Assessment of the Rate of Complications of Peripherally Inserted Central (PIC) Catheters
A National Surveillance Program.

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Background

Peripherally inserted (PIC) catheters have gained widespread acceptance and usage in the Australian health care setting due to their ease of insertion and removal, reported low infection rate, longevity, and patient satisfaction. However, despite their widespread use, almost no Australian data exists regarding their rate of complications, especially in the home care setting.

Aims and Objectives

Aims

To conduct an audit of peripherally inserted central (PIC) catheters inserted in inpatients or outpatients managed by hospitals throughout Australia.

Objectives

To measure the rates of mechanical and infectious complications associated with PIC catheters.

To ascertain if these complications are associated with clinical variables such as method of insertion, brand of catheter, therapy administered via the catheter, catheter maintenance protocol, and duration of catheter in situ and inpatient/outpatient status.

Methods

Research design

This prospective study was a multi-centre investigation of patients requiring long term therapy via central catheters.

Population and sample

The cohort was a collection of patients in a large network of Hospital in Home (HIH) Unit managed patients and hospital inpatients. Tertiary teaching or large rural hospitals within Australia generally managed these patients.

Instrumentation

A data collection form was developed for the PIC line study (see Appendix I). The form comprised primarily items that required tick a box responses. However, there was some limited scope for open ended answers, or categorical (yes/no) responses. There were no scaled items.

The form was prepared by consensus of studies in the literature and local experience in PIC catheterization. The form had been piloted four times before being used in the audit. The face validity (whether the form was assessing the desired qualities) and the content validity (whether the form was measuring all the relevant or important content) could be determined. However, there was no standard audit form against which this study form could be judged.

The data was collected as: -

- Patient demographics including sex, age, hospital admission and Hospital in Home (HIH) Unit management.
- Information on predisposing illness of the patient, underlying reason for the catheter insertion and therapy administered through the PIC catheter, and/or infection.
- PIC catheter information including insertion date, type of catheter and by whom and where the catheter was inserted.
- PIC catheter outcome including information on PIC removal, complications such as readmission and whether patient would agree to another PIC catheter insertion if required.
- PIC catheter complications detailing information on the type of complication.

Data collection

The nursing/medical staff who managed the patients, completed the audit forms which were submitted regularly to the co-ordinating institution (Monash Medical Centre). Data was entered into a relational database (Microsoft Access). Forms with incomplete data were returned to the referring centre for completion and then resubmission. Outcomes included complications such as infection, thrombosis, occlusion, catheter damage, and dislodgment. Allowances were made for other complications to be specified by the nursing/medical staff. The criteria for local infection were erythema / induration and tenderness or purulent discharge. Bacteraemia was also an indicator of infection. The date of catheter removal was to be documented on the audit form with any complications, if present.

Data analysis

The outcomes measured were completion of planned or required therapy via catheter, and complications including infections. The data analysis included the commonly reported summary data such as the crude percentage rates for complications. The rates of complications per catheter days were calculated. Other descriptive information addressed the basic patient demographic information such as age, sex, underlying illness, and reason for therapy.

Definitions

A *treatment episode* was defined as the period needed to administer therapy required for the underlying illness of a patient, which was the reason for the PIC or other catheter insertion. The period did not include relapse of illness where a new catheter was inserted because the previous catheter(s) had been removed. During a treatment episode one or more PIC catheters were inserted. The first catheter had to be inserted between the 27 April 1998 and the 27 April 1999. Subsequent catheters that were required to complete the patients' therapies may have been inserted during or after this period.

A *catheter episode* was the period from the insertion to the removal of one PIC catheter. The reason for catheter removal was completion of therapy and/or planned catheter removal, or a complication of catheter insertion.

Results

Survey data was submitted by 28 institutions, that represented all Australian States and territories except the Australian Capital Territory, and one New Zealand institution. Details of 972 patient treatment episodes were reported. This number included 30 patients with 30 catheter insertions from three institutions that formally withdrew before

the study was completed. Details of catheter insertions per institution are presented in Table I (Total evaluable catheter insertions per institution).

