

ORIGINAL ARTICLE

Pericardial effusion and cardiac tamponade as complications of neonatal long lines: are they really a problem?

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Aim: To estimate the frequency of pericardial effusion/cardiac tamponade associated with the use of neonatal percutaneous long lines (PLLs) over the past five years.

Method: A retrospective nationwide postal survey, of all neonatal and special care units in the United Kingdom.

Results: Eighty two cases of pericardial effusion/cardiac tamponade were reported from the five year period, during which we estimate that 46 000 PLLs were inserted. The calculated frequency of pericardial effusion/cardiac tamponade occurring with PLLs was 1.8/1000 lines. There were 30 deaths, giving a fatality rate after pericardial effusion of 0.7/1000 lines.

Conclusions: Pericardial effusion/cardiac tamponade is a serious but infrequent complication of PLL use.

Percutaneous long lines (PLLs) are an essential part of the nutritional care of the premature infant. They are known to be associated with significant clinical risks.¹ These range from local and systemic infection, to pericardial effusions and subsequent tamponade.² There are a number of case reports of infants who have died or suffered significant morbidity as a consequence of pericardial tamponade.^{3–6} One unit reported that pericardial effusion/tamponade occurred in 3% of inserted lines.⁷ Reports in the popular press⁸ have also suggested this to be a common complication and that doctors were putting infants lives at unnecessary risk by inserting PLLs. Although the risk is acknowledged, there are no national data on the use and complications of these lines in the United Kingdom. The aim of this study was to estimate the frequency of pericardial effusion/cardiac tamponade associated with the use of PLLs.

METHODS

Using the Directory of Emergency and Special Care Units⁹ and the British Association of Perinatal Medicine Handbook, we identified a lead consultant in every hospital with a neonatal or special care unit. These consultants were sent a questionnaire, covering letter, and a prepaid envelope for return. The questionnaire was designed to establish details of the number of lines inserted, choice of tip position, line type, and the number of cases of pericardial effusion/cardiac tamponade occurring over the past five years. If a reply had not been

received within eight weeks, a follow up telephone call was made to the consultant and a further questionnaire was sent. The data were analysed using binomial regression, allowing for over dispersion. This allowed comparisons of different risk factors such as the numbers of lines sited in an individual neonatal unit.

RESULTS

Questionnaires were distributed to 243 consultants; we received 192 replies including two joint responses (response rate of 80%). Twenty four units never inserted PLLs. Table 1 gives details of line type, accepted tip position, and number of lines sited per year in the remaining 168 units. Vygon lines (Vygon UK Ltd, Bridge Road, Cirencester, Gloucestershire) were used exclusively in 71% of units, and 8% of units used solely Medex lines (Medex Medical, Haslingden, Rossendale, Lancashire). All units checked the position of the PLL by *x* ray examination, but only 44 (26%) routinely used intravenous contrast. The majority of units aimed to position the line tip outside the heart, but 26 units aimed for the right atrium.

Eighty two cases of pericardial effusion/cardiac tamponade were remembered from 53 units over a five year period. Tables 2 and 3 show details of these cases in relation to the number of lines sited by the unit, type of line, and the accepted tip position. In order to determine the risk of pericardial effusion/cardiac tamponade we needed to determine a denominator for the number of PLLs sited per year. We used the mean number

Table 1 Unit responses indicating number, type of line inserted, and accepted tip position

| Number of lines sited per year | Number of units | Accepted PLL tip position | | | | Line type | | |
|--------------------------------|-----------------|---------------------------|----------|---------|---------------|-----------|-----------|------------|
| | | SVC/IVC | RA | Either | Not specified | Medex | Vygon | Both/other |
| <20 | 51 (30%) | 43 | 5 | 2 | 1 | 5 | 43 | 3 |
| 20–50 | 58 (35%) | 40 | 10 | 7 | 1 | 3 | 38 | 17 |
| 50–100 | 33 (20%) | 27 | 3 | 3 | 0 | 3 | 20 | 10 |
| 100–200 | 21 (13%) | 14 | 6 | 1 | 0 | 1 | 14 | 6 |
| >200 | 5 (3%) | 3 | 1 | 1 | 0 | 1 | 4 | 0 |
| Total | 168 | 127 (76%) | 25 (15%) | 14 (8%) | 2 (1%) | 13 (8%) | 119 (71%) | 36 (21%) |

PLL, percutaneous long line; SVC, superior vena cava; IVC, inferior vena cava; RA, right atrium.

