

Inventory Practice Survey 2007

Blood Storage – Fridges and Alarms

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1 **Headline Summary**

- Data was collected from 240 hospitals on 1100 fridges of which 777 (71%) were issue fridges.
- 504 (46%) of fridges were located in the blood transfusion laboratory, 224 (20%) in theatres and 6% in Obstetric units.
- The highest number of fridges in any one hospital was 21.
- 231 (21%) of fridges had electronic tracking.
- 451/1100(41%) of fridges held O Rh D Negative flying squad units.
- 957 (87%) of fridges complied with BS4376.
- 902 (82%) of fridges and 858 (78%) of alarms were on a “maintained” power supply
- 216 (90%) of hospitals had a SOP for alarm testing.
- For 844 (77%) of fridges the low activation temperature was 2°C and for 476 (43%) of fridges the high activation temperature was 6°C using an air sample for both activation temperatures.
- 210 (84%) of hospitals calibrated their alarm monitoring system.
- 216 (86%) of hospitals had a SOP for the transport of units from the main storage fridge to remote fridges and 235 (98%) of hospitals used insulated containers for journeys to remote fridges of over 20 minutes.
- The transfusion lab had full or partial responsibility for authorising repairs for 739 (68%) of fridges.
- External contractors were most likely to be responsible for servicing fridges, being responsible for 665 (61%) of fridges.
- Hospitals were satisfied that 869 (79%) of fridges and 847 (77%) of alarms were maintained to a satisfactory standard.
- 550 (50%) of fridges had their temperature record kept for 21-30 years.

2 Introduction

In the last quarter of 2007 a survey of hospitals was conducted, with the intention of gathering information about their fridges and the associated alarms. This survey was similar to a survey carried out in 2004, and part of the rationale behind the 2007 survey was to monitor improvements as a result of the publication of the 2004 survey, and the 2005 Blood Safety and Quality Regulations.

The survey was sent to 309 hospitals, and 240 questionnaires were returned (78%). The returned questionnaires covered a total of 1100 fridges.

3 General Fridge and Alarm Information

3.1 Fridge Numbers and Type

The number of fridges per hospital was analysed, together with the type of fridge (Stock, Issue or Joint). This was cross referenced with the hospital size (determined by their level of Red Cell usage). This analysis is summarised in Table 1.

Hospital Size (Red Cell Usage)	Issue	Stock	Joint	Not Known	Fridge Total	Hospital Count	Average Fridges per Hospital
Very High	302	66	6	1	375	47	8.0
High	190	69	7	1	267	51	5.2
Moderate	159	76	6	5	246	64	3.8
Low	80	39	7	0	126	40	3.2
Very Low	46	31	9	0	86	38	2.3
	777	281	35	7	1100	240	4.6

Table 1 Numbers of Fridges by Type

There was an average of 4.6 fridges per hospital, with the larger hospitals (as would be expected), having more fridges on average than smaller hospitals. There was an average of 8 fridges in the largest hospitals. The maximum number of fridges in any one hospital was 21.

71% of fridges were Issue fridges, with 26% being Stock fridges. Only 3% were Joint Stock and Issue fridges. The comparable numbers in the 2004 survey were 74% Issue, 22% Stock and 4% Joint. There has therefore been no significant change in the proportions of different types of fridges since 2004.

3.2 Fridge Capacity

The capacity of fridges, measured in red cell units, was analysed both by type of fridge and by size of hospital.

Figure 1 shows the overall proportions of fridge capacity across all hospitals returning the survey.

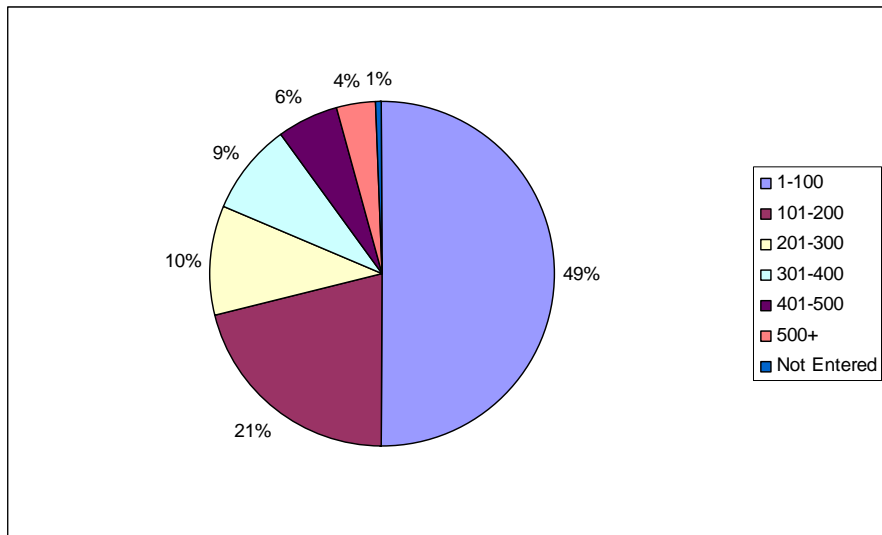


Figure 1 Proportion of Fridge Capacity Across all Hospitals

Nearly half of all fridges were of the smallest capacity, containing up to 100 red cell units. Only 4% of fridges were of the largest capacity, containing more than 500 red cell units.

These results were further analysed by hospital size, and Figure 2 shows the proportions of each size of fridge for the various sizes of hospital.

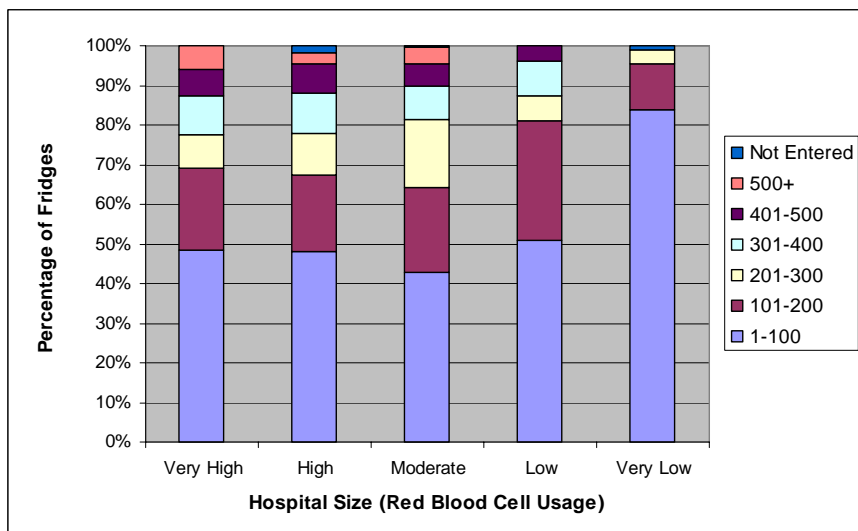


Figure 2 Proportion of fridge capacity by hospital size

This shows that, as would be expected, the smaller hospitals had a larger proportion of the smaller fridges. In the smallest hospitals 84% of the fridges had a capacity of 100 or fewer units, whereas in the largest hospitals, this proportion was 48%. In the largest hospitals, 6% of the fridges had a capacity of over 500 units, but there were no large capacity fridges in the smallest hospitals.

A further analysis of fridge capacity by type of fridge, gave the results in Figure 3.

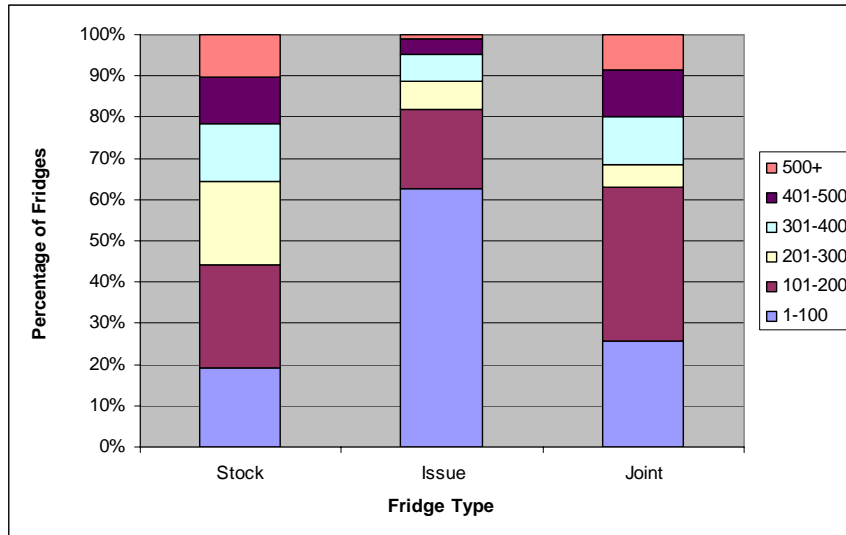


Figure 3 Proportion of Fridge Capacity by Fridge Type

The larger fridges tended to be Stock and Joint fridges. 63% of Issue fridges were of the smallest size, compared to only 19% of Stock fridges.

74% of the largest fridges (500+ red cell units capacity) were Stock fridges. 89% of the smallest fridges (up to 100 red cell units capacity) were Issue fridges (Figure 4).

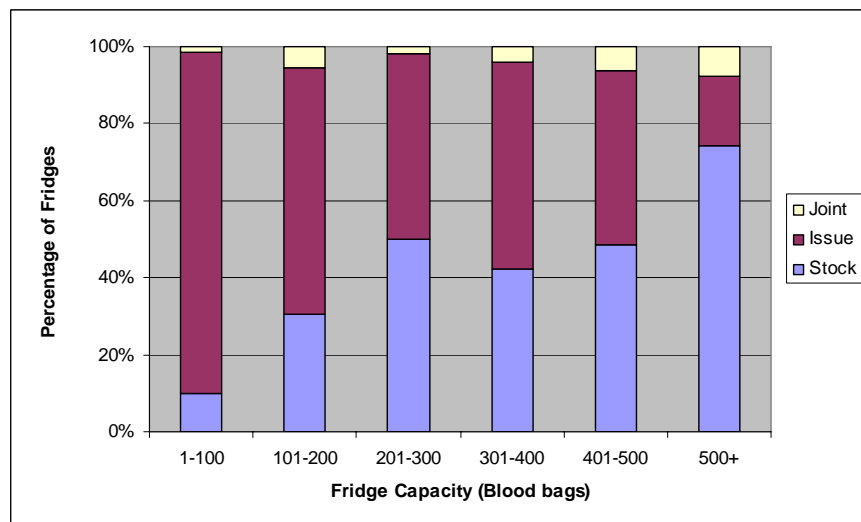


Figure 4 Proportion of Fridge Type by Fridge Capacity

3.3 Fridge Location and Distance from Lab

The fridges were analysed as to their location. The distance of the fridges from the main transfusion laboratory was analysed, measured as the journey time in minutes from the main transfusion lab to the fridge. Any fridge with a journey time greater than zero was defined as a 'remote' fridge for the purposes of this report. 659 fridges (60%) were classified as remote.

Table 2 shows the breakdown of fridges by their location, for all fridges, and then for remote fridges.

Fridge Location	Total Number of Fridges	Number of Remote Fridges
Transfusion Lab	504	90
Theatres	224	218
Obstetrics	70	68
ICU	38	36
A & E	21	20
Other Location	243	227
Total	1100	659

Table 2 Breakdown of Fridges by Location

Nearly half (46%) of all fridges were located in Transfusion Labs, with a further 20% in theatres, and 22% in 'other' locations. One third (33%) of remote fridges were in theatres, with a further 34% being in 'other' locations. 3% of fridges were located in A&E.

The breakdown of journey times for remote fridges is shown in Table 3.

Fridge Journey Time Band (minutes)	Number of Remote Fridges
1 to 5	420
6 to 10	97
11 to 20	45
21 to 30	46
31 to 40	9
41 to 50	12
51 to 60	13
Over 1 hr	17
Grand Total	659

Table 3 Journey times from main transfusion laboratory for remote fridges

The majority of remote fridges (64%) were within five minutes journey of the main transfusion laboratory. A total of 51 remote fridges (8%) were more than 30 minutes away from the main transfusion laboratory.

The journey times were further analysed by the fridge location, and the results are summarised in Figure 5.

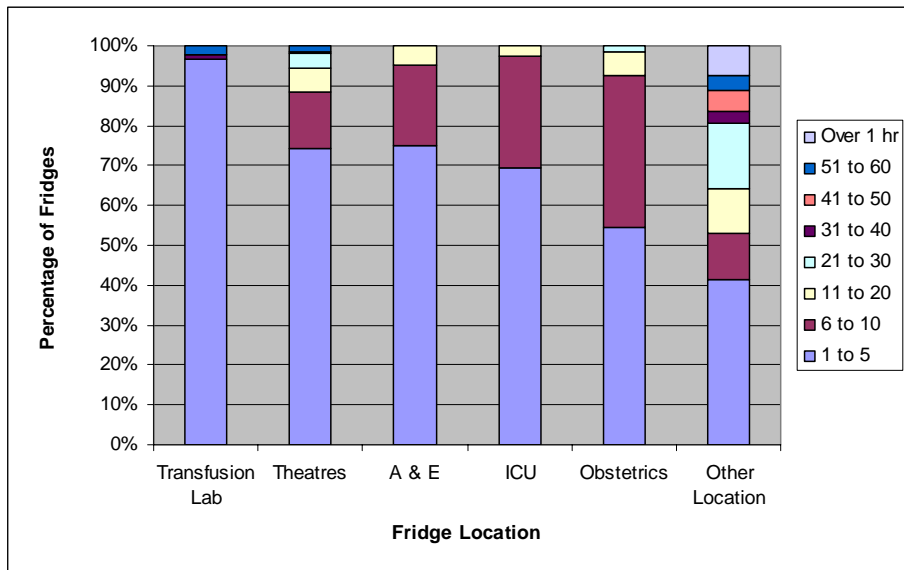


Figure 5 Journey times from transfusion laboratory to remote fridge, by location type

The majority (86%) of journeys which were more than 30 minutes long were for fridges in 'other' locations.