Patient demographics: In this audit 906 patients had PIC catheters inserted in the study period. However, 7 patients (3 males, and 4 females) were lost to follow up. Four of these patients were patients at institutions that withdrew from the study and another patient lost to follow up when transferred to another hospital. No details were given by the reporting institution as to why the seventh patient was "lost to follow up." No further analysis was conducted on these patients. Therefore, there were 899 evaluable patients (581 males and 318 females). The patient's age was available for all but 18 patients. The average age was 52.2 years for males and 52.3 for females. The age range was 7 to 96 years. Only 25 patients were less than 18 years old. Of these 25 patients, only 4 patients were less than 11 years.

Treatment episodes: Nine hundred and sixty-five treatment episodes were reported for the 899 patients during the study period. There were 55 patients who had more than one treatment episode. Of these 55 patients, 46 had two episodes, 7 had 3 episodes and 2 had 4 episodes.

Catheter episodes: There were a total of 1072 catheter insertions in 899 patients that were reported for the study. However, there were 5 (0.5 %) catheter insertions where the details at first catheter insertion were collected, but post insertion data for subsequent catheters was unable to be collected because the patient was lost to follow up. Another catheter outcome, the third for a patient was also lost to follow up. All these 6 catheters were not included in the catheter analysis. However, the outcome(s) of the preceding catheters were available and were included in data analysis. In addition, the catheter removal data was not available for 13 (1.2 %) catheter insertions, however in absence of complications it was assumed that the date of therapy completion was the removal date. In the cases of another 13 catheter insertions the removal date was not available but the date when the catheter was last known to be patent was recorded as the removal date. This date included readmission and transfer to another unit or discharge dates. Incomplete data was also not available for 4 episodes involving 2 catheter insertions each, where the date for the first catheter insertions and the second catheter removal only were recorded. In these situations the number of indwelling catheter days for each episode were equally distributed between the two catheter insertions. In total of 1066 catheter insertions were evaluated. The total indwelling time for these catheters was 23,941 days, an of average 22.5 days per catheter. Details of multiple insertions plus patient demographic data are summarized in Table II (Patient demographics and catheter requirements).

Predisposing risk factors: A patient could have more than one potential; pre-disposing risk factor, and therefore the total does not tally to the number of catheters inserted. The predominant potential predisposing risk factor was chronic lung disease and was noted in 205 catheter episodes. Malignancy or complication and a history of immunosuppression/autoimmune disease were recorded in 141 and 113 catheter episodes, respectively. It was also noted that surgery was recorded as a potential predisposing risk

factor in 165 catheter episodes. Further details and catheter complications are presented in Table III (Factors associated with catheter complication).

Underlying reason for catheter insertion: The most common underlying reason for patient requiring a PIC catheter insertion was infection, and this occurred in 800 (74%) catheter episodes. Malignancy or a complication of a malignancy such as febrile neutropenia and malignancy related infections such as fungal, accounted for 16% reasons for insertion. Transplant complications that included transplant rejection, transplant related infections such CMV pneumonia and other complications, were the underlying reason for catheter insertion in 3% of cases. The category "respiratory diseases" did not include pneumonia or respiratory tract infections, as these were recorded as infection. The frequencies for other underlying reasons for insertion are presented in Table II (Factors associated with catheter complication) and Figure 1 (Underlying reason for therapy and catheter insertion). The types of infections are also indicated in figure 1. The most common specified infections were respiratory in cystic fibrosis (CF) patients (16%), respiratory infection in patients not specified as CF (12%), osteomyelitis (13%), endocarditis (12%) and wound (11%).

Therapy administered: Patients received a variety of therapies or combinations of therapies, however antibiotics were the most common category of medication. There were 900 (84.4%) catheter episodes where patients received antibiotics. In 722 (67.7%) of these episodes the patient received only antibiotic(s). Chemotherapy was administered to 129 (12.1%) of the episodes, but was the only therapy in 101 (9.5%). In 53 (5.0%) episodes some type of parenteral nutrition was given. Parenteral nutrition only was given for 10 (0.9%) catheter episodes. Blood products were recorded, usually in combination with other therapy for 16 (1.5 %) episodes.

