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ARTICLE

# Self-administration of outpatient parenteral antibiotic therapy and risk of catheter-related adverse events: a retrospective cohort study

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**Abstract** Despite increasing use, limited data has been published comparing safety of different outpatient parenteral antimicrobial therapy (OPAT) models. Potential risks of self-administration at home include venous access device infection and other line complications. This study aims to investigate rates and predictors of intravenous access device complications in a large OPAT cohort. This is a retrospective cohort study of all uses of midlines, peripherally inserted central catheters (PICCs) and tunnelled central venous catheters (TCVCs) with univariate and multivariate (logistic regression) analysis of factors associated with line infections (LIs) and with other line events (OLEs). On univariate analysis, line infections were associated with length of line use, female sex and TCVC lines (compared to midlines). Patients self-administering OPAT in the home had a non-significantly lower rate of LIs. On multivariate analysis only duration of line use was a significant predictor of LIs—OR 1.012 (95%CI 1.001–1.023). For OLEs, multivariate analysis suggested that only line type and use of flucloxacillin were significant explanatory variables. In this cohort, there is no evidence that self-administration of OPAT is associated with higher rates of venous access device complications after controlling for confounding variables.

## Introduction

Outpatient parenteral antimicrobial therapy (OPAT) is increasingly used internationally, with many reported benefits to patients and health systems. Models of OPAT delivery vary widely in different settings [1]. Broadly, three delivery models can be defined [2]:

1. Administration of intravenous antimicrobials at an OPAT clinic or infusion centre in a hospital outpatient/clinic setting (termed C-OPAT in this study)
2. Administration is by a health care professional in the patient's home (H-OPAT in this study)
3. Self or carer administration in the patient's home after a period of training by OPAT staff (S-OPAT in this study)

Any individual OPAT service may employ a combination of these models depending on local logistic factors and constraints. For example, S-OPAT has been used in settings where restricted antibiotic policies didn't allow for use of antibiotics with once daily dosing [3], and in settings where increasing numbers of patients could otherwise not have been accommodated [4].

Reliable intravenous access devices (IV lines) are essential to any OPAT model and concern about IV line safety in ambulatory care is seen as a potential barrier to development of OPAT services [5].

With some exceptions [6], the comparative safety of different OPAT models has not been the subject of evaluation. This study aims to investigate rates and predictors of intravenous access device complications in a large OPAT cohort, with comparison of S-OPAT and C-OPAT models.

## Materials and methods

This was a retrospective cohort study of IV line use in patients attending the Glasgow OPAT service. The purpose was to determine factors associated with venous access device complications in this ambulatory care setting. In particular, the hypothesis that patient or carer self-administration of intravenous antibiotics at home (S-OPAT) was associated with higher

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rates of line complications, compared to administration in the OPAT clinic setting (C-OPAT), was to be tested. Use of H-OPAT in this cohort is negligible and therefore not assessed in this study. Outcome and explanatory variables were chosen for analysis based on discussions with OPAT clinicians (nurses, doctors and pharmacists) and review of literature for factors previously associated with line complications.

### Intravascular device policies at Glasgow OPAT

Specialist nurse practitioners assess patients on an individual basis to determine the most appropriate venous access device for use during OPAT. Factors which influence this decision include patient's vasculature, anticipated length of therapy, antibiotic to be infused and frequency of therapy (Fig. 1).

Local and national [7] policy for the insertion, care and maintenance of IV devices are followed by all staff involved in the placement and care of these lines. Before self-administering infusions at home, all S-OPAT patients are assessed, supervised and trained to self-prepare and administer IV antibiotics by specialist OPAT nurses. This includes an initial assessment of suitability (based on home circumstances, cognitive and motor function) and observation of independent self-administration after training to ensure competence, at the OPAT clinic or while an inpatient prior to discharge. Patients are kept under a minimum weekly review and have 24-hour support contact details.

### Data collection

Data was collected through interrogation of the previously described prospectively maintained OPAT database [8] and, where necessary, chart review.

