

**A Case Study Exploring
the Early Identification of Performance Failure
in an Acute Hospital**

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Summary

This study explored the feasibility of using Hospital Episode Statistics to help identify performance failure in acute hospitals. In particular an attempt was made to identify one individual cardiac surgical unit that was alleged to have had performance problems during those years. HES data for all provider units in England that performed cardio-thoracic surgery was obtained for a four year period. Each unit was given a code number so as not to identify the units to the research team.

The results showed that one unit had consistently high death rates compared with all other units in respect of surgery on children in the 0-5 age group. Over the four year period it had the highest death rate for all surgical procedures and the highest rate for the 'switch' operations for which the unit's performance had been publicly criticised.

If the unit selected is the Bristol Royal Infirmary it is recommended that:

1. the recently established enquiry into children's cardiac surgery in Bristol should compare the Hospital Episode Statistics data with that of the Cardiac Register and examine the use of these data sets in the study of the alleged performance failure;
2. consideration be given to examining the performance of one other unit whose case fatality rates are very much higher than most other units;
3. further study of HES data be undertaken to see if a scanning mechanism can be developed to give early warning of performance failure in acute hospitals.

Introduction

From time to time the NHS suffers from performance failures that cannot simply be put down to occasional and unavoidable human error. Some can rightly be called disasters, but others appear as clusters of significant errors. Disasters include the spate of major mental hospital enquiries from 1965 to 1985,^[1,2] hospital fires causing significant damage and loss of life^[3] and major outbreaks of food poisoning^[4] and Legionnaire's disease.^[5] Clustering of errors include hospitals where levels of efficiency and equity have necessitated police investigations,^[6] locations where large groups of patients have been waiting excessive periods for admission,^[7,8] hospitals subject to external enquiry because of high death rates^[9] and the possible links between low volume (or occasional) surgeons and high complication and death rates.^[10]

In other fields there has been considerable study of catastrophic failures and violent disasters. When aeroplane^[11] and train^[12] crashes and mining disasters^[13] occur, subsequent studies show that there were a large number of failures in and around the organisation, many of which had been known about for some considerable period of time. Turner^[14] identified 19 typical features of disasters and Bignell et al^[13] suggest that whilst accidents happen, disasters are carefully planned. One apparent weakness of these theories is the large element of hindsight combined with the absence of accurate prediction. Often after a major disaster it has been discovered that some form of warning was offered by someone inside or outside the organisation, and yet that warning was ignored. The problem is that some organisations exhibit so many warning signs that it is difficult to distinguish between those that can be safely ignored and those which should be taken seriously.

In order to reduce this weakness an attempt was made to quantify the risks identified by setting the work alongside the more statistical 'catastrophe' theory of Zeeman^[15] and the mixed scanning approach advocated by Etzioni^[16] which advocates a form of exception reporting. The result was a model which showed that a high proportion of mental hospital disasters could have been predicted. When the data was used prospectively, hospitals and health authorities throughout England were provided with comparative data supported by explanatory text and, where appropriate, warnings of potential performance failure. The comparative data was widely, but not universally, used. The failure of the Department of Health and one regional authority to use the system was heavily criticized by the judicial enquiry into the food poisonings at Stanley Royd Hospital.^[4]

Given the poor quality of much of the data about mental illness hospitals the results of the study were quite surprising. If it was possible to identify the cohesive nature of the performance of some mental illness institutions, is it possible that major performance failures in acute hospitals might also be detected by scanning routine data? There have been some examples of unusual data values before or following some enquiries. There were extremely high admission rates in child and adolescent psychiatry in the Tees districts following the Butler-Schloss enquiry,^[17] but data was not available for the period prior to the enquiry. During the time of serious allegations about fraud and misconduct in general surgery at Meryth^[6] the performance of the district was extreme in a large number of variables. The question this paper addresses is whether Hospital Episode Statistics data can be used to identify patterns of activity in acute hospitals which are inappropriate, insufficient, dangerous or inefficient.