Catheter brands and lumen size: In case of the first catheter insertion per episode where the catheter outcome was available (n = 1066) the most commonly used brand was Cook (n = 396, 37.1%) followed by V-catheter (n =203, 19.0%) and Bard Groshong (n = 174, 16.3%). Cook was the main brand that was used by the institution that reported the largest number of catheters and one of the main brands used by the institution that reported the second largest number. The lumen size was 4 French for 654 of the PIC catheters used. There were 94 catheters of 5 French size, 205 3 French and the 19 remaining catheters were varied other sizes or the size was not specified. Descriptive data on the catheter insertion is provided in Table IV (Descriptive data for catheters and the outcome).

Complications: Complications occurred in 253 catheter insertions. These complications resulted in the removal of all but 18 of the catheters. The associated complications of these 18 catheters were occlusion on 11 occasions, 3 incidences of infection and 3 cases of phlebitis. There was also one insertion where the sutures pulled out, and required re-suturing in order for the catheter to remain in use. On some of these 18 incidences of complication, urokinase was used on occluded catheters and antibiotics only were administered to treat catheter-related infections. Specific details of the types of complications are listed in Table V (Total complications).

Discussion

The overall complication rate for PIC catheter insertions in this multi-centre Australian study was 23.7%. If all the catheters that were lost to follow up were analyzed as complications this rate would have been 24.7%. Either way these complication rates seem to compare favourably with the published data. Reported as rates per 1000 catheter days, the respective rates are 10.6 and 11.1. Again this data is in line with published results. However, most of the data reported in the literature is reported as complications resulting in catheter removal. In this study there were 18 catheters that were not removed, so the Australian data would appear even better (22.1% or 9.8 complications per 1000 catheter days for the 1066 evaluable catheters, or 23.3 % and 10.4 per 1000 catheter days if the 13 lost to follow up catheters are included).

The complication rates for PIC catheter insertion in the literature range from 14.5 to 45.9%,[1],[2] with most authors quoting a range of 15-37%. The range for total complications per 1000 catheter days is 2.8 – 47.1[3],[4] but most studies reporting this rate quoted 7.5 to 18. However, the literature rates need to be interpreted and compared cautiously because there is a lack of standardized data collection, case definition, and reporting formats.

Most of the data on PIC catheter insertion outcomes has been obtained from descriptive studies, and there are very few cohort studies particularly those comparing rates with other long-term central venous catheters.[5],[6],[7],[7],[8],[9],[10] The data in some of these studies is difficult to extract as results are often reported with other catheters such as porta catheters or short term central venous catheters, as as non PIC catheters rather than specifying tunnelled catheters. Where obtainable from these published cohorts, rates for long term central venous catheters such as Hickmans and Leonards vary (7.2% to 35.7%).[10],[5] In other studies of Hickmans and other central venous tunnelled catheters report rates complication rates vary considerably. Press *et al* [11] reported in their study a total complication rate of 18.6% (1.5 per 1000 catheter days) but also reviewed the literature. Extrapolating the data from several published studies they calculated where data was available, that the average complication rate was 25.7% (range 14.2 to 93.7%) and there was an average of 3 complications per 1000 catheter days (range 1.3 to 17.7). The average catheter duration was 92.4 days (range 25 - 153 days).

Long term central venous catheters such as Hickmans and Leonards seem to have longer duration and less complications per 1000 catheter days than the PIC catheters. Although the catheter complication rate by percentage catheters for both catheter types seem comparable. However, the results are likely to be biased by current clinical practice of not inserting tunnelled catheters into patients who have projected needs of less than 3-4 months.[12] This clinical observation is also indirectly supported by The Australasian PIC Catheter Study, where the average duration of catheters not associated with a

complication was 23.3 days. It can be concluded that PIC catheters provide an effective alternative to Hickmans and related catheters when venous access is required for 3-4 weeks.

Conclusion

- Although comparisons of should only undertaken with caution, Australasian rates for PIC catheter outcomes are comparable to those published from overseas studies.

- In view of the relatively cheaper insertion costs, PIC catheters appear to be a cost effective alternative to other long term central venous catheters when venous access is required for 3 to 4 weeks.

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