### Inclusion criteria

All episodes of midline (including Leaderflex®), peripherally inserted central catheter (PICC) and tunnelled central venous catheter (TCVC e.g. Hickman®) use by Glasgow OPAT service between 1st January 2001 and 31st May 2011 were included. If a patient was recorded as using multiple line types during their treatment period then these were defined as multiple episodes for inclusion—the use of a line type ('line-episode') being the unit of analysis rather than patient episode. For example, a patient who used a midline for 7 days, removed due to phlebitis and replaced with a PICC line to complete a further 7 days without incident, would be included as two line episodes, both of 7 days duration, with line event recorded for the midline episode. As discussed above, a large proportion of patients from this OPAT service used no indwelling venous access device (i.e. single use butterfly ± temporary short IV cannula), and were excluded due to negligible rates of line complications in these patients.

### Outcome variables

Two dependent variables were considered.

Line infection (LI): diagnosis recorded prospectively based on OPAT clinician documentation (i.e. clinical or microbiological evidence of infection that resulted in line removal and antibiotic prescription). This includes suspected local infection and blood stream infection associated with IV access device.

Other line event (OLE): diagnosis recorded prospectively based on OPAT clinician documentation. This includes chemical or mechanical phlebitis, external leakage, extravasation, occlusion (thrombotic or non-thrombotic), and if the line fell out or was removed non-electively.

### Explanatory variables

The main explanatory variable for investigation was self or carer administration of intravenous agent at home (S-OPAT) versus administration by staff in the OPAT clinic setting (C-OPAT). The following independent variables were selected as plausible explanatory variables for analysis based on literature review and discussion with OPAT clinicians: length of IV course (duration line use); type of line used; OPAT experience, measured in years since formal instigation of OPAT in 2001; patient age, sex, and comorbidity including presence of diabetes as a separate indicator variable. Of the antibiotics used in this OPAT cohort, vancomycin and flucloxicillin are perceived to be associated with higher rates of chemical phlebitis [9, 10], and were therefore included as potential explanatory variables for other line event outcome (erythromycin, also associated with higher rates of chemical phlebitis, was not used intravenously in this cohort).

### Statistical analysis

All statistical tests were carried out using MedCalc® version 11.6.1.0 (MedCalc Software byba, Mariakerke, Belgium). Univariate analyses were performed on all independent variables for both dependent variables under investigation (LI and OLE). Categorical variables were reported as proportions, odds ratios (OR), 95% confidence interval for OR, and p values generated using $\chi^2$ tests. Continuous variables were reported using means with 95% confidence intervals, and compared with t test if parametric following normality and equal variance testing. Median, interquartile range and