Table 2 Relation between cases of pericardial effusion/cardiac tamponade over the study period, and the number of lines inserted by the units per year

| Units by no. lines sited per year | Cases | Deaths | Outcome not known |
|-----------------------------------|-------|--------|-------------------|
| <20 | 7 | 3 | 1 |
| 20–50 | 27 | 12 | 0 |
| 50–100 | 28 | 6 | 1 |
| 100–200 | 15 | 7 | 0 |
| >200 | 5 | 2 | 0 |
| Total | 82 | 30 | 2 |

Table 3 Relation between cases of pericardial effusion/cardiac tamponade, accepted tip position, and line type over the five year study period

| Line type | Position | | | Totals |
|-----------|----------|----|------------------------|--------|
| | SVC/IVC | RA | Position not specified | |
| Medex | 20 | 3 | 6 | 29 |
| Vygon | 31 | 5 | 2 | 38 |
| Not known | 7 | 5 | 3 | 15 |
| Total | 58 | 13 | 11 | 82 |

SVC, superior vena cava; IVC, inferior vena cava; RA, right atrium.

Table 4 Calculation of the denominator for the number of lines inserted annually

| Units by number of lines sited per year | Mean number of lines sited per year | Number of units within this banding | Estimated total number of lines sited per year |
|---|-------------------------------------|-------------------------------------|--|
| <20 | 10 | 51 | 510 (6%) |
| 20–50 | 35 | 58 | 2030 (21%) |
| 50–100 | 75 | 33 | 2475 (27%) |
| 100–200 | 150 | 21 | 3150 (34%) |
| >200 | 200 | 5 | 1000 (11%) |
| Total | | 168 | 9165 |

of lines for each band and multiplied it by the number of units in this banding. Table 4 shows these calculations. We estimated that 9165 lines were sited per year, with approximately 46 000 over the five year study period. The calculated frequency of remembered pericardial effusion/cardiac tamponade was 1.8/1000 PLLs inserted.

Thirty four cases (41%) occurred in units that inserted less than 50 PLLs per year, and only 20 cases (24%) occurred in units inserting more than 100 PLLs per year. When considering the number of cases in relation to the total number of lines inserted by the unit bands there appears to be a statistically significant increased risk of pericardial effusion/cardiac tamponade ($p = 0.005$) associated with units that inserted smaller numbers of lines. This increased risk was not associated with either line type or tip position. The majority of cases (71%) occurred in units whose choice of PLL tip position was the vena cavae, and 35 (43%) cases occurred in units where contrast had been used to confirm the tip position. There were 29 cases (35%) of pericardial effusion/cardiac tamponade associated with Medex PLLs compared to 44 cases (54%) with Vygon PLLs; in nine cases (11%) the type of line was not stated.

Information was available for 80 of the 82 cases regarding, diagnosis, management, and outcome (fig 1). There were 30 remembered deaths, of which 20 were diagnosed only at post-mortem examination. Over the study period the calculated fatality rate was 0.7/1000 PLLs inserted. Of the 60 cases of pericardial effusion/cardiac tamponade that were clinically suspected, an echocardiogram confirmed the diagnosis in 40 infants. Pericardial tap was performed in 47 cases. In the group where a clinical diagnosis was suspected there were only 10 deaths, and survival was 83%.

Other complications included those of line blockage, infection, thrombophlebitis, extravasation, and broken PLLs. More serious complications included four cases of thrombosis in the right atrium, and one of a cardiac arrest secondary to the PLL entering the coronary sinus. Ten hospitals reported cases of pleural effusions, and two cases of parenteral nutrition being aspirated from the endotracheal tube. One unit surprisingly reported finding parenteral nutrition in the cerebrospinal fluid.