Method

In order to test whether Hospital Episode Statistics (HES) data could, retrospectively, identify a performance failure we decided to select one high profile example of alleged performance failure and then tried to identify the unit concerned from amongst all units in England. The initial proposal to undertake this study was made in May 1995 at a point when the Bristol Royal Infirmary had been reported in the media as having an unexpectedly high death rate for children undergoing cardiac surgery.^[18,19,20,21,22] This unit was selected because the decision made by the Trust to set up an independent enquiry suggested there was some likelihood of performance failure. It was reported that concern had been expressed by one of the hospital's anaesthetists to the Trust manager and that the Royal College of Surgeons had made representations to the Department of Health. As far as could be ascertained both the initial and subsequent enquiries and the decision making process of the Trust, Region and Department of Health concentrated on data collected internally and comparative information from the United Kingdom Cardiac Surgical Register. There was no published evidence that Hospital Episode Statistics data was referred to at any time.

The hypothesis sought to test whether Bristol Royal Infirmary could be identified as having a high case fatality rate for children in cardiac surgery when compared with other units in England. Two limited pieces of data gathering were undertaken. Firstly a literature search was undertaken of the information released by the Trust and its staff^[e.g. 23,24,25] in order to ascertain what characteristics, if any, might distinguish the Trust from others in England. Secondly the Department of Health was asked to provide HES data for all English units undertaking cardiac surgery over the five year period from 1990/91 to 1994/95. An initial specification was drawn up which selected data for 0-5 years, 0-15 years and all ages for one year. Given the very small number of cases in the 6-15 age group it was decided to concentrate on the 0-5 years and all age groups for the study of further years.

In March 1997 the Department of Health supplied the HES data for all provider units that admitted patients in Cardio-thoracic surgery for the four year period 1991/2 to 1994/5. For each unit the number of episodes and the number of deaths were identified for the following categories:

- finished consultant episodes (specialty code 170) for all ages and 0-5 age group;
- all heart (OPCS4 'K' code) operations for the 0-5 years;
- atrial inversion operations for transposition of great vessels (K05) for 0-5 years;
- other correction of transposition of great vessels (K06) for the 0-5 years.

The data for each provider was given a code which was not given to the research team. It was hoped to allocate a unique code number for each provider unit which would remain with that provider over the four year period. However, changes between authorities and trusts, mergers and name changes meant that the Department of Health was able to link the data for some, but not all units.

Based on the information gathered the research team then attempted to identify Bristol Royal Infirmary from amongst all English providers. The initial screening simply identified providers that specialised in children's surgery by excluding all units that had less than 100 episodes per annum in the 0-5 year age group. From the remaining providers a selection was made of the unit with the most consistently high fatality rates in each of the selected categories over the period.

Results

The literature search suggested that the unit had a number of characteristics. It was reported that it:

- a) specialised in paediatric cardio-thoracic surgery;
- b) had a higher than average death rate;
- c) had a number of fatalities following certain 'switch' operative procedures;
- d) in October 1993 stopped doing neonatal switch operations for a period.

As a result of this analysis the hypothesis was refined to seek to identify not only whether Bristol Royal Infirmary had a high case fatality rate, but also whether it had a high case fatality rate for 'switch' operations. Over 60 units admitted cardio-thoracic patients each year, but less than half of them admitted children and in any one year only 11 or 12 providers admitted more than 100 children under the care of a cardio-thoracic surgeon (Table 1). These units were markedly different from smaller units as the next largest only treated 33 children in one year. In each year the major units accounted for over 96% of total finished consultant episodes and 99% of deaths for the four year period 1991/2 to 1994/5 (Table 2) and these units appear to be the major specialist children's cardio-thoracic units in England. This list presumably includes Bristol Royal Infirmary.