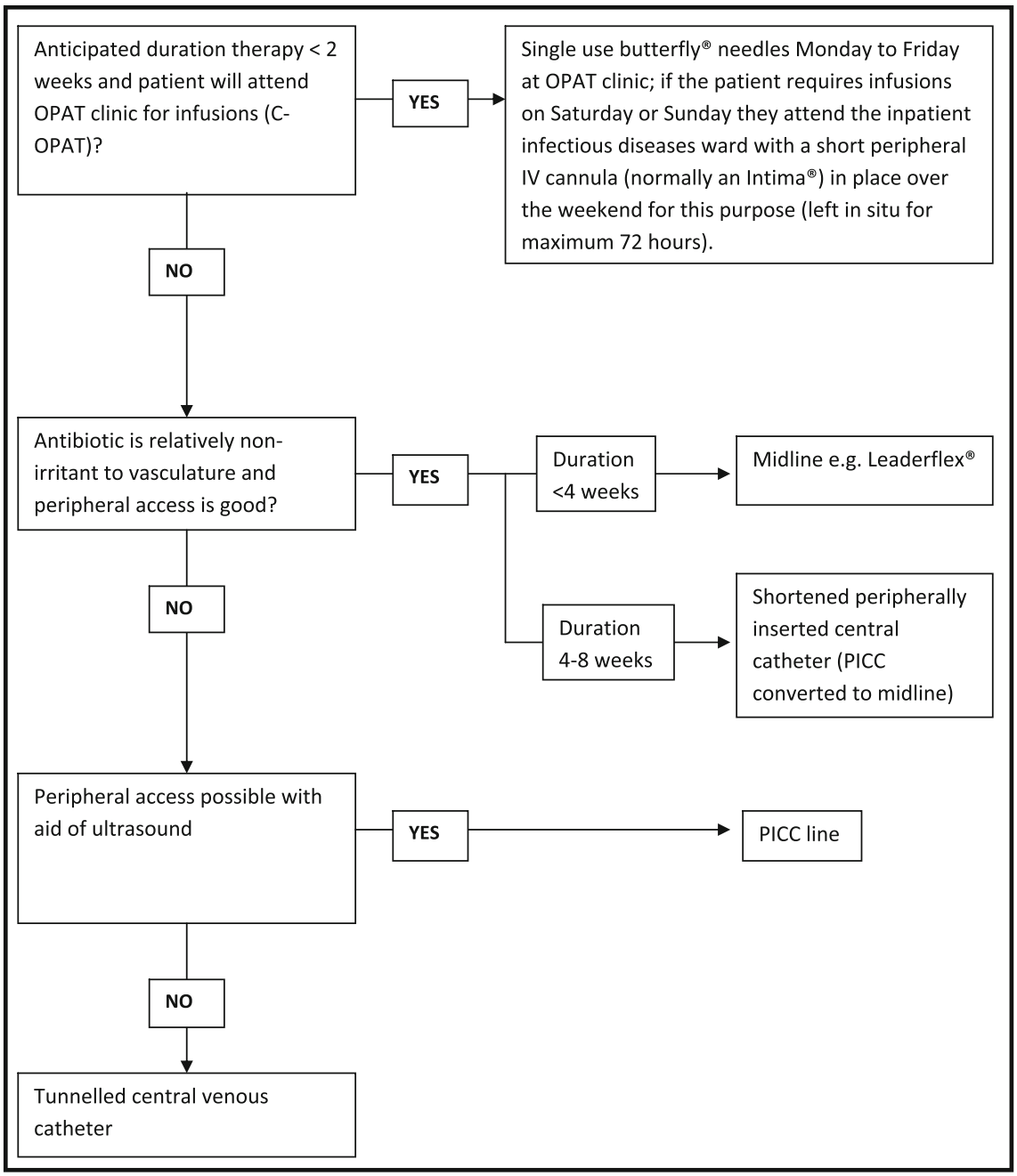


**Fig. 1** Flow chart describing IV access device selection in Glasgow OPAT service

Mann-Whitney U test were used for non-parametric variables with unequal variances. All probabilities were two tailed and considered significant at p value 0.05 level, or having a trend towards significance if $p<0.10$. Statistically significant variables or those with trends towards significance between the groups in univariate analysis were entered as potential confounders in a multivariate logistic regression model. This examined the effect of S-OPAT versus C-OPAT on the logged odds of line complications. Associations of the independent variables with outcome variables found on multivariate analysis are reported as odds ratios with 95% confidence intervals. Overall fit of the logistic regression models generated were assessed using −2 log likelihood and resulting $\chi^2$ statistic, as well as Hosmer-Lemeshow test.

## Ethics statement

Ethical approval for this study was not deemed necessary as the data were routinely collected and analysed for service development, clinical governance and quality assurance purposes.

## Results

For the study period the database recorded 2,766 OPAT patient episodes and 42,238 OPAT patient days, which resulted in 2,814 line episodes. In this whole cohort there were 24 line infections (0.57 per 1,000 OPAT patient days) and 128 other line events (3.03 per 1,000 OPAT patient days). A total of 69% of line episodes involved butterfly® devices and short peripheral IV lines, 23% utilised midlines, 5% TCVCs, 1.5% PICCs, and 1% other access modalities (e.g. intramuscular injections, Portacath®). Therefore, 1,960 line episodes were excluded as used delivery method excluded from this study, and 854 midline, PICC or TCVC (indwelling) line episodes, totalling 25,292 days of IV infusion, were included in analysis.