There is further information on remote fridges in Section 8, on page 37.

3.4 Fridge and Alarm Age

The age of fridges and their associated alarms were mapped. This is shown in Figure 6.

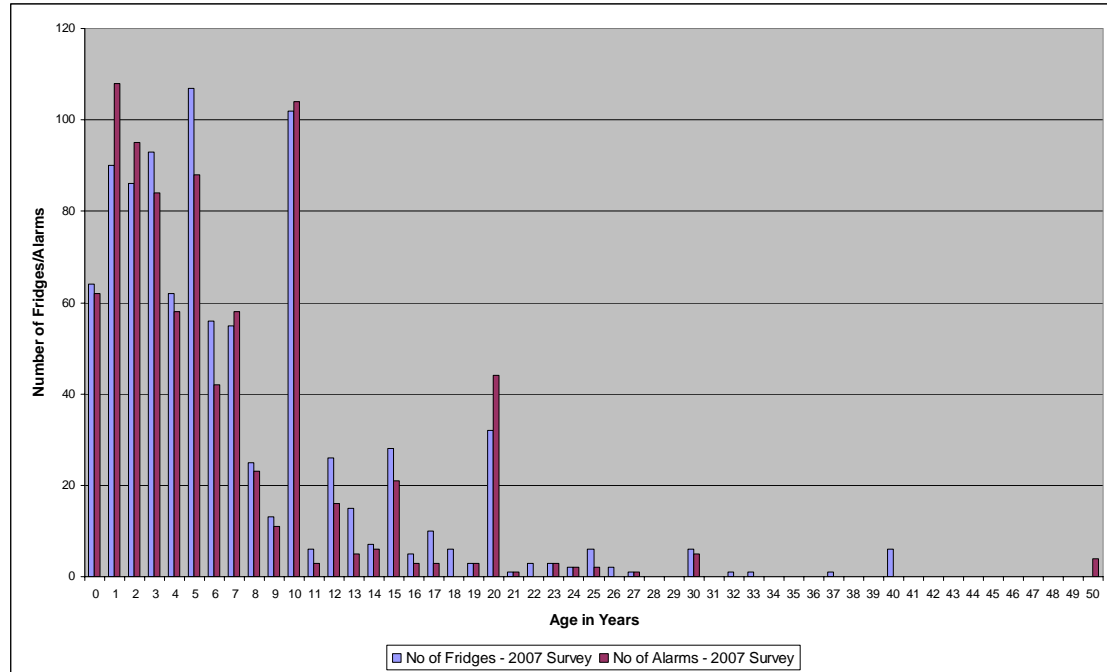


Figure 6 Fridge and Associated Alarm Age

51% of fridges and 49% of alarms were under 7 years old. When compared to the results of the 2004 survey, this was an improvement, in that the age of fridges and alarms had decreased. In the 2004 survey, 46% of fridges and 45% of alarms were under 7 years old. This improvement represents older alarms being replaced.

Although the 2007 survey showed that on average fridges and alarms were newer, there were still a number of fridges and alarms (3% of fridges, 2% of alarms) which were over 20 years old, and some as old as 40 years old (for fridges) or even 50 years old (for alarms).

A summary of fridge age, which compares the results of the 2004 and 2007 surveys, is shown in Figure 7.

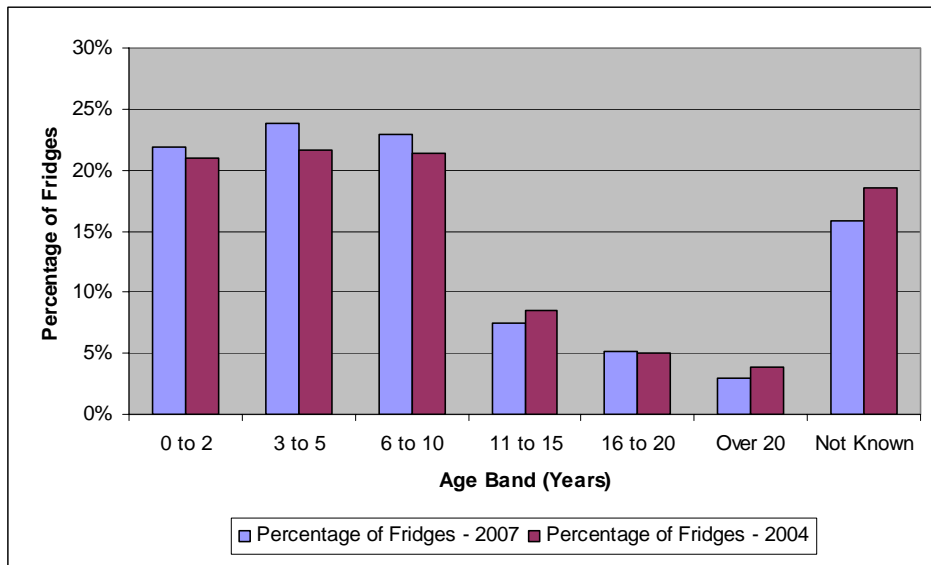


Figure 7 Comparison of Fridge Age in 2004 and 2007 surveys

A similar summary for alarm age is shown in Figure 8.

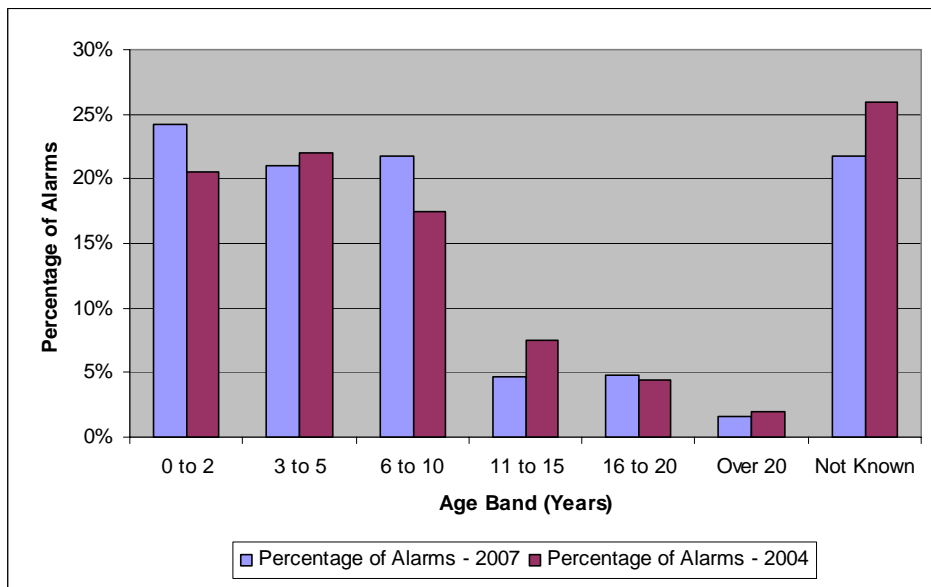


Figure 8 Comparison of Alarm Age in 2004 and 2007 surveys

There was generally an increase in the number of fridges in the lower age bands, and a decrease in the numbers in the higher age bands, when comparing the 2007 results with the 2004 results.

3.5 Electronic Tracking

Hospitals were asked whether their fridges had electronic tracking. Only 21% of fridges had electronic tracking, as shown in Table 4.

Electronic Tracking?	Percentage of Fridges
Yes	21%
No	78%
Not Known	1%
Total	100%

Table 4 Is Electronic Tracking Associated with the Fridge?

These results were further analysed by hospital size, and the results are shown in Figure 9.

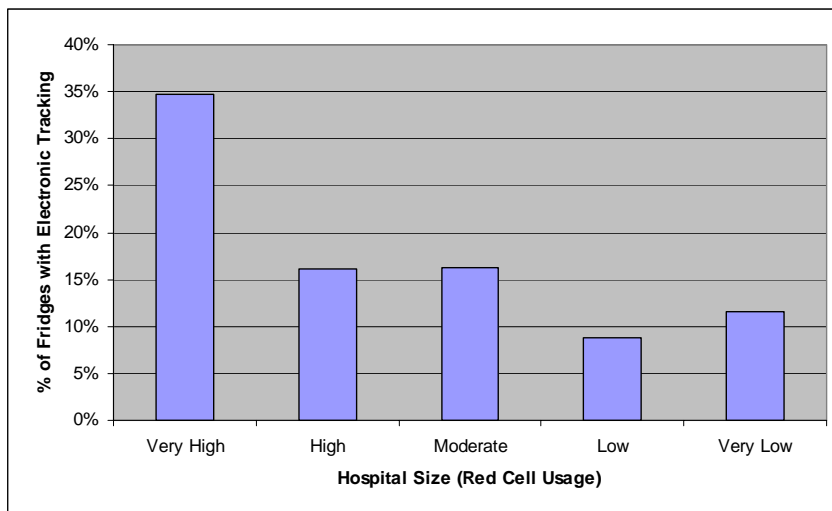


Figure 9 Percentage of Fridges with Electronic Tracking, by Hospital Size

Hospitals with very high red cell usage had a higher proportion of fridges with electronic tracking (35%), when compared to smaller hospitals (12%).

Across all hospitals, 26% of remote fridges had electronic tracking, compared to only 14% of non-remote fridges.

3.6 'Flying Squad' Units

The number of fridges which held O Negative 'Flying Squad' units was analysed. 41% of all fridges held Flying Squad units. When the analysis was restricted to Remote fridges, the percentage was slightly higher at 46%. These figures are shown in Table 5.

Flying Squad Units Held in Fridge?	All Fridges	Remote Fridges
Yes	41%	46%
No	58%	54%
Not Entered	1%	0%

Table 5 Percentage of fridges containing O Negative 'Flying Squad' Units

The figures for Remote fridges were further analysed by location, to determine which location had the largest proportion of 'Flying Squad' units. 96% of Remote Obstetrics fridges and 95% of Remote A&E fridges contained 'Flying Squad' units. By contrast only 17% of Remote ICU fridges contained 'Flying Squad' units. See Figure 10.

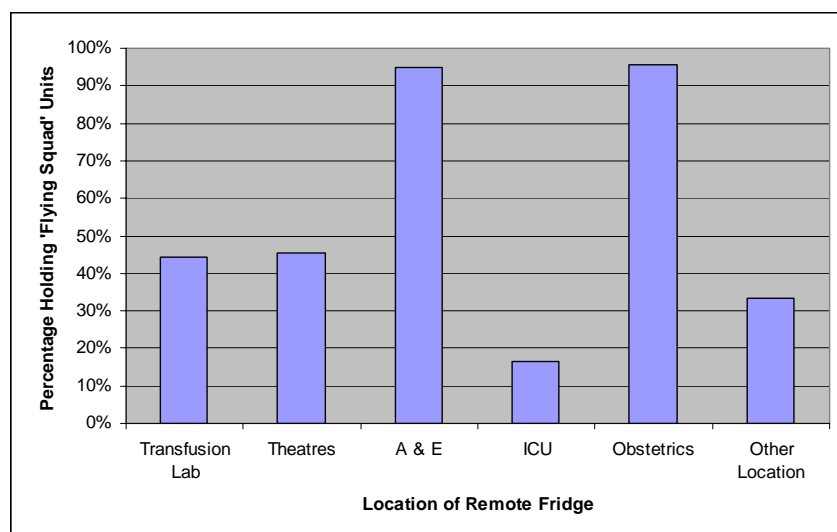


Figure 10 Percentage of Remote Fridges Holding O Neg 'Flying Squad' Units

In the 2004 survey this question was only asked for Remote fridges. 84% of Remote Obstetrics fridges and 86% of Remote A&E fridges contained 'Flying Squad' units. In 2007 a greater percentage of Obstetrics and A&E Remote fridges contained 'Flying Squad' units. ICU was the only location where the percentage of fridges containing 'Flying Squad' units had decreased (from 28% in 2004 to 17% in 2007).

Further analysis of the 2007 data was done to see the distribution of fridges containing 'Flying Squad' units between the various locations. This showed that 32% of fridges containing 'Flying Squad' units were in Theatres, with a further 25% in 'other' locations, and 20% in Obstetrics. The full results are shown in Table 6.

Location	Distribution of Remote Fridges Holding Flying Squad Units
Theatres	32%
Other Location	25%
Obstetrics	21%
Transfusion Lab	13%
A & E	6%
ICU	2%
	100%

Table 6 Distribution of Flying Squad Units in Remote Fridges

3.7 Compliance with BS4376

The compliance of fridges to BS4376 (Part 1) was analysed. 87% of fridges complied with the standard. This was an improvement on 2004, when only 77% complied with the same standard (Figure 11).