Although each year had only 11 or 12 major providers in the four year period studied there are 19 provider codes for units with over 100 episodes. It is highly unlikely that there were 19 separate units some of which opened and closed during this period. The failure to provide

Table 1**Number of Units Treating Cardio-thoracic patients in England**

<i>Year</i>	<i>All ages</i>	<i>0-5 age group</i>	<i>Over 100 cases in the 0-5 age group</i>
1991/92	67	33	12
1992/93	75	35	12
1993/94	70	30	11
1994/95	61	29	11

Table 2**11 or 12 Major Units undertaking Children's Cardiac Surgery**

<i>Year</i>	<i>Major Units</i>		<i>All Units</i>		<i>Major Units as a % of Total</i>	
	<i>FCEs</i>	<i>Deaths</i>	<i>FCEs</i>	<i>Deaths</i>	<i>FCEs</i>	<i>Deaths</i>
1991/92	3640	227	3811	228	96	99
1992/93	3400	206	3552	208	96	99
1993/94	3583	197	3726	199	96	99
1994/95	3891	120	3988	120	98	100
Total	14514	750	15077	755	96	99

Source: HES data supplied by Department of Health.

unique codes masks the fact that there was a much smaller number of units specialising in children's cardio-thoracic surgery in this period. Table 3, for example, shows that units 3 and 92 admitted patients in 1991/92, but had no further episodes in subsequent years. In the following year units 71 and 100 started to admit patients having had no episodes in the previous year. It is highly likely that these are the same two units, but that they were given different codes.

The overall pattern for England of episodes and procedures for children 0-5 years of age is shown in Table 4, together with the total number of deaths in each category and the average case fatality rate. Table 5 presents the aggregated results over the four year period for each of the major units identified. When the results of that table are placed in rank order for each of the four case fatality rates, two provider units display a pattern of activity which is substantially different from other providers in the same period (Table 6). Unit 100 had the highest fatality rate for patients admitted and the second highest rate for patients operated on. The detail of the individual years is shown in Table 7. It is unlikely, however, that the unit was Bristol Royal Infirmary if one makes the assumption that the HES data is reasonably accurate, as the unit undertook very few 'switch' operations and only had one operative death in that group of patients in the three years.

Provider unit 138 had the highest case fatality rate for all heart operations and for both groups of operations that might cover the 'switch' procedure. It also had the second highest case fatality rate for all children admitted. The unit had case fatality rates that were often two, three times and four times greater than the average for episodes, operations or 'switch' operations. An examination of the individual years shows that in 1991/92 and 1993/94 it had by far the highest case fatality rates for cardiac surgery on children and the second highest rate in 1994/5 (See Figure 1). In the four year period its overall death rate for all cardiac operations was the highest in the country and this unit accounted for five of the nine deaths that occurred in England for atrial inversion operations for transposition of great vessels (K05) for 0-5 years and eight of the 47 deaths for other correction of transposition of great vessels (K06) in the 0-5 year age group.

Given this background and the fact that in 1993/94 there were no recorded cases of switch operations as reported by staff at the hospital^[21] (Table 8) it seems **highly likely that unit 138 is Bristol Royal Infirmary.**

Table 3
Providers with over 100 Episodes for Children (0-5 years) in Cardio-thoracic Surgery

Unit No.	1991/92			1992/93			1993/94			1994/95		
	FCEs	Deaths	%	FCEs	Deaths	%	FCEs	Deaths	%	FCEs	Deaths	%
2										166	5	3
3	169	4	2.4									
9	211	13	6.2	186	10	5.4	175	11	6.3	230	13	5.6
10	255	22	8.6	285	12	4.2	268	11	4.1	241	5	2.1
13										426	18	4.2
22	526	31	5.9	168	10	5.9						
39	188	12	6.4	226	20	8.8						
42							184	9	4.9	158	12	7.6
70	108	8	7.4	120	13	10.8	125	8	6.4			
71				251	15	6	247	8	3.2	171	3	1.7
75	191	9	4.7	178	15	8.4						
92	134	5	3.7									
97	294	18	6.1	285	10	3.5	363	14	3.9			
100				150	14	9.3	157	18	11.5	118	16	13.6
109	1012	63	6.2	1005	56	5.6	1352	58	4.3			
110	348	20	5.7	345	19	5.5	372	36	9.7	361	8	2.2
117							153	6	3.9	166	8	4.8
138	204	22	10.8	201	12	6	187	18	9.6	145	16	11
140										1709	16	0.9

Note that although 19 unit codes are listed it is highly likely that data for only 12 different providers are shown in this table (i.e. the codes are not unique).