As expected these 854 line episodes contained the majority of line infections and other line events. Twenty patients were recorded as having clinically diagnosed line infections (local infection or IV catheter associated blood stream infection), i.e. 2.3% of all indwelling line episodes (95%CI 1.4–3.5%) and incidence of 0.79 per 1,000 line use days (95%CI 0.68–0.91). All these patients had line tips and peripheral blood sent for culture; 12 had at least one positive culture (Table 1). Only one patient had a positive culture of the same organism for both line tip and peripheral blood (therefore meeting the 2009 Infectious Diseases Society of America definition of catheter related blood stream infection) [11]. There were no confirmed episodes of catheter associated *Staphylococcus aureus* bacteraemia. Recorded incidence of other line events was 125 out of 854 indwelling line episodes, i.e. 14.6% (95%CI 12.3–17.1%) and incidence 4.9 per 1,000 indwelling line use days (95%CI 4.68–5.21). Characteristics of the Glasgow OPAT cohort, including range of conditions treated and intravenous agents used, have been described elsewhere [8].

**Table 1** Positive microbiology results associated with clinically diagnosed line infection

| Organism | Peripheral blood cultures only | Line tip culture only | Both peripheral blood and line tip culture |
|---|---|---|---|
| Coagulase negative *Staphylococcus* | 3 | 1 | 1 |
| *Serratiasp* | 1 | 1 | 0 |
| *Stenotrophomonas sp* | 1 | 0 | 0 |
| *E. coli* | 0 | 1 | 0 |
| *Enterobacter* | 0 | 1 | 0 |
| "Non-lactose fermenting coliform" | 0 | 1 | 0 |
| *Candida sp* | 1 | 0 | 0 |
| Mixed growth[a] | 1 | 0 | 0 |
| Total | 7 | 5 | 1 |

[a] Coagulase negative *Staphylococcus*, *Enterococcus* species, and unidentified aerobic gram positive bacillus

### Univariate analysis for line infection

On univariate analysis male sex was associated with lower rate of line infection (OR 0.35, $p=0.0449$). Length of intravenous course (number of days line used) tended to be higher in cases of line infection compared to line episodes without infection (median 44 days versus 38 days, $p=0.0408$). Compared to midlines, TCVC lines were more likely to be associated with infection (OR 3.02, 95%CI 1.21–7.53) and PICC lines had a lower infection rate (OR 0.60) but with 95%CI crossing 1.0 (0.03–10.24). P value based on $\chi^2$ value for 3×2 contingency table of line type was significant at 0.0225.

The odds ratio associated with S-OPAT compared to C-OPAT suggests lower rate of infection in those self-administrating IV agents at home, but did not reach statistical significance. No other independent variable considered met statistical significance for association with line infection (Table 2).

### Multivariate analysis for line infection

Logistic regression (multivariate) modelling was used to assess if there was association of S-OPAT of OPAT with occurrence of line infection in this cohort, after inclusion of variables found to be significant on univariate analysis as potential confounders (i.e. patient sex, line type and length of IV course). In this model, only length of IV course was a statistically significant predictor of line infection, with OR 1.012 (95%CI 1.001–1.023). This equates to a 1.2% increase in odds of line infection per additional day of length of line use. S-OPAT again had an OR below 1.0 but was not significant at the 0.05 level (Table 2).

#### *Univariate analysis for other line event (OLE)*

On univariate analysis S-OPAT was associated with OLE when compared to C-OPAT (OR 1.62 [95%CI 1.06–2.46, $p=0.0318$]). In addition, presence of comorbidity was associated with lower risk of OLE (OR 0.60, $p=0.04$) with a similar trend for presence of diabetes which did not reach statistical significance. Line type was a significant predictor of OLE, with p value<0.0001 for $\chi^2$ test on 3×2 contingency table of the three line types. TCVC line compared to midline had a OR of 0.06 (95% CI 0.01–0.25) and PICC compared to midline OR was 0.34 (95%CI 0.10–1.11). There was a trend towards younger age in those with OLE (median age for no OLE 56.1 years, median age for OLE 50.9 years, $p=0.0536$). Finally, both vancomycin and flucloxicillin use were associated with