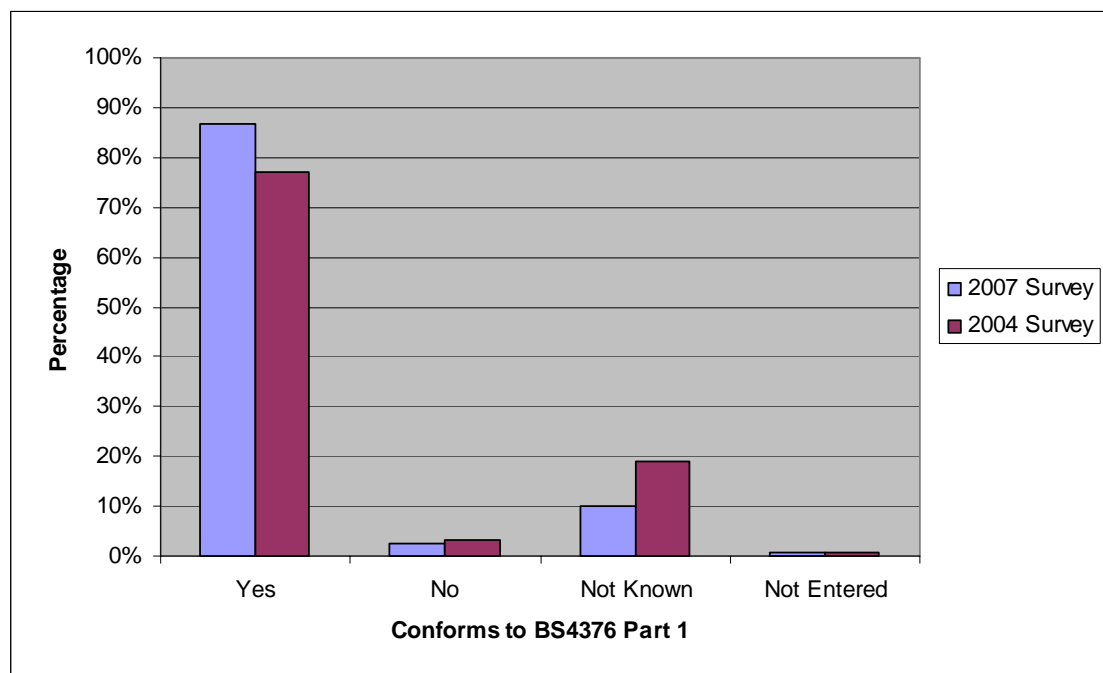


Figure 11 Compliance to BS4376 – Comparison of 2007 to 2004 data.

The 2007 results were further analysed by the age of the fridge. This analysis showed that there was a clear correlation of fridge age with compliance with BS4376. 98% of fridges under 2 years old complied, whereas only 55% of those over 20 years old complied. The full results are shown in Table 7.

Fridge Age Band (Years)	% Conforming to BS4376
0 to 2	98%
3 to 5	89%
6 to 10	90%
11 to 15	88%
16 to 20	63%
Over 20	55%

Table 7 Percentage of fridges in each age band which conform to BS4376

4 Alarm and Power Supply Information

4.1 Fridge and Alarm Power Supplies

Hospitals were asked whether the power supply to their fridges and to their alarms was maintained/protected. 902 (82%) of fridge power supplies and 858 (78%) of Alarm power supplies were maintained/protected (Figure 12).

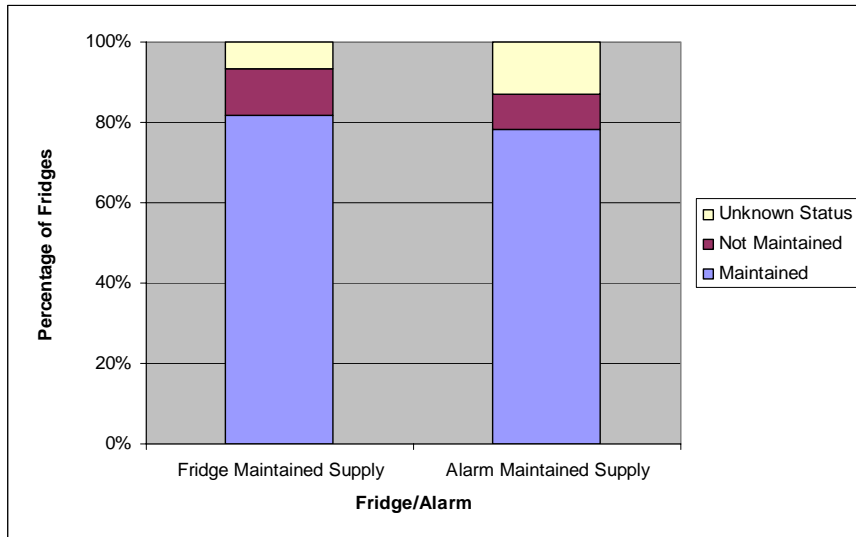


Figure 12 Fridge and Alarm Maintained Supply Status 2007

The same question was asked in the 2004 survey, and the comparison of the 2007 results with those in 2004 is shown in Figure 13.

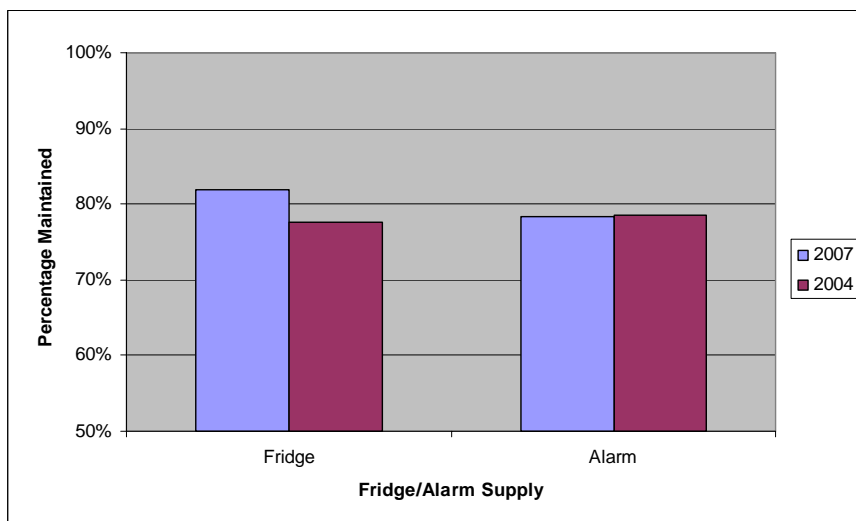


Figure 13 Percentage of Maintained Supplies – Comparison of 2007 with 2004

There was a slight improvement in the percentage of fridge power supplies which were maintained/protected. This increased from 78% in 2004 to 82% in 2007. The percentage of alarm power supplies which were protected has reduced slightly from 79% to 78%.

In the 2007 survey, hospitals were additionally asked whether their maintained power supplies were tested. 90% of fridge maintained power supplies, and 89% of alarm maintained power supplies were tested. The results are shown in Figure 14.

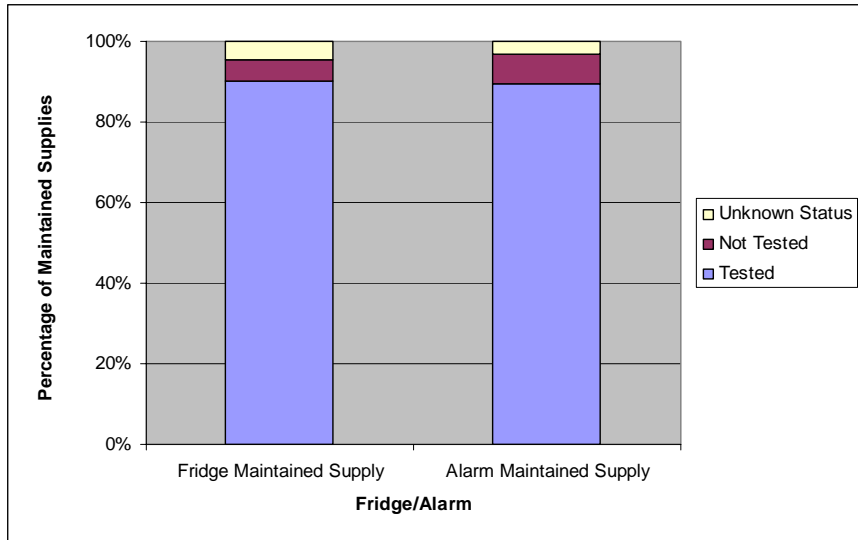


Figure 14 Fridge and Alarm Maintained Supply Testing Status 2007

4.2 Alarm Location

For each fridge, the hospitals were asked where the associated alarm sounded. For 441/1100 fridges (40%), the alarm only sounded in one location. For 485/1100 (44%) of fridges, the alarm sounded in two locations. A full breakdown of number of locations is given in Table 8.

Number of Alarm Locations	% of Fridges
1 Locations	40%
2 Locations	44%
3 Locations	15%
4 Locations	1%
Not Entered	0%
Grand Total	100%

Table 8 Number of Locations in Which Alarm Sounds

The location of the alarm was further analysed for the 441 fridges with alarms sounding in only one location. The most common single alarm location was the switchboard, with 45% of the 441 fridges. 30% of the alarms sounded only locally to the fridge, and this increased to 40% when only remote fridges were considered. 298 of the 441 fridges with alarms sounding in only one location were remote fridges (68%). The full analysis is shown in Table 9 and Figure 15.

Alarm Location	Non-Remote Fridges	Remote Fridges	All Fridges
Switchboard	63%	37%	45%
Locally	9%	40%	30%
Transfusion Lab	22%	10%	14%
Other	3%	7%	6%
Remote	3%	4%	4%
Porter's Office	1%	1%	1%
Grand Total	100%	100%	100%

Table 9 Breakdown of Alarm Location for Alarms Sounding in Only One Location

A further analysis, for remote fridges with alarms sounding only locally, showed that only 20 fridges (17%) did not have a maintained fridge power supply. This was an improvement on 2004, when the figure was 75 fridges (40%).

Analysis of the location of the fridges for which the alarm sounded only locally showed that 85 (60%) were in 'other' locations, with theatres as the next most common location with 25 fridges (18%).

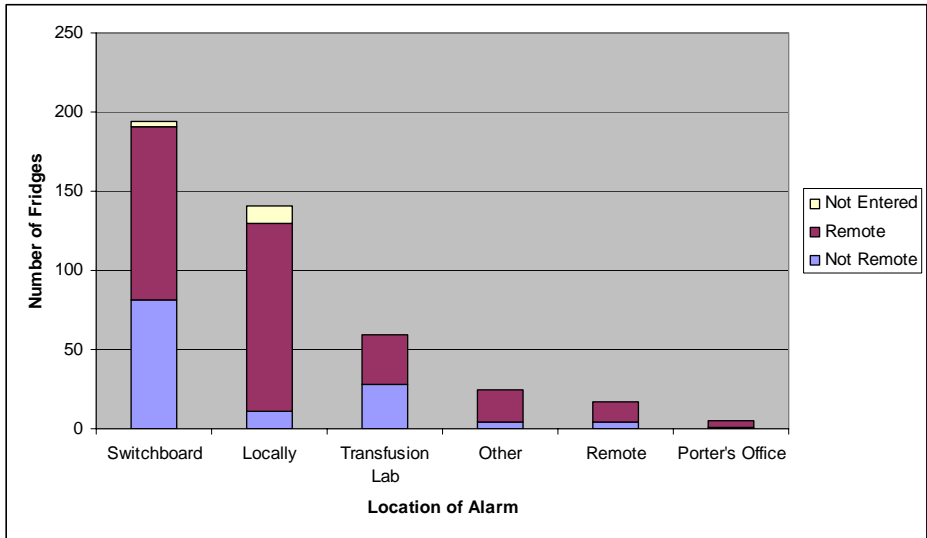


Figure 15 Site of Alarm Sounding in Only One Location

A comparison of the 2007 results with the 2004 survey showed that for alarms on remote fridges which sound in only one location, there was an increase in the number which sound at the switchboard, and a corresponding decrease in the number of alarms sounding only locally. The full results are shown in Figure 16.

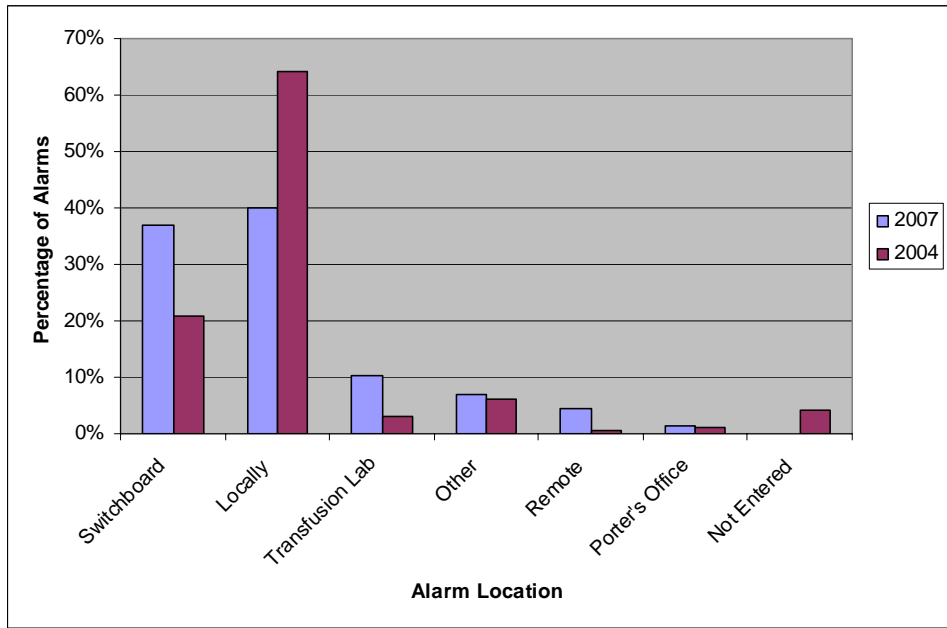


Figure 16 Location of Alarm Sounding in Only One Location for Remote Fridges Only – Comparison of 2007 with 2004

Of the fridges which have alarms sounding in multiple locations, 480 (73%) featured the switchboard as one of the locations which the alarm sounded.