Source: HES data supplied by Department of Health

Table 4
Episodes and Procedures on Children 0-5 years of age: 11/12 Major Cardiac Surgery Units in England

Year	Inpatient and Day Case Episodes		All 'K' Procedures		K05 Procedures			K06 Procedures		
	Episodes	Deaths	Episodes	Deaths	Episodes	Deaths	%	Episodes	Deaths	%
1991/2	3811	228	1545	107	49	3	6.1	94	12	12.8
1992/3	3552	208	1524	114	50	3	6.0	108	19	17.6
1993/4	3726	199	1542	105	8	0	0.0	110	2	1.8
1994/5	3988	120	1150	76	26	3	11.5	103	14	13.6
Total	15077	755	5761	402	133	9	6.8	415	47	11.3

NB: The 1993/94 data for K05 and K06 procedures was markedly different in some aspects than for the other years (e.g. FCEs for K05s and deaths for K06s). No immediate explanation is obvious.

Source: HES data supplied by Department of Health.

Table 5

**Provider Units with over 100 Episodes for Children (0-5 years) in Cardio-thoracic Surgery
for aggregate four year period, 1991/92-1994/95**

Unit No.	No. of years	FCEs in specialty		All K Operations		K05 Operations		K06 Operations					
		No.	Deaths	%	No.	Deaths	%	No.	Deaths	%			
2	1	166	5	3.0	96	4	4.2	0	0	-	9	1	11.1
3	1	169	4	2.6	105	4	3.8	0	0	-	13	0	0.0
9	4	802	47	5.9	329	19	5.8	7	0	0.0	23	1	4.3
10	4	1049	50	4.8	295	10	3.4	3	0	0.0	41	1	2.4
13	1	426	18	4.2	159	12	7.5	3	0	0.0	15	3	20.0
22	2	694	41	5.9	266	21	7.9	3	0	0.0	17	2	11.8
39	2	414	32	7.7	186	16	8.6	11	1	9.1	9	3	33.3
42	2	342	21	6.1	160	11	6.9	3	0	0.0	5	0	0.0
70	3	353	29	8.2	187	19	10.2	1	0	0.0	18	4	22.2
71	3	669	26	3.9	383	19	5.0	8	0	0.0	15	2	13.3
75	2	369	24	6.5	198	15	7.6	6	0	0.0	14	2	14.3
92	1	134	5	3.7	80	3	3.8	7	0	0.0	0	0	-
97	3	942	42	4.5	447	22	4.9	8	1	12.5	24	0	0.0
100	3	425	48	11.3	287	40	13.9	14	1	7.1	13	1	7.7
109	3	3369	177	5.2	1010	64	6.3	11	1	9.1	119	10	1.8
110	4	1426	83	5.8	975	51	5.2	27	0	0.0	32	3	9.4
117	2	319	14	4.4	184	13	8.1	0	0	-	29	6	20.7
138	4	737	68	9.2	376	57	15.1	22	5	23.7	19	8	42.1
140	1	1709	16	0.9	0	0	-	0	0	-	0	0	-

Source: HIES data provided by Department of Health

Table 6

**Rank Based on Highest Percentage of Deaths
as shown in Table 5**

	FCEs	All K Operations	K05 Operations	K06 Operations
2	17	15	-	9
3	18	16	-	16=
9	8	11	10=	12
10	11	18	10=	13
13	14	8	10=	5
22	7	6	10=	8
39	4	4	3.5	2
42	6	9	10=	16=
70	3	3	10=	3
71	15	13	10=	7
75	5	7	10=	6
92	16	17	10=	-
97	12	14	2	16=
100	1	2	5	11
109	10	10	3.5	14
110	9	12	10=	10
117	13	5	-	4
138	2	1	1	1
140	19	-	-	-