**Table 2** Comparison of independent variables for line episodes with or without line infection

| Categorical Variables | Odds line infection | Probability of line infection | Univariate analysis | | | Multivariate analysis | |
|---|---|---|---|---|---|---|---|
| | | | OR | 95% CI for OR | P value | OR | P value |
| Male | 6/460 | 1.3% | 0.3484 | 0.1326 to 0.9156 | 0.0449 | 0.3834 | 0.0556 |
| Female | 14/374 | 3.6% | | | | | |
| Diabetic | 2/123 | 1.6% | 0.6423 | 0.1472 to 2.8029 | 0.7844 | _ | _ |
| Non-diabetic | 18/711 | 2.5% | | | | | |
| Any comorbidity | 18/701 | 2.5% | 1.7076 | 0.3916 to 7.446 | 0.6816 | _ | _ |
| No comorbidity | 2/133 | 1.5% | | | | | |
| S-OPAT | 11/532 | 2.0% | 0.6846 | 0.2805 to 1.671 | 0.362 | 0.8422 | 0.7181 |
| C-OPAT | 9/298 | 2.9% | | | | | |
| **Multilevel categorical variable** | **Odds line infection** | **Probability of line infection** | **Univariate analysis** | | | **Multivariate analysis** | |
| | | | **Chi squared statistic for 3x2** | | **P value** | **OR** | **P value** |
| Midline (reference) | 12/648 | 1.8% | | | | _ | _ |
| TCVC | 8/143 | 5.3% | 7.592 | | 0.0225 | 2.0467 | 0.1595 |
| PICC | 0/43 | 0.0% | | | | 0.0000 | 0.9944 |
| **Continuous Variables** | **No line infection** | **Line infection** | **Univariate analysis** | | | **Multivariate analysis** | |
| | | | **P value** | | | **OR** | **P value** |
| Age in years, median (IQR) | 55.6 (42.4 to 66.6) | 58.0 (49.2 to 69.5) | 0.5736 | | | _ | _ |
| Length IV course in days, median (IQR) | 38 (20 to 49) | 44 (31.5 to 82.0) | 0.0408 | | | 1.0119 | 0.0373 |
| OPAT experience in years from 2001, median (IQR) | 6.4 (4.5 to 8.0) | 6.5 (5.6 to 8.2) | 0.9908 | | | _ | _ |

*S-OPAT* self or carer administered infusions in patient's home, *C-OPAT* infusions administered in OPAT clinic by staff, *TCVC* tunnelled central venous catheter, *PICC* peripherally inserted central catheter, *IQR* interquartile range, *OR* odds ratio, *95% CI* 95% confidence interval

Univariate analysis of all variables; selected variables entered into multivariate analysis (logistic regression model)

higher rates of OLE, but neither reached statistical significance at the 0.05 level. Results are summarised in Table 3.

*Multivariate analysis for other line event (OLE)*

As with line infection, multivariate modelling was used to assess if S-OPAT was associated with OLE after correction for potential confounders. To this end, variables which were statistically significant or had a trend towards statistical significance on univariate analysis were entered into a logistic regression model. These variables were presence of comorbidity, use of flucloxicillin, line type, and age of patient (presence of diabetes was not included as it was covariate with presence of any comorbidity).

On this model S-OPAT was no longer associated with OLE (Table 3). Line type remained significant on multivariate analysis. Compared to midline, TCVC line was associated with OR of 0.068 (95%CI 0.017–0.281). PICC line showed a similar trend (OR 0.343) but did not reach statistical significance (95%CI for OR 0.104–1.129). Flucloxicillin use, with odds ratio 3.0, became a statistically significant predictor of OLE in the multivariate model ($p$=0.01).

## Discussion

In this analysis of line events limited to midlines, PICCs and TCVCs, infections occurred in 2.3% of all line episodes (0.8 per 1000 line use days) and other line events (OLEs) were recorded in 14.6% of all line episodes (4.9 per 1000 line use days). The study intentionally excluded a majority of patients who were managed without indwelling catheter use; consequently, line complication rates reported here are an overestimate compared to the rates seen overall in the service (and therefore differ from previously reported rates).

Reported line complication rates in other OPAT cohorts vary widely, from 0–5% of patient episodes for infection and 0–