DISCUSSION

The use of PLLs is a routine and essential part of neonatal intensive care. They provide a safe and secure route of vascular access for the administration of parenteral nutrition. Technological advances in vascular access have contributed to improved survival at the extremes of prematurity. Preterm infants have a high metabolic requirement and the provision of parenteral nutrition peripherally can be extremely difficult. Peripheral extravasation of parenteral nutrition can cause severe tissue injury and scarring.¹⁰ It is important that we establish the risks associated with any medical procedure, such as the use of PLLs. It has previously been suggested that in neonates the risk of pericardial effusion associated with the use of PLLs is 3%.⁷ This study was performed on a background of comments in the popular press that pericardial effusion/cardiac tamponade was a common complication of PLLs, and that paediatricians were putting infants' lives at unnecessary risk. We hoped to determine the relative risks of PLL use in neonates.

As a retrospective study we acknowledge that this survey is dependent on the memory and motivation of clinicians to complete postal questionnaires. However, we feel that neonatal staff tend to discuss and have good memories of infrequent but serious clinical complications, and were likely to remember events such as pericardial effusion or cardiac tamponade. Although we had a good response rate (80%) there may be some response bias. Additional cases may have been missed if postmortem examinations were not performed after an unexpected death. To ensure a high response rate we designed a simple questionnaire to determine the frequency of the event and outcome. As a retrospective study we did not aim to obtain specific details of individual cases; this could only be achieved with a prospective study. As our data show that pericardial effusion/cardiac tamponade is rare, any prospective study reviewing this complication of PLLs would need to be multicentred and over several years. Such a study may not yield accurate information as large numbers of lines will be inserted by different personnel, making data collection difficult. While reporting through the British Paediatric Surveillance Unit might provide more accurate information on the number of cases it would still be difficult to determine the denominator for the number of lines actually inserted.

This survey estimates the risk of pericardial effusion/cardiac tamponade associated with the use of PLLs as 1.8 per 1000 lines inserted, with a fatality rate of 0.7 per 1000 PLLs.

Our 80% response rate included replies from 81% of units that have been provisionally accredited for neonatal intensive care training. We therefore feel that our study is representative of neonatal care in the United Kingdom. We calculated that approximately 9000 lines were inserted by responding units