5 Alarm Monitoring

5.1 Alarm Testing During Normal Working Hours

Hospitals were asked how frequently they tested their alarms during normal working hours. 84% of alarms were tested every 1 to 7 days during normal working hours, and only 1% (alarms for 8 fridges) were never tested during normal working hours.

The complete range of testing frequencies and the breakdown of these figures for remote and non-remote fridges is shown in Table 10.

Testing Frequency – During Normal Working Hours	Non-Remote Fridges	Remote Fridges	All Fridges
Every 1-7 Days	86%	83%	84%
Every 8-14 Days	4%	3%	3%
Every 15 Days or More	9%	10%	10%
Never	0%	1%	1%
Unknown	0%	3%	2%
Total	100%	100%	100%

Table 10 Testing frequency during normal working hours, showing remote and non-remote fridges

The 2007 figures were compared with those obtained from the 2004 survey. There had been a slight shift to more frequent testing since 2004, with the percentage of alarms which were tested every 1 to 7 days increasing from 80% to 84%, and the percentage tested less frequently than every 14 days reducing from 18% to 10%. The full comparison is shown in Figure 17.

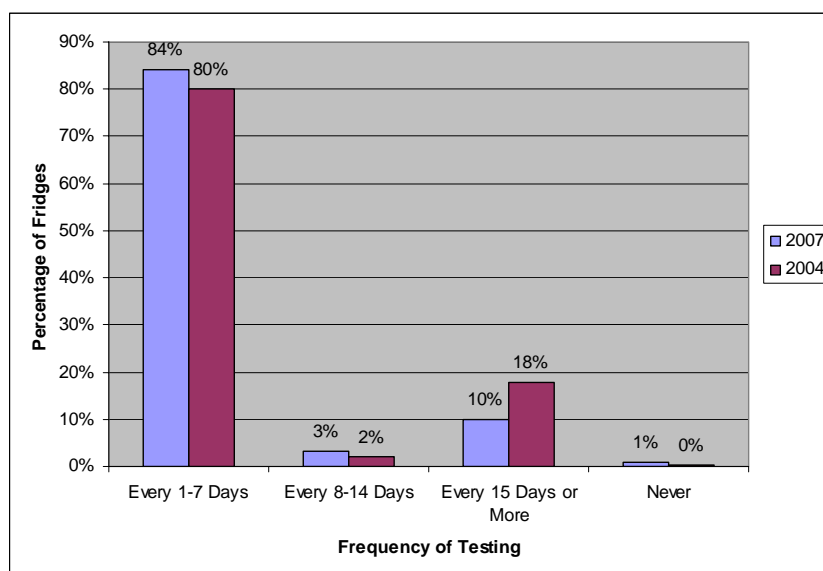


Figure 17 Alarm Testing During Normal Working Hours – Comparison of 2004 and 2007 Results

5.2 Alarm Testing Out of Hours

The frequency of alarm testing at weekends was also analysed. 67% of fridge alarms were never tested at the weekend, with only 18% being tested at least every 3 months.

The complete range of testing frequencies and the breakdown of these figures for remote and non-remote fridges is shown in Table 11.

Testing Frequency – At Weekends	Non-Remote Fridges	Remote Fridges	All Fridges
Every 3 Months or less	21%	16%	18%
Every 4-6 Months	2%	2%	2%
Every 7-12 Months	4%	4%	4%
Every 13 Months or more	4%	8%	6%
Never	68%	67%	67%
Unknown	0%	3%	2%
Total	100%	100%	100%

Table 11 Testing frequency at weekends, showing remote and non-remote fridges

The 2007 results were compared with 2004. This showed an improvement, in that the percentage of fridge alarms which were never tested had reduced from 83% to 67%, and the percentage tested every 3 months or less had increased from 10% to 18%. The full comparison is shown in Figure 18.

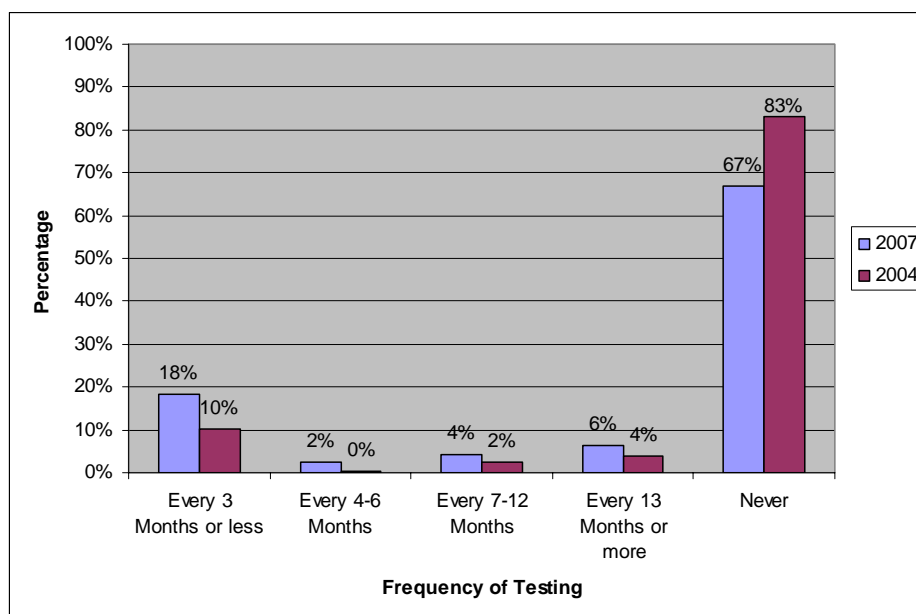


Figure 18 Alarm Testing - Weekends Comparison of 2004 with 2007

Finally, the testing frequency out of hours during the normal working week was analysed. Here nearly three quarters (74%) of fridge alarms were never tested out of hours, and only 11% were tested every 3 months or less. This means that the testing out of hours during the week was the least likely to be done.

The complete range of testing frequencies and the breakdown of these figures for remote and non-remote fridges is shown in Table 12.

Testing Frequency - Out of Hours During the Week	Non-Remote Fridges	Remote Fridges	All Fridges
Every 3 Months or less	15%	9%	11%
Every 4-6 Months	4%	3%	3%
Every 7-12 Months	6%	5%	5%
Every 13 Months or more	4%	4%	4%
Never	71%	75%	74%
Unknown	0%	3%	2%
Total	100%	100%	100%

Table 12 Testing frequency out of hours during the week, showing remote and non-remote fridges

Comparison of the 2007 and 2004 results showed an improvement, in that the percentage of fridge alarms which were never tested had reduced from 87% to 74%, and the percentage tested every 3 months or less had increased from 7% to 11%. The full comparison is shown in Figure 19.

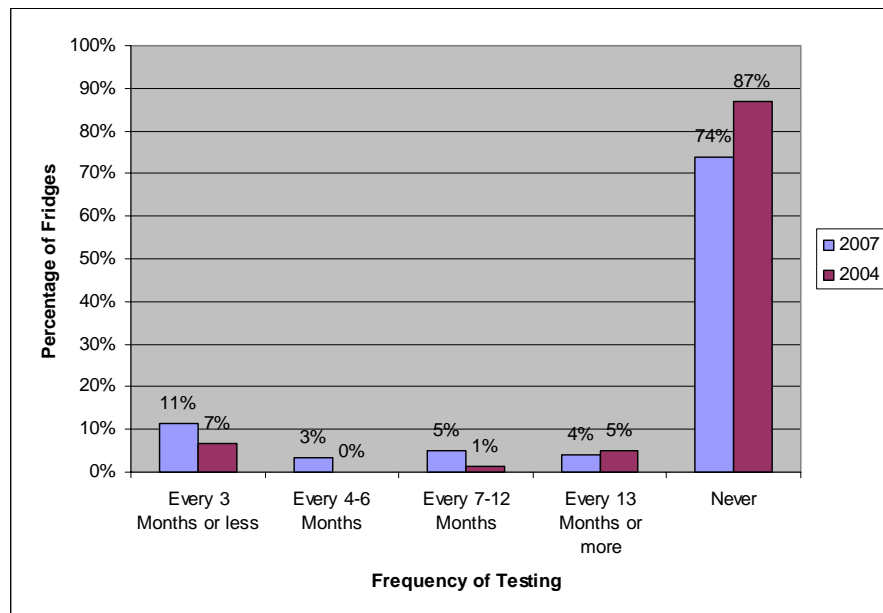


Figure 19 Alarm Testing - Out of Hours Comparison of 2004 to 2007

The proportion of hospitals doing out of hours testing at any frequency was analysed by hospital size. It was found that the size of hospital most likely to be doing out of hours testing were the smallest hospitals, while those most likely to be doing weekend testing were the medium sized hospitals. The full results are shown in Figure 20.

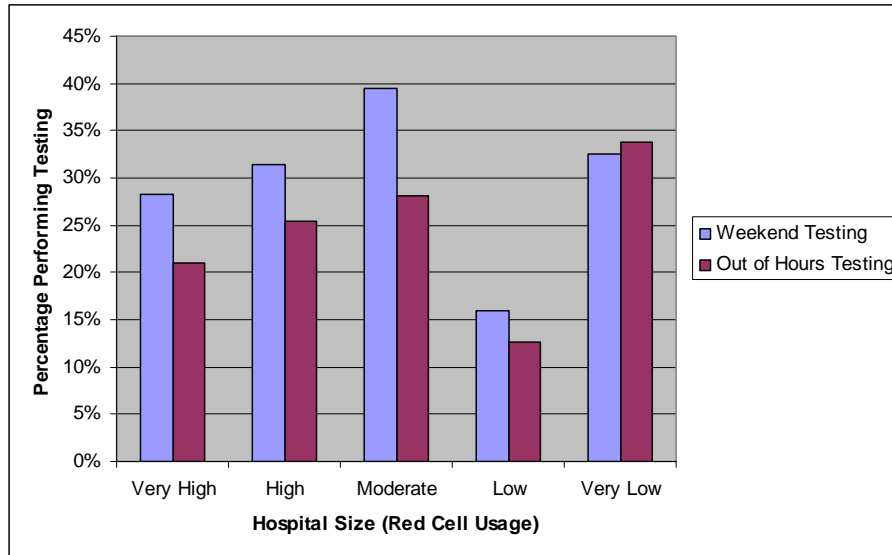


Figure 20 Analysis of Out of Hours and Weekend Testing by Hospital Size

5.3 Responsibility for Alarm Testing

The hospitals were asked who was responsible for testing their alarms. Laboratory staff were the most common with 86% of alarms being tested by laboratory staff. Within this, 41% were tested by qualified BMS staff, and 45% by trained MLA or trainee BMS. For the majority of fridges, only one type of staff was responsible for testing alarms, but for 9% of fridges two types of staff were responsible. The full breakdown in testing responsibilities is shown in Table 13.

Who Tests?	% of Alarms
Laboratory MLA	45%
Laboratory BMS	41%
Facilities Staff	12%
Nurse	4%
Other	3%
ODA / MTO	1%
Clerical Staff	1%
Porter	0%

Table 13 Proportion of alarms tested by each type of staff (note some alarms are tested by more than one type of staff)

The staff responsible for testing in 2007 was compared with the results of the 2004 survey. This showed that there had been an increase in the proportion of Laboratory staff responsible for testing, and a corresponding decrease in facilities staff and 'other' staff. The full analysis is shown in Figure 21.

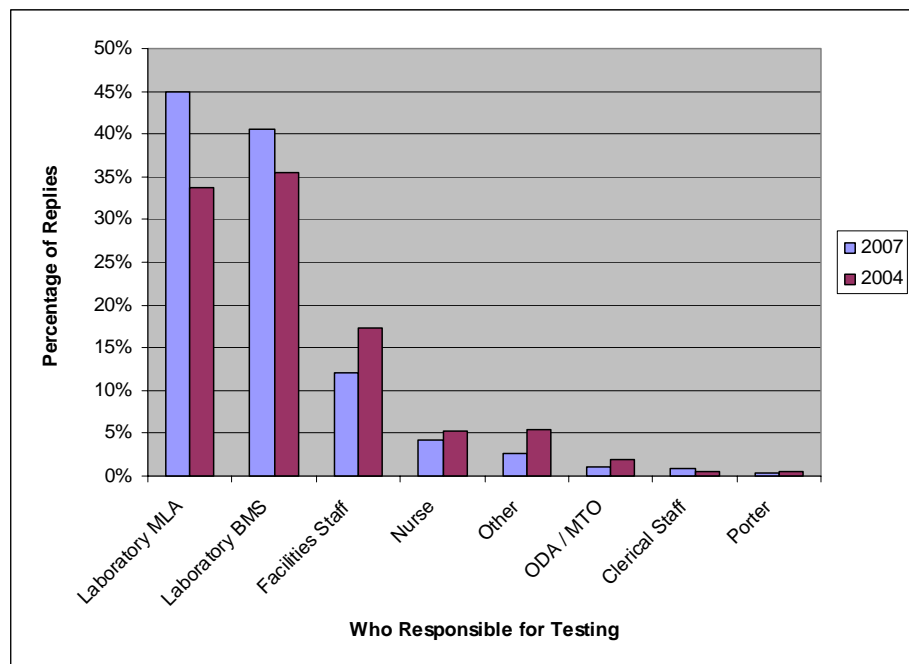


Figure 21 Responsibility for Alarm Testing 2004/2007 Comparison

5.4 SOP for Alarm Testing

There was a SOP for testing the alarm for 90% of fridges. This was a significant increase from the 2004 survey, when the figure was 64%.

85% of the SOPs in place covered documentation. This question was not asked in 2004.

6 Temperature Recording System Monitoring

6.1 Type of Temperature Recording System

Hospitals were asked about the type of temperature recording system in their fridges. Some fridges had only one type of temperature recording system on the fridge (62%), a further 26% had two different types of temperature recording. The maximum number of different types of temperature recording on one fridge was 4.

The most common single type of temperature recording method was 'Separate Analogue Motorised', with 697 fridges (63%) using this temperature recording method, and 431 of these (62%) using this as the only temperature recording method. The least common single type of temperature recording method was 'Separate Analogue Windup', with only 64 fridges (6%) using this method. Of these, 26 fridges (41%) used this as the only temperature recording method (Table 14).

Type of Temperature Recording	No of Fridges	% of Fridges
Integrated Digital	316	29%
Separate Digital	133	12%
Separate Analogue Motorised	697	63%
Separate Analogue Wind-Up	64	6%
Network Monitoring System	290	26%
Data Loggers	126	11%
Not Entered	12	1%

Table 14 Number and Percentage of Fridges with Each Type of Temperature Recording (Note: Fridges may have more than one type of Temperature Recording)

The results were further analysed to show the breakdown between Analogue and Digital recording method. 49% of fridges used an analogue recording method, but did not use a digital method, and 18% used a digital method, but did not use an analogue method. 20% of fridges used both an analogue and a digital method. 11% of fridges used neither an analogue nor a digital recording method, but did use network monitoring. For 1% of fridges, the only temperature recording method used was Data Loggers (Table 15).

Analogue or Digital Temperature Recording	Number of Fridges	Percentage of Fridges
Analogue	538	49%
Digital	198	18%
Analogue & Digital	223	20%
Network Monitoring	116	11%
Data Loggers Only	13	1%
Not Entered	12	1%
Total	1100	100%

Table 15 Breakdown of Temperature Recording into Analogue and Digital

6.2 Temperature Records

Hospitals were asked for how long they kept their temperature records. The Blood Safety and Quality Regulations 2005 recommend that paper or electronic records should be kept for 15 years.

For those hospitals having digital temperature recording on their fridges, the format of the temperature records available was also analysed. The result of this analysis is given in Table 16. 182/421 (43%) of the fridges which had digital Temperature Recording, had only printouts of the temperature records, and 105/142 (25%) had only computer records. 106/142 (25%) had both computer and printouts, but 28 fridges (7%) had neither (or did not answer this question).

Type of Records Available	Number of Fridges	Percentage
On Computer	105	25%
On Printout	182	43%
Both	106	25%
Neither	28	7%
Total	421	100%

Table 16 Type of Record Keeping for Fridges Using Digital Temperature Recording Methods

An analysis of the length of time which a printout was kept (for those fridges where a printout was kept), showed that half of the fridges had their temperature printout records kept from 21 to 30 years, with only 6% keeping the record for 10 years or less. In 6% of cases, the printout was not saved, and in the majority of these cases (76%), there was no computer record available (Figure 22).

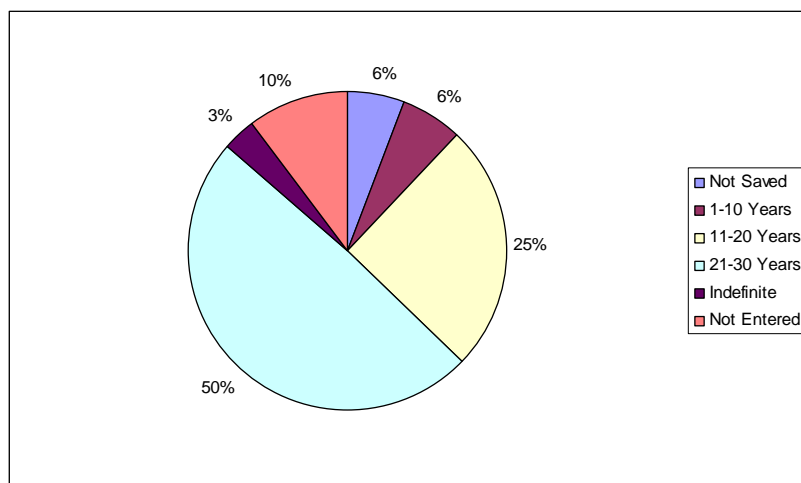


Figure 22 Digital Temperature Recording – Time Records are Kept

The 2007 results were compared with the results of the 2004 survey. This showed an improvement in the time for which printouts were kept. The percentage of printouts kept for over 20 years had increased from 29% to 52%, and the percentage not saved had reduced from 12% to 6% (Figure 23).

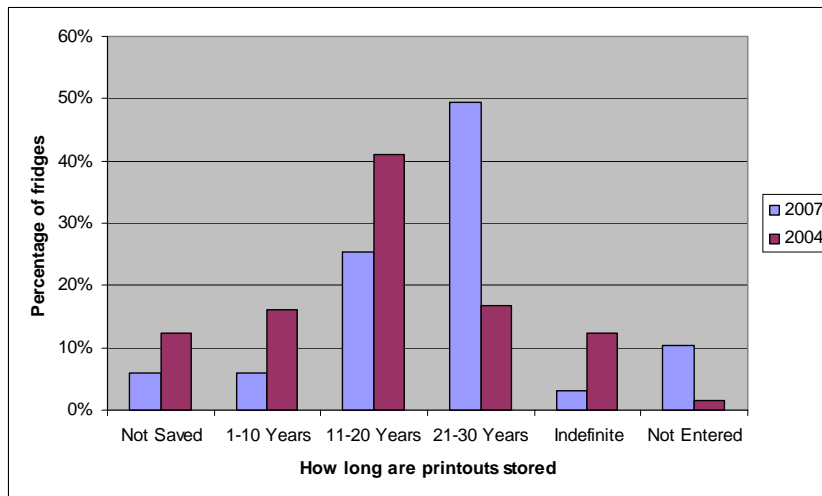


Figure 23 Digital Temperature Charts - Time Stored - Comparison of 2004 and 2007

A similar analysis was done for fridges with analogue temperature recording. This showed that in the 2007 survey, 55% of fridges had temperature records which were kept for 21 to 30 years, with only 7% keeping the record for 10 years or less. There were no fridges where the temperature records weren't kept (Figure 24).

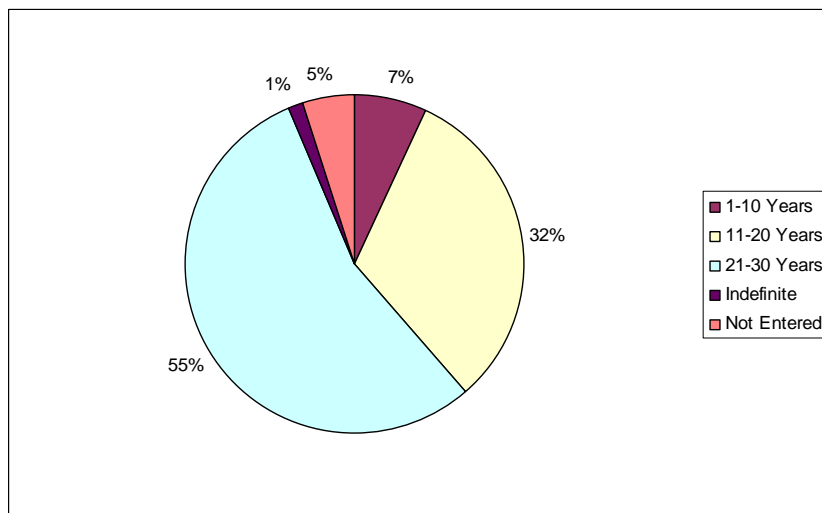


Figure 24 Analogue Temperature Recording - Time Printout is kept

A comparison of the 2007 results with those of the 2004 survey again showed a noticeable improvement. The percentage of printouts kept for over 20 years had increased from 20% to 56%, while the percentage kept for 20 years or less had decreased from 80% to 39% (Figure 25).



Figure 25 Analogue Temperature Charts - Time Stored - Comparison of 2004 and 2007

6.3 High and Low Activation Temperatures

The hospitals were asked about the type of temperature recording equipment on their fridges. 58% of the fridges monitored only air temperature, but as 30% monitored both air and core temperature, air temperature was monitored in 88% of fridges. Only 10% of fridges monitored core temperature only, but adding in those which measure both air and core temperature, core temperature was measured in 40% of fridges. See Table 17.

Which Temperature Monitored	Number of Fridges	Percentage of Fridges
Air	643	58%
Core	111	10%
Both	326	30%
Not Entered / Not Known	20	2%
Total	1100	100%

Table 17 Analysis of which temperature type is monitored

The hospitals were asked about the low and high activation temperatures. They were asked both the value, and whether the air temperature or a dummy sample was measured. Some hospitals stated the temperature, but not the method. This is indicated in the tables as 'unknown'.

The majority of fridges (77%) had a low activation temperature of 2°C with air temperature being measured. A further 12% had a 2°C low activation temperature, with a dummy sample being measured. Totalling all fridges where the low activation temperature was 2°C (including the 'unknowns'), the percentage of fridges with a 2°C low activation temperature was 96%.

In 79% of fridges the low activation temperature was measured as air temperature. The full analysis is in Table 18.

Low Activation Temperature	Number of Fridges	% of Fridges
0°C - Air	8	1%
2°C - Air	844	77%
2°C - Dummy Sample	130	12%
2°C - Unknown	81	7%
4°C - Air	15	1%
4°C - Dummy Sample	4	0%
4°C - Unknown	2	0%
Not Entered / Not Known	16	1%
Total	1100	100%

Table 18 Analysis of Low Activation Temperature

When the high activation temperature was considered, 43% of fridges had a high activation temperature of 6°C with the air temperature being measured, and 34% of fridges had a high activation temperature of 8°C with the air temperature being measured. Overall in 79% of fridges the high activation temperature was measured as air temperature (the same proportion as for low activation temperatures). The full analysis is shown in Table 19.

High Activation Temperature	Number of Fridges	% of Fridges
10°C - Air	10	1%
10°C - Dummy Sample	3	0%
8°C - Air	376	34%
8°C - Dummy Sample	11	1%
8°C - Unknown	29	3%
7°C - Air	5	0%
6°C - Air	476	43%
6°C - Dummy Sample	117	11%
6°C - Unknown	55	5%
5°C - Unknown	2	0%
Not Entered / Not Known	16	1%
Total	1100	100%

Table 19 Analysis of High Activation Temperature

7 Calibration of Alarm Monitoring System

7.1 Alarm System Calibration

A number of questions were asked about alarm calibration and temperature mapping. These questions were not asked in the 2004 survey.

The majority of hospitals calibrated their alarm monitoring system (Figure 26).

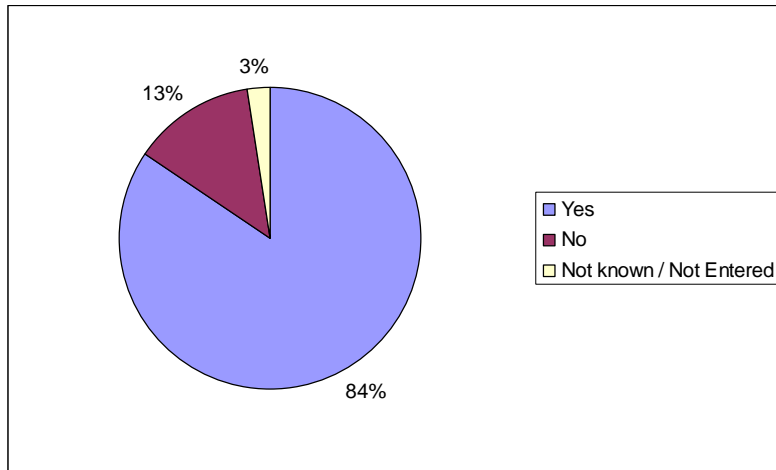


Figure 26 Is Alarm Monitoring System Calibrated?

Of those fridges in which the alarm monitoring system was calibrated, 71% calibrated annually, with 25% calibrating every six months (Figure 27).