Source: HES data supplied by Department of Health

Table 7
Episodes and Procedures on Children 0-5 years of age: Provider Unit 100

Year	Inpatient and Day Case Episodes			All 'K' Procedures			K05 Procedures			K06 Procedures		
	Episodes	Deaths	%	Episodes	Deaths	%	Episodes	Deaths	%	Episodes	Deaths	%
1991/2												
1992/3	150	14	9.3	105	12	11.4	10	1	10.0	2	0	0.0
1993/4	157	18	11.5	99	12	12.1						
1994/5	118	16	13.6	83	16	19.3	4	0	0.0	1	0	0.0
Total	425	48	11.3	287	40	13.9	14.1	1	7.1	3	0	0.0

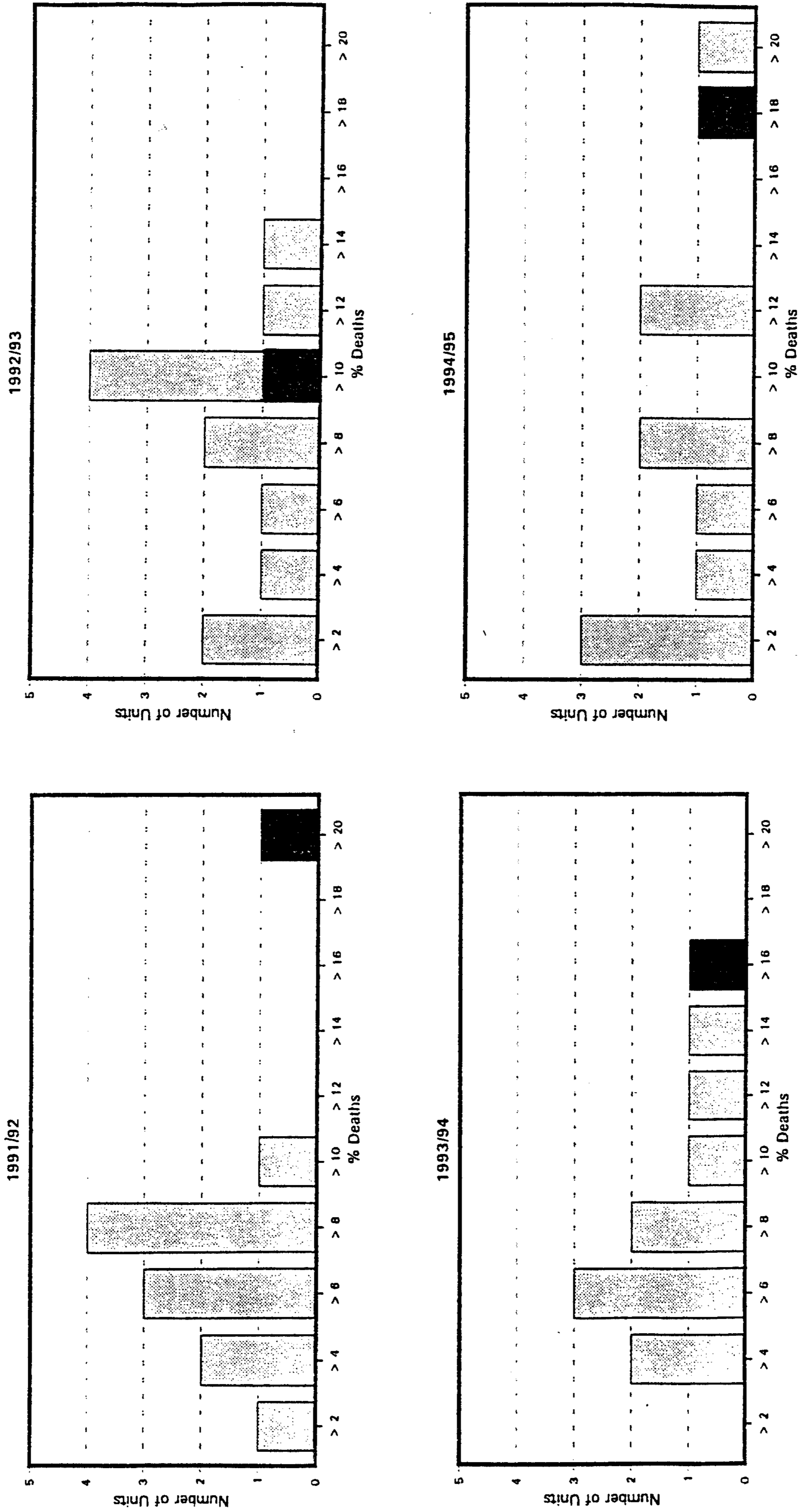
Table 8
Episodes and Procedures on Children 0-5 years of age: Provider Unit 138