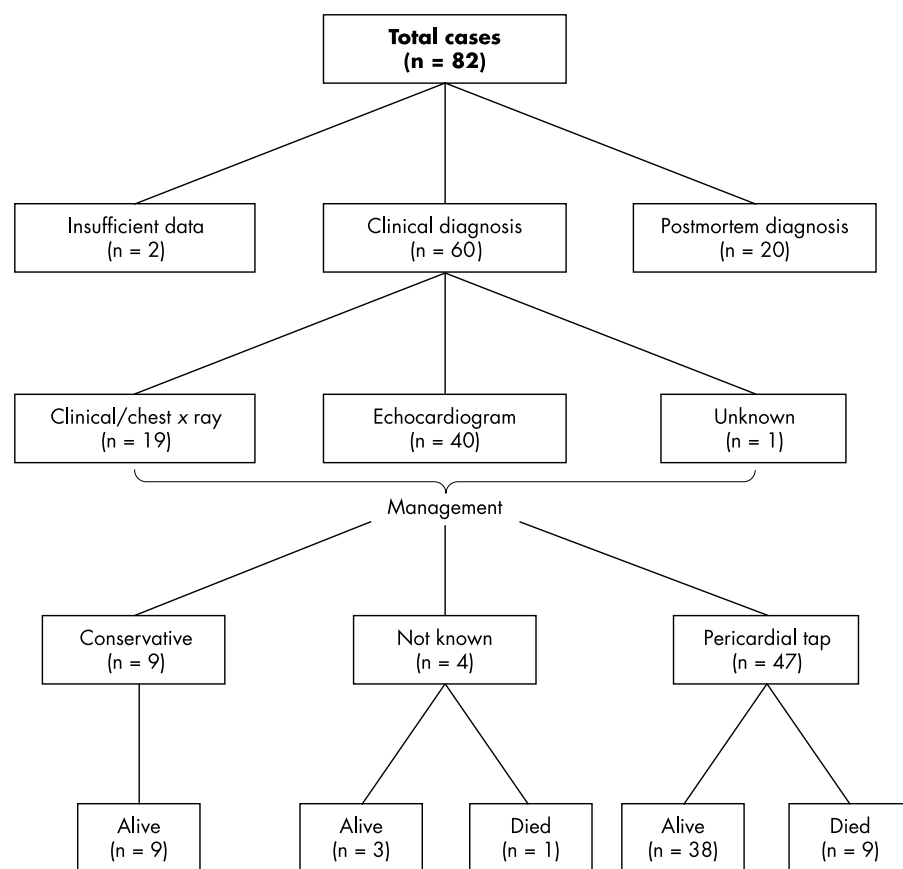


Figure 1 Management and outcome of neonatal pericardial effusion/cardiac tamponade.

and would extrapolate that approximately 11 000 lines would be inserted per year in the UK. This estimate is in keeping with the sales figures of the leading longline manufacturers who have sold approximately 15 000 lines per year in the UK over the study period (personal communication). The difference in the number of lines sold and our estimate will be made up of wasted lines due to failed insertions and from the use of PLLs in older paediatric patients.

In the unlikely event that 50% of cases of pericardial effusion/cardiac tamponade were not remembered, this would double the frequency to 3.6/1000 lines. This risk remains low in the context of a 19.7% mortality rate for very low birth weight babies in whom the majority of these lines are inserted.¹¹ In such a group of 1000 high risk infants, about 200 might be expected to die, but only one or two of these deaths is likely to be attributable to pericardial effusion/cardiac tamponade secondary to a PLL.

Thirty five per cent of cases were associated with Medex PLLs compared to 54% with Vygon lines. This has to be taken in the context of the number of lines of each type used. Many more Vygon PLLs were inserted and there did not appear to be any confounding factors associated with line type or tip position. However, due to a large number of units sited both types of lines in unknown proportions it was not possible to consider any real statistical relation between make of line and the risk of pericardial effusion/cardiac tamponade. The only statistically significant risk factor was that effusions were more likely to occur in units that inserted fewer lines.

Concerns about positioning of central lines in the right atrium have been documented¹² and have led to recommendations being issued by the US Food and Drug Administration,¹³ and by the UK Department of Health.¹⁴ It has been assumed, rightly or wrongly, that pericardial effusion/cardiac tamponade result from PLL tips placed in the atrium. From our questionnaire, as often is the case clinically, we do not know the exact position of the PLL tip at the time

the pericardial effusion/cardiac tamponade occurred. However in the majority of cases reported in this study the choice of PLL tip position was stated to be the vena cavae. These results would appear to show no relation between positioning lines in the atrium and the risk of pericardial effusion/cardiac tamponade. Alternatively in our study either line tips were not placed as intended or migrated over time. In paediatric patients central venous catheters placed through the subclavian or jugular veins can advance 2 cm with neck movements, and there may be additional migration with stretching and straightening of lines after insertion.¹⁵ It has been shown that it is often difficult to be sure of tip location without the use of intravenous contrast.¹⁶ However, our results do not indicate that the use of intravenous contrast to accurately determine tip position will prevent pericardial effusion/cardiac tamponade.

Although pericardial effusion/cardiac tamponade associated with PLLs is a recognised cause of morbidity and mortality this retrospective study indicates that the risk is low. Accurate information could only be obtained from a prospective multicentre study that we believe would be difficult to conduct. Survival after a clinical diagnosis of pericardial effusion/cardiac tamponade was high at 83%, although we do not have any data on long term neurological outcome. Our study shows that 76% of cases of pericardial effusion/cardiac tamponade occurred in units who aimed to position the PLL tip in the vena cavae. Therefore simply following the new Department of Health guidelines to avoid the atrium may not be sufficient to prevent these complications. We recommend the monitoring of PLL tip position over time. In any infant with a PLL in situ who clinically deteriorates or has a cardiac arrest, pericardial effusion/cardiac tamponade must be considered and appropriate action taken. Further prospective studies will be important in assessing the overall risks and benefits in the use of PLLs.

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