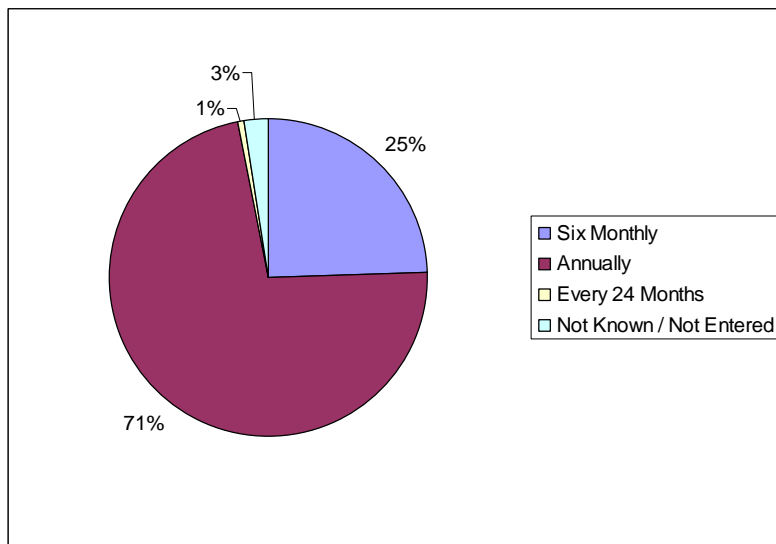


Figure 27 How Often Is Alarm Monitoring Calibrated?

Where the alarm monitoring system was calibrated, the calibration equipment had an in date certificate in 91% of cases (Figure 28).

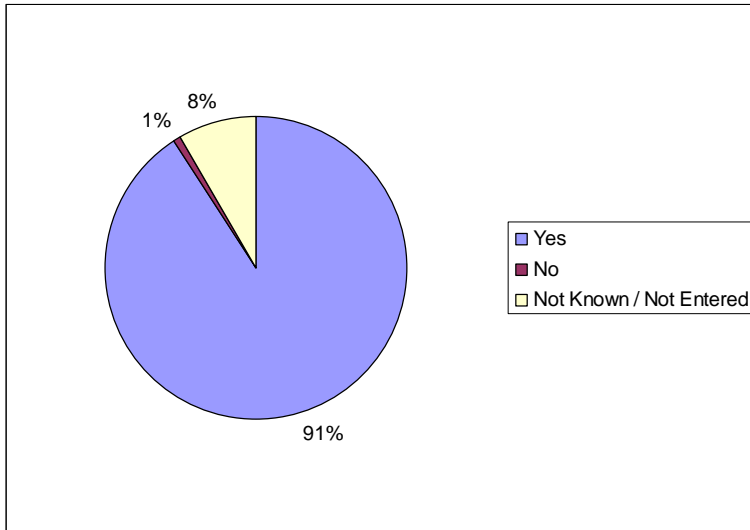


Figure 28 Does Calibration Equipment Have In Date Certificate?

The hospitals were asked whether their probes were calibrated to UKAS standards. 240/1100 hospitals did not answer this question, but it is thought that this is because it was asked after another question about temperature control equipment mapping (see section 7.2), and many hospitals without mapping thought the question about probe calibration was related and did not answer it. For this reason, the percentages given in Figure 29 relate only to those hospitals who answered the question.

Of those who answered the question, 94% said that their probes were calibrated to UKAS standards.

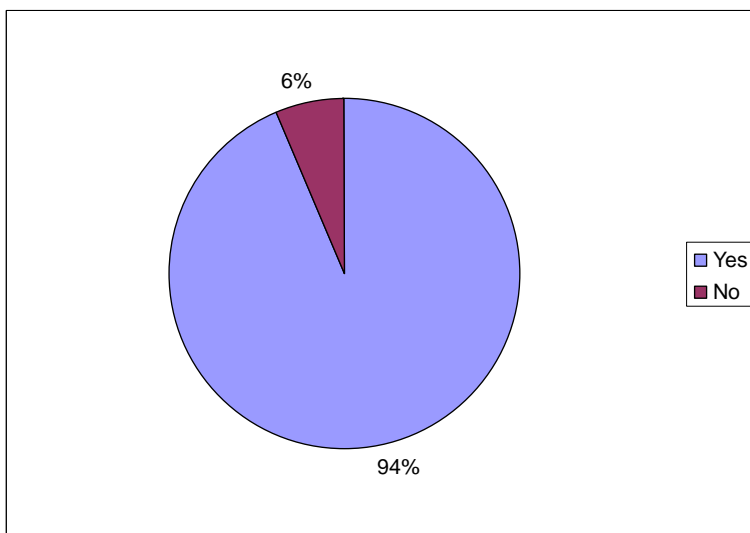


Figure 29 Are probes Calibrated to UKAS Standards?

Hospitals were asked who calibrates the probes. Of those fridges for which the probes were calibrated to UKAS standards, two thirds were calibrated by the manufacturer, and only 2% were calibrated by the hospital (Figure 30).

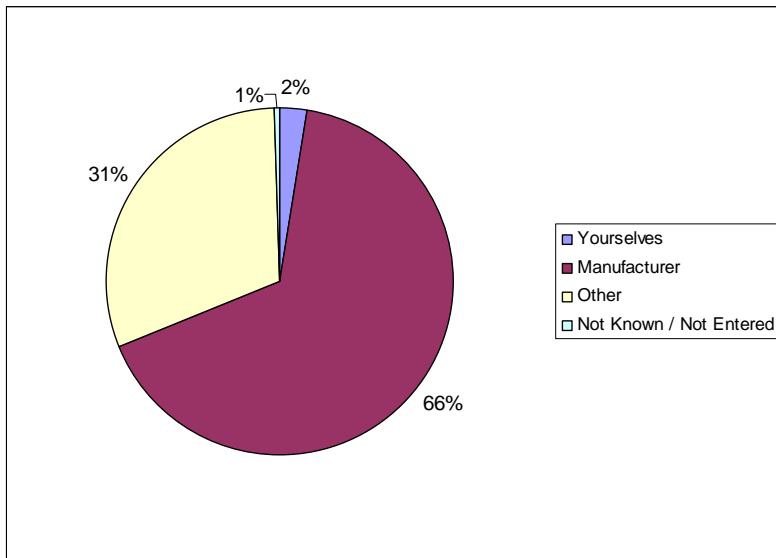


Figure 30 Responsibility for Calibration of Probes

7.2 Temperature Controlling Equipment Mapping

The temperature controlling equipment was mapped for over half (58%) of fridges, (Figure 31).

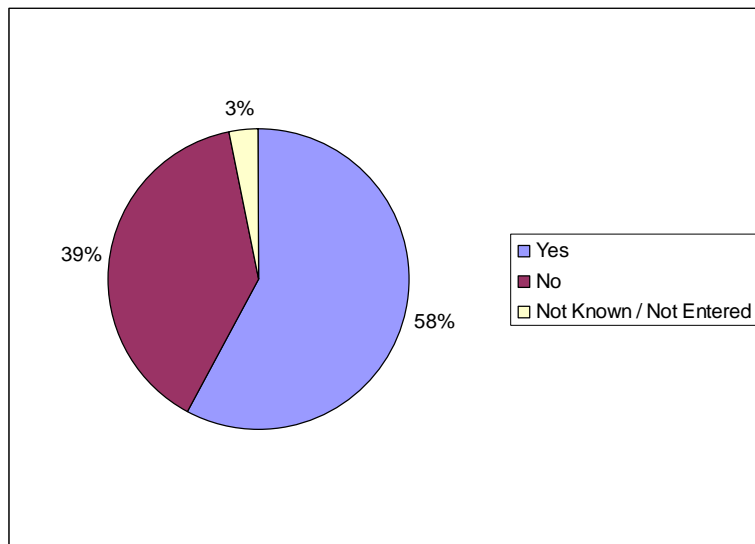


Figure 31 Is Temperature Controlling Equipment Mapped?

Of those fridges where the temperature controlling equipment was mapped, in the majority of cases (89%), this mapping was carried out annually, as recommended in the Blood Safety and Quality Regulations 2005 (Figure 32).

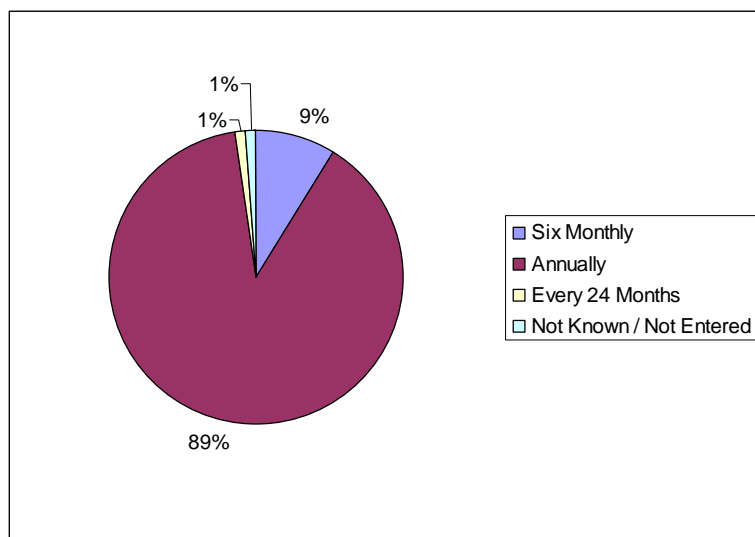


Figure 32 Frequency of Mapping

The regulations recommend that at least 3 probes are used, and this was the most common number used, with 27% of fridges in which the mapping was undertaken using 3 probes. Other probe numbers varied from 1 probe (10% of fridges), to over 13 probes. It is not known whether those hospitals who responded that only one probe was used mean that they were using the same probe in multiple locations in the fridge. A written comment from one hospital suggested this may be the case. The breakdown of numbers of probes used is shown in Figure 33.

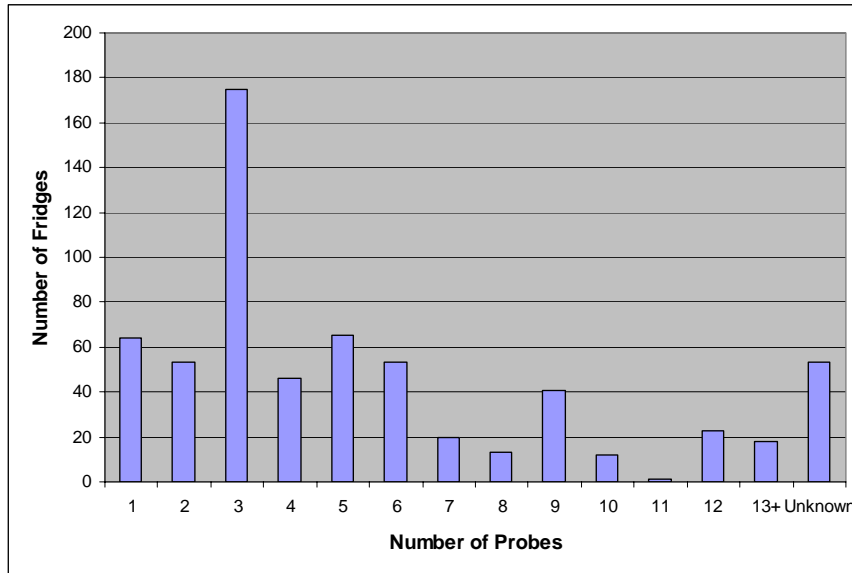


Figure 33 Number of Probes Used for Mapping

8 Remote Fridges

8.1 Transport

The transport of blood to and from remote fridges was reviewed. For the purposes of the analysis, a remote fridge was defined as any fridge with a journey time greater than zero from the transfusion laboratory. 105 fridges which were 'remote' fridges by this definition did not have this section of the questionnaire completed by the hospital. For this reason, the 'not entered' responses are excluded from the analysis in this section, so as not to distort the figures.

The hospitals were asked whether there was a SOP for the transport of units from the main storage fridge to the remote fridge. A SOP was in place for 86% of the fridges (Figure 34).

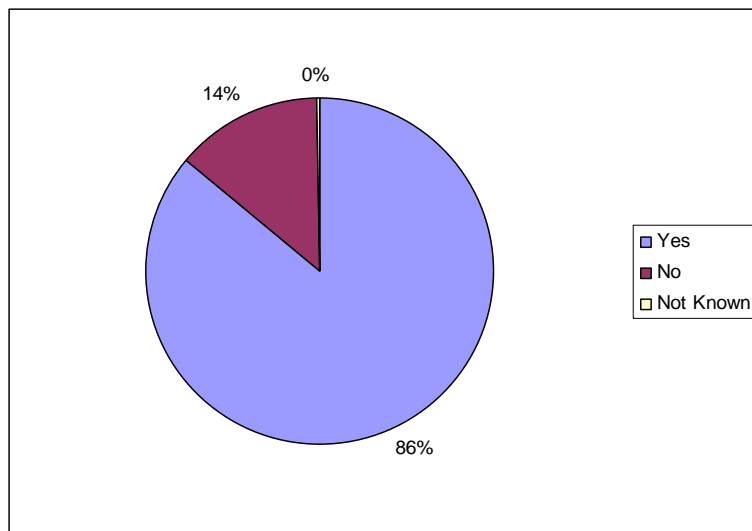


Figure 34 Is There a SOP for Transport From Main Storage to Satellite Fridges?

Two thirds of fridges had their blood transported in insulated containers from the main storage fridge to remote fridges (Figure 35).

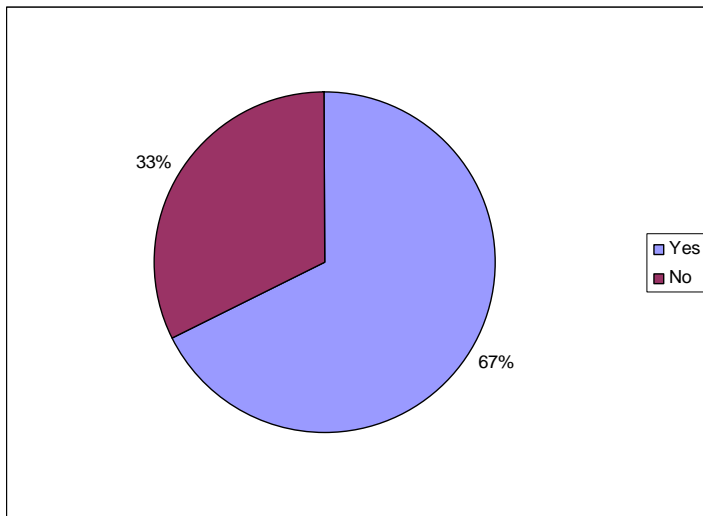


Figure 35 Are Units Transported in Insulated Container?

The data was further analysed by the distance of the fridge from the transfusion laboratory, and this analysis is shown in Figure 36. Insulated containers were always used for journeys over 30 minutes, and for 98% (all but one) of the journeys over 20 minutes. It was for the shorter journeys that insulated containers were not so often used.

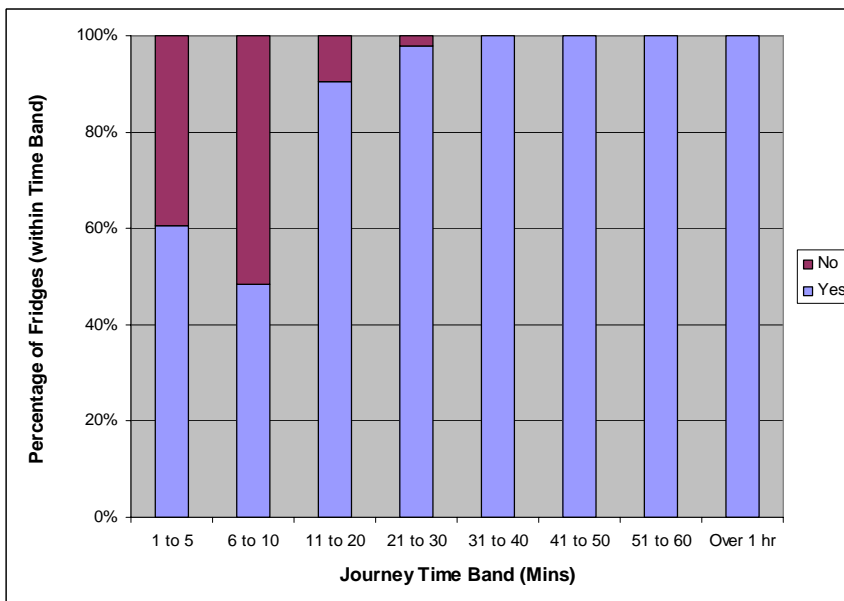


Figure 36 Are Units Transported in Insulated Containers (Remote Fridges Only) - Split by Journey Time Band

For those transfers where an insulated container was used, the hospitals were asked whether these containers were validated. The containers were validated in 85% of cases (Figure 37).

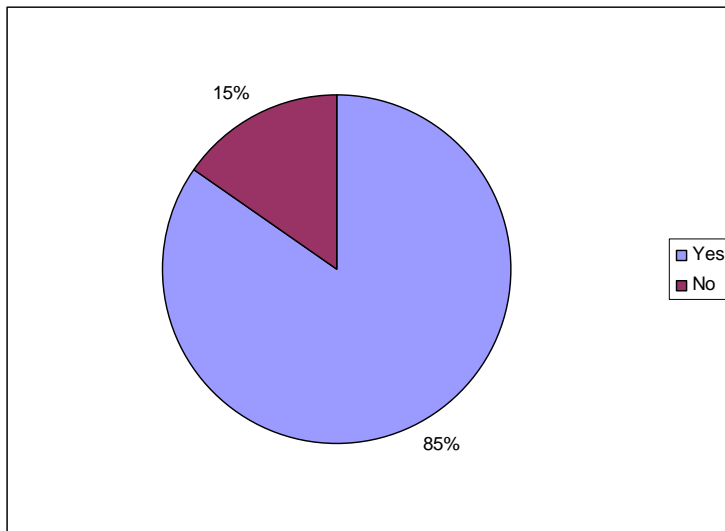


Figure 37 Is Insulated Container Validated?

For those containers which were validated, the frequency of validation was analysed. Just over half were validated annually, with a further 41% being validated every two years, or less frequently (Figure 38).

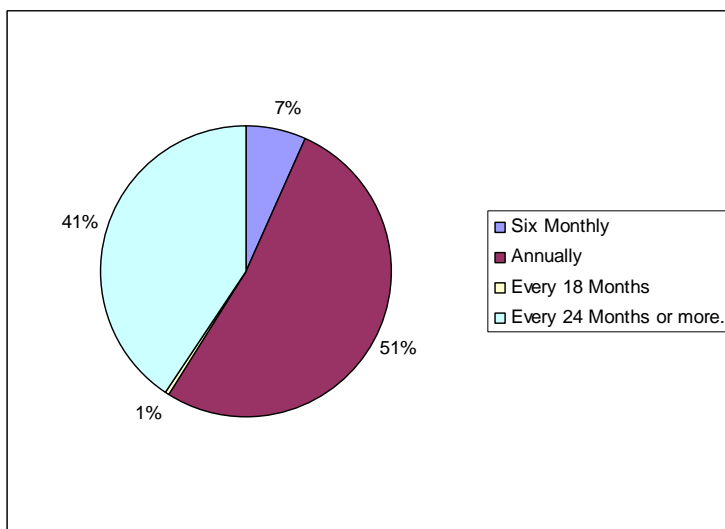


Figure 38 Frequency of Validation of Insulated Container

8.2 Review

Hospitals were asked how often the need for a remote fridge was reviewed. 38% reviewed this at least annually, but for 42% of remote fridges, the need was never reviewed.

The same question was asked in the 2004 survey. There was a slight decrease in the percentage of fridges where the need was never reviewed (down from 48% in 2004), and a very slight increase in the percentage of fridges reviewed at least annually (up from 36% in 2004). So this showed a slight improvement (Figure 39).

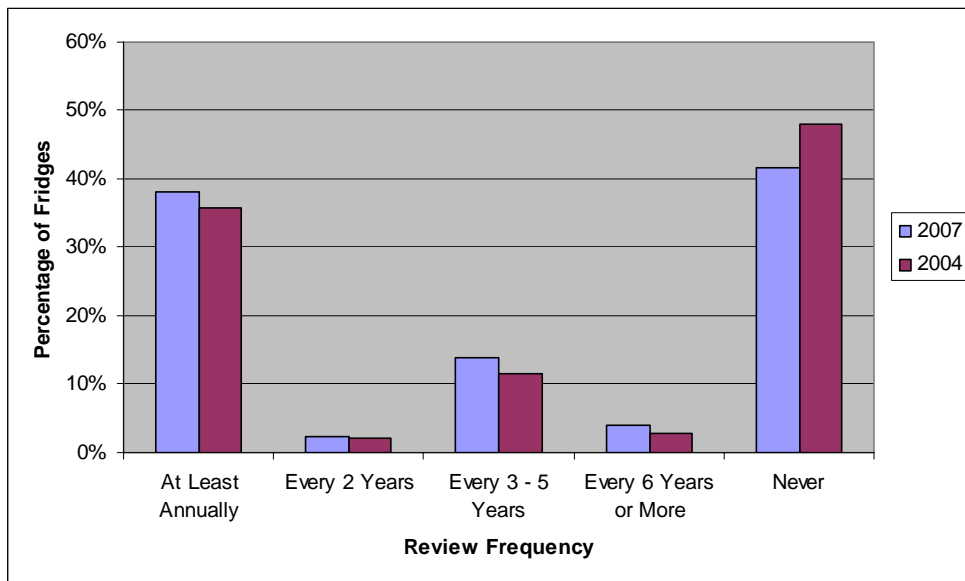


Figure 39 Review Frequency for Remote Fridges - Comparison of 2007 and 2004

9 Fridge and Alarm Maintenance and Service

9.1 Fridge and Alarm Repair Authorisation

Hospitals were asked who was responsible for authorising repairs of their fridges. For the great majority of hospitals (87% of those who entered data), only one function was responsible. Only 2 hospitals (16 fridges) had 3 functions responsible for authorising repairs. There were 122 fridges in 29 hospitals for which 2 functions were responsible for authorising repairs. The analysis is shown in Table 20.

How Many Responsible?	Number of Fridges	Percentage of Fridges
1 Responsible	941	86%
2 Responsible	122	11%
3 Responsible	16	1%
Not Entered	4	0%
Not known	17	2%
Total	1100	100%

Table 20 Number of functions responsible for authorising Fridge Repair

The transfusion laboratory was the most common function to be involved in authorising fridge repairs, having full or partial responsibility in 68% of fridges (739 fridges). The hospital facilities department was fully or partially responsible for authorising repairs in a quarter of all fridges. The split of responsibilities for authorising repairs is shown in Table 21. Those where the responsibility was unknown or not entered have been excluded from Table 21 (and also from the similar Table 23).

	1 Responsible	2 Responsible	3 Responsible	Overall
Transfusion Laboratory	605	118	16	739
Hospital Facilities Department	191	67	16	274
Trust Facilities Department	77	26		103
External Contractor	15	31	16	62
PFI Holder	30	2		32
Other	23			23

Table 21 Authorisation of Fridge Repairs – Numbers of fridges where repairs are authorised by each function

A similar analysis was done for the authorisation of alarm repairs. Again the majority of fridges had only one function responsible for authorisation of repairs. There were 112 alarms in 29 hospitals for which 2 functions were responsible, and only 23 alarms in 3 hospitals where 3 functions were responsible. The summary of these results is shown in Table 22.

How Many Responsible	Number of Alarms	Percentage of Alarms
1 Responsible	950	86%
2 Responsible	112	10%
3 Responsible	23	2%
Not Entered	4	0%
Not known	11	1%
Total	1100	100%

Table 22 Number of functions responsible for authorising Alarm Repair

The transfusion laboratory was, as for fridges, the most common function to be involved in authorising alarm repairs, having full or partial responsibility for 64% of alarms (697 alarms). The hospital facilities department was fully or partially responsible for authorising repairs for 30% of all alarms (323 alarms). The split of responsibilities for authorising repairs is shown in Table 23.

	1 Responsible	2 Responsible	3 Responsible	Grand Total
Transfusion Laboratory	566	108	23	697
PFI Holder	41	2		43
Hospital Facilities Department	221	79	23	323
Trust Facilities Department	88	12		100
External Contractor	11	23	23	57
Other	23			23

Table 23 Authorisation of Alarm Repairs – Numbers of alarms where repairs are authorised by each function

A summary chart showing the responsibilities for authorising fridge and alarm repairs is shown in Figure 40.

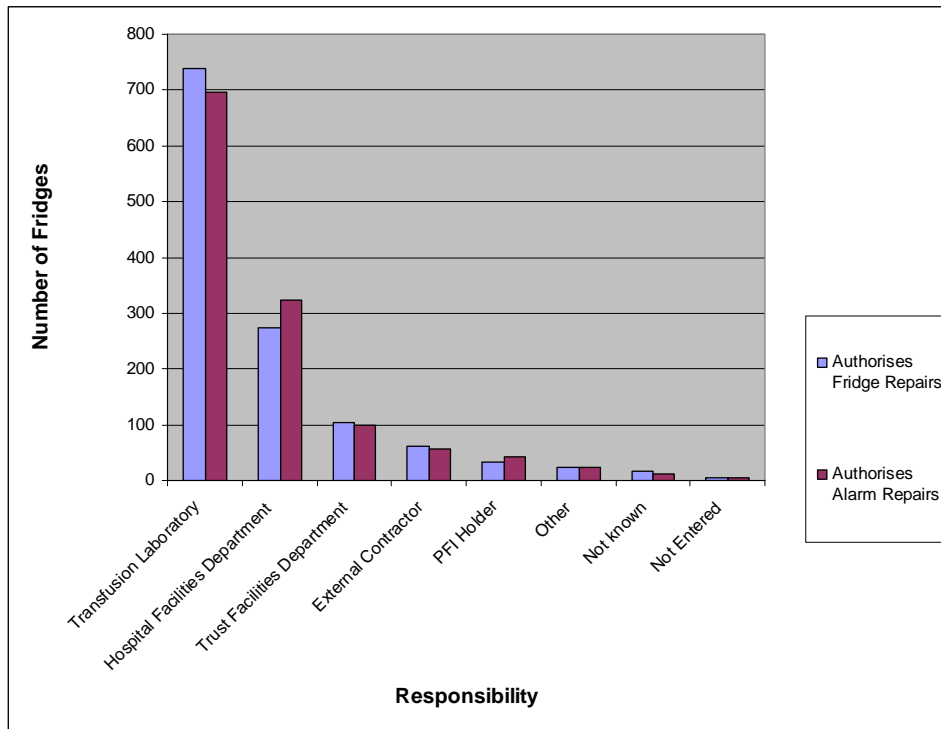


Figure 40 Authorisation of Repairs for Fridges and Alarms

9.2 Fridge and Alarm Servicing Responsibilities

The hospitals were asked who was responsible for servicing their fridges. For 95% of fridges only 1 function was responsible for fridge servicing. For 14 fridges across 3 hospitals, no-one was responsible for servicing. A summary of these figures is shown in Table 24.