Year	Inpatient and Day Case Episodes			All 'K' Procedures			K05 Procedures			K06 Procedures		
	Episodes	Deaths	%	Episodes	Deaths	%	Episodes	Deaths	%	Episodes	Deaths	%
1991/2	204	22	10.8	102	19	18.6	8	2	25.0	3	2	66.7
1992/3	201	12	6.0	95	9	9.5	8	0	0.0	13	4	30.8
1993/4	187	18	9.6	98	15	15.3						
1994/5	145	16	11.0	81	14	17.3	6	3	50.0	3	2	66.7
Total	737	68	9.2	376	57	15.2	22	5	22.7	19	8	42.1

Source: HES data supplied by Department of Health.

Figure 1

% of Deaths with Cardiac Surgery Operation for Age Group 0-5 years in Major Units in England 1991/92 to 1994/95



■ = Unit 138

Discussion

Clinicians and managers have for many years shown considerable reticence in using the HES data base because of concern about its accuracy and completeness. It was originally established as an epidemiological tool, but has never really fulfilled its original promise. It does, however, remain a potentially useful tool for scanning activity as it gives almost total coverage of every patient discharged from all NHS hospitals. The fact that it is now used for counting transactions since the introduction of the internal market may have helped increase its completeness, though not necessarily its accuracy. If such a data base fails to record deaths of young children undergoing a major operative procedure this would raise some fundamental concerns about its accuracy and usefulness. Therefore if this study has failed to identify the Bristol Royal Infirmary correctly there should be some doubt about HES data recording methods, both in that Trust and quite possibly in other Trusts.

If, on the other hand, the unit has been correctly identified a number of issues arise:-

1. Should the enquiry into children's cardiac surgery in Bristol announced by the Secretary of State on 18th March 1997 include an analysis of the use of comparative data by the Trust, the Region and the DoH and in particular examine how the HES data compares with that obtained from the Cardiac Register? There appears to be some mismatch between the information presented to the *British Medical Journal* ^[20,21] and the recorded HES data both in terms of the dates when switch operations were suspended and on the reported case fatality rates. Are these due to errors in HES data, reported information sent to the Cardiac Register or both?
2. Is there a case for looking carefully at the data for unit 100, given its high case fatality rate? In 1994/95 it was undertaking less children's cardio-thoracic surgery than any of the other specialised units. Can 118 cases per year in a unit that treats over 3800 adults in the same specialty be fully equipped to offer all the facilities needed for children's care (specialised anaesthetists, nurses etc)? One of the criticisms laid at the door of the Bristol Royal Infirmary was that it failed to make parents fully aware of the risks involved prior to major surgery. Would it be even more worrying if unit 100 was facing legal action for failing to make parents fully aware of the risks their children were to face when undergoing surgery?

3. Does this study suggest that HES data could be used to identify unusual patterns of activity that might be a precursor of major failure? It may be that scanning this and other data sets would enable us to establish internal enquiries before, rather than after a string of failures. There is little doubt that a more in-depth examination of data sources could create the possibility that potential major failures could be identified and predicted in the acute sector, just as they were in the case of psychiatric institutions. The next steps would be to gather the HES data from each region to examine the work of individual teams:

- repeat this analysis in cardiac surgery, but at consultant team rather than unit level for all English regions;
- move the study into other specialties and also examine other areas such as low volume surgery and inappropriate surgery;
- start comparing HES data with other sources of data on major incidents and litigation.

If the analysis of data reveals that extreme data patterns consistently match a high proportion of known performance failures, then a scanning mechanism to give early warning of performance failure is a real possibility.

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