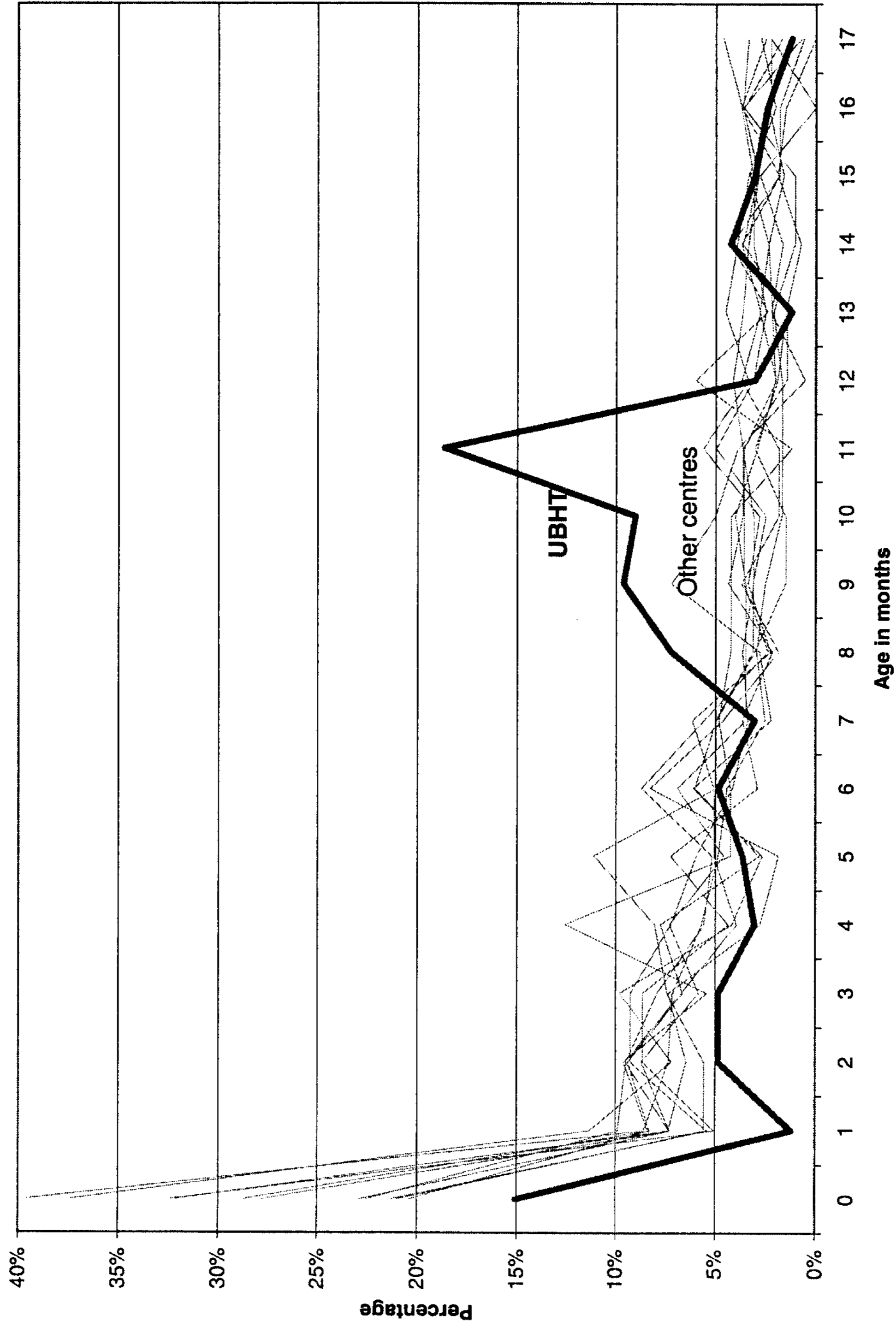
UBHT represented by narrow bars

Figure 8.3 PAS data: Age at open operations by calendar year – Bristol.



Age in months for those 2 years & under

Figure 8.4 Comparison of percentage of open operations including outcome (death, alive or unknown) by age at admission (in months) between UBHT and individual centres between April 1991 to 31 March 1994, aged under 18 months.



**Table 8.2 Age at which open operations took place: distribution elsewhere and in Bristol, mortality elsewhere and in Bristol and relation to excess mortality.
HES data Epoch 3: April 1991 – March 1995.**

Age group. Mths	Percentage operations carried out by end of age-group.		Mortality rate		Bristol deaths / num ops	Bristol expect deaths	Bristol excess deaths
	Elsewhere	Bristol	Else-where.	Bristol			
0 - 2	23	9	15 %	65 %	22 / 34	5.2	16.8
3 - 5	32	13	7 %	28 %	5 / 18	1.3	3.7
6 - 8	39	21	5 %	9 %	3 / 34	1.7	1.3
9 - 11	43	35	5 %	18 %	11 / 60	3.2	7.8
12 - 14	47	38	8 %	6 %	1 / 16	1.3	-.3
15 - 17	50	42	7 %	6 %	1 / 17	1.2	-.2
18 - 20	54	45	3 %	21 %	3 / 14	.4	2.6
21 - 23	57	49	4 %	6 %	1 / 18	.7	.3
2 yrs +	65	57	4 %	10 %	4 / 40	1.6	2.4
3 yrs +	72	66	4 %	7 %	3 / 41	1.6	1.4
4 yrs +	78	73	4 %	3 %	1 / 35	1.4	-.4
5 yrs +	93	91	4 %	6 %	5 / 84	3.4	1.6
10 yrs +	100	100	4 %	4 %	2 / 46	2.0	0.0
Total							34.1