How Many Responsible	Number of Fridges	Percentage of Fridges
1 Responsible	1047	95%
2 Responsible	23	2%
No-one	14	1%
Not Entered	4	0%
Not known	12	1%
Total	1100	100%

Table 24 Number of functions responsible for Fridge Servicing

External Contractors were most likely to be responsible for fridge servicing. They were fully or partially responsible for servicing 665 (61%) fridges. Transfusion Laboratories said they had sole responsibility for servicing only 13% of fridges (134 fridges across 34 hospitals). The full breakdown of these results is shown in Table 25.

	1 Responsible	2 Responsible	No-one	Overall
External Contractor	649	16		665
Hospital Facilities Department	165	10		175
Transfusion Laboratory	134	16		150
Trust Facilities Department	60	4		64
PFI Holder	23			23
Other	16			16
No-one			14	14
Total	1047	46	14	1107

Table 25 Responsibility for Fridge Servicing – Percentage of Each Function having responsibility for servicing fridges

A similar analysis was done for the servicing of alarms. For 92% of alarms, only 1 function was responsible for alarm servicing. For 19 alarms across 4 hospitals, no-one was responsible for servicing. A summary of these figures is shown in Table 26.

How Many Responsible	Number of Alarms	Percentage of Alarms
1 Responsible	1017	92%
2 Responsible	41	4%
3 Responsible	7	1%
No-one	19	2%
Not Entered	4	0%
Not known	12	1%
Total	1100	100%

Table 26 Number of functions responsible for Alarm Servicing

As for fridges, External Contractors were most likely to be responsible for alarm servicing, they were fully or partially responsible for servicing 52% of alarms (569 alarms), a lower percentage than for fridges. The next most likely to be responsible was the Hospital Facilities Department, who were fully or partially responsible for servicing 26% of alarms (284 alarms). Transfusion Laboratories said they had sole responsibility for servicing only 11% of alarms. The full breakdown of these results is shown in Table 27.

	1 Responsible	2 Responsible	3 Responsible	No-one	Overall
External Contractor	527	35	7		569
Hospital Facilities Department	262	15	7		284
Transfusion Laboratory	108	18	7		133
Trust Facilities Department	78	14			92
PFI Holder	37				37
No-one				19	19
Other	5				5

Table 27 Responsibility for Alarm Servicing – Percentage of Each Function having responsibility for servicing alarms

A summary chart showing the responsibilities for servicing fridges and alarms is shown in Figure 41.

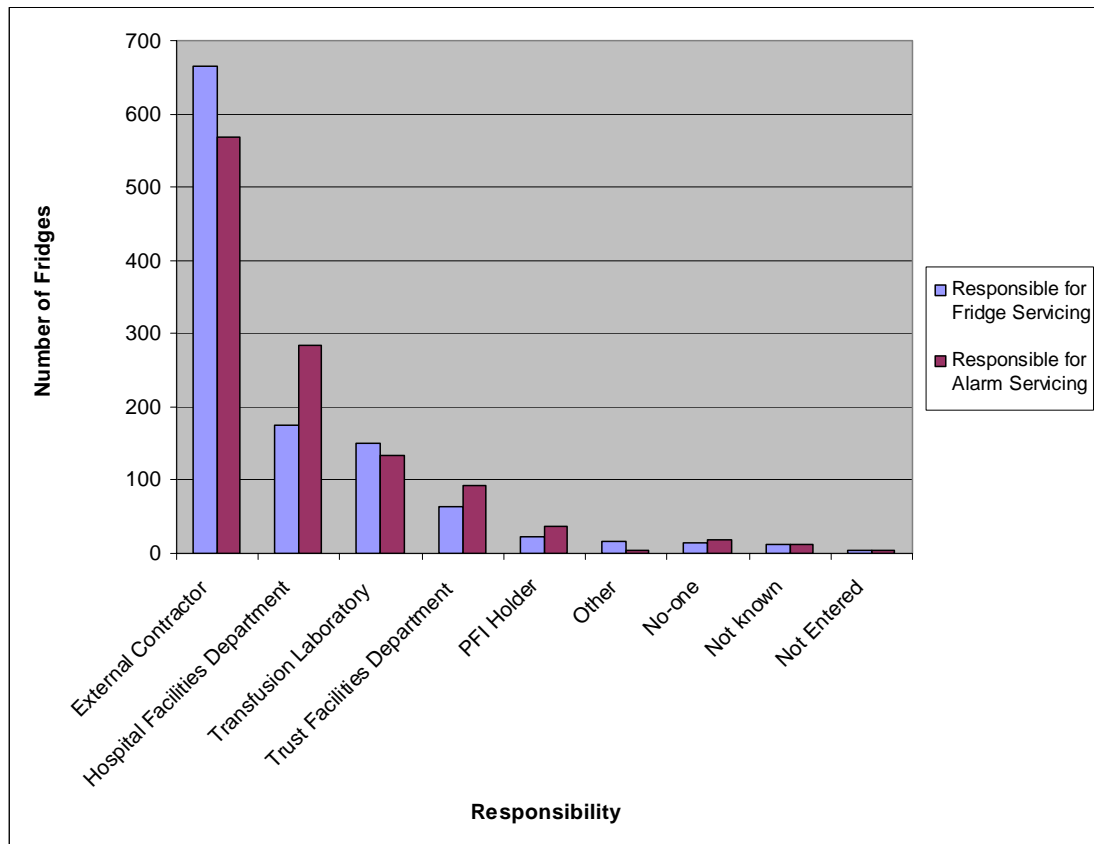


Figure 41 Responsibility for Fridge and Alarm Servicing

9.3 Servicing Frequency and Satisfaction with Maintenance

Hospitals were asked whether they were satisfied that their fridges and alarms were serviced to either "Blood Safety and Quality Regulations" (BSQR) or to "Good Manufacturing Practice" (GMP) standards.

For 79% of fridges, the hospitals were satisfied that the fridges were maintained to a satisfactory standard, and the satisfaction figure was 77% for alarms. The levels of satisfaction were not noticeably different depending on who was responsible for servicing, with the exceptions that there was a greater than average satisfaction level when the Transfusion Lab was responsible for servicing (90% satisfaction for fridges, 83% for alarms), and when the PFI was responsible (100% for fridges, 92% for alarms). Interestingly, one hospital where no-one was responsible for fridge or alarm servicing was nevertheless satisfied that the fridges and alarms were serviced to standard. A summary of these results is shown in Figure 42 and Figure 43.

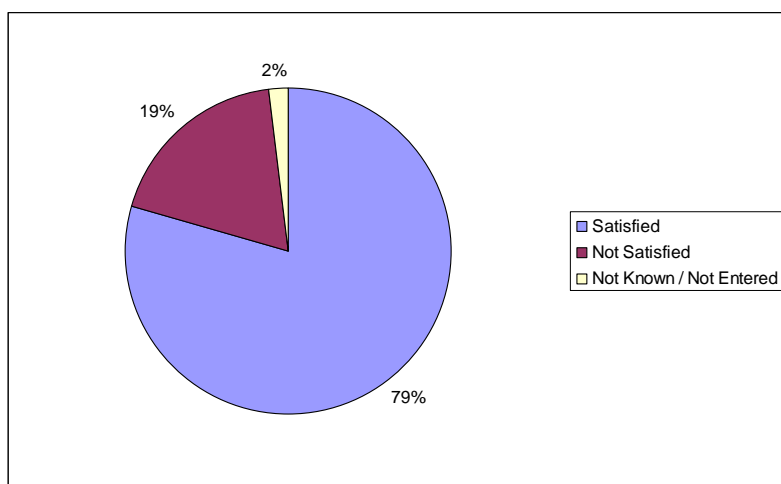


Figure 42 Satisfaction that Fridge is Serviced to BSQR/GMP Standards

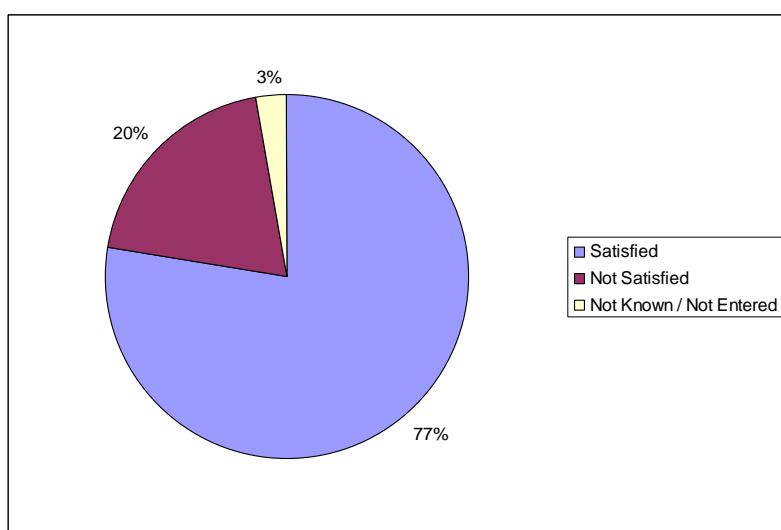


Figure 43 Satisfaction that Alarm is Serviced to BSQR/GMP Standards

Finally, hospitals were asked how often their fridges were serviced. The majority (90%) were serviced at least annually, with only 7% services less frequently than every 2 years. The full breakdown of these figures is shown in Figure 44.

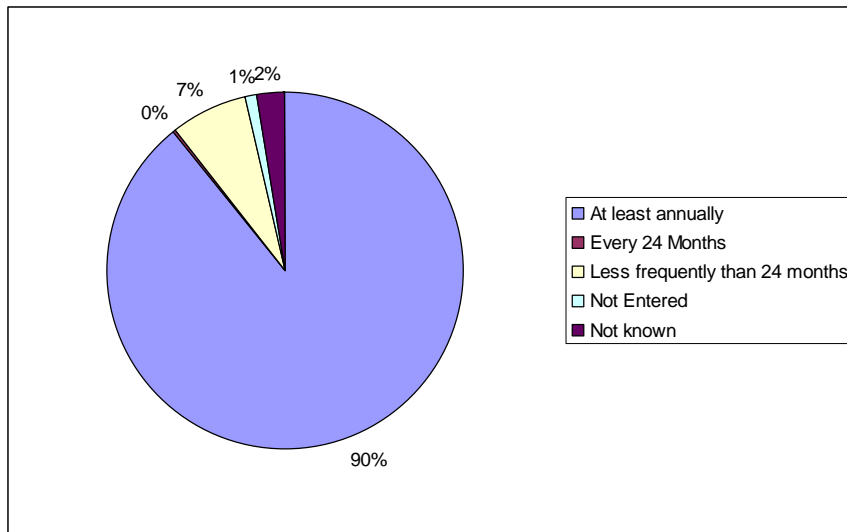


Figure 44 Frequency of Fridge Servicing

10 Conclusions

The 2004 Inventory Practice Survey identified a number of deficiencies in the management of blood storage refrigerators and it was hoped that the introduction of the Blood Quality and Safety Regulations would help hospitals to address some of the problems identified in the survey.

The 2007 survey is encouraging as it has identified that some improvements have been made namely:-

- An increase in the number of fridges compliant with BS4376
- An increase in the number of fridges on a maintained power supply
- An increase in the number of hospitals with a SOP for alarm testing
- A decrease in the number of alarms that sound locally to remote fridges

The BSQR identify the importance of ensuring red cell components are stored within the temperature range 2°C - 6°C core temperature and 2°C - 10°C air temperature. Temperature monitoring, temperature mapping and calibration of monitoring equipment are all important aspects of the regulations. The survey identified that:-

- There is variation in temperature monitoring especially related to the high activation temperature which ranged from 5°C to 10°C
- The temperature controlling equipment was mapped in only just over half of all fridges
- The majority of hospitals calibrate their alarm monitoring systems

There was a significant increase in the number of hospitals that had a SOP for alarm testing. In 2004 only 64% of hospitals had a SOP; in 2007 the number of hospitals had increased to 90%. 85% of the SOPs in place covered documentation in the event of an alarm being activated. 86% of hospitals have a SOP for transport of units between the main storage fridge and remote fridges.

The 2007 SHOT report highlighted 34 cold chain errors of which seven were alarm related. 3/7 were alarm failures on a platelet agitator and the other four associated with fridge alarms. These errors with potential associated blood wastage and adverse reactions for the patient outline the importance of ensuring a high standard for cold chain validation.

11 Recommendations

- All fridges and alarms should be on a “maintained” power supply.
- The “maintained” power supply should be regularly tested.
- There should be a SOP for responding to an alarm alert.
- There should be a SOP for alarm testing.
- Laboratories should ensure that the location in which an alarm sounds is constantly staffed or if unstaffed for some of the time there is a facility in place to alert the transfusion laboratory to an alarm incident.
- The low air temperature activation temperature is 2°C and is an alert alarm.
- The buffered load alarm is required to work on the core temperature of the blood and must have a trigger point of 2°C. This is an action alarm.
- The high air temperature activation temperature is 8°C and is an alert alarm.
- A buffered load alarm works on the core temperature of the blood and must have a trigger point of 6°C. This is an action alarm and must not have a time delay.
- All equipment controlling temperature must be temperature mapped once a year.
- The chart recorder, digital readout, max/min thermometer and central monitoring system must be calibrated annually. A certificate for the calibration equipment traceable to national standards is required.
- There should be a SOP for transport of units between the main storage and remote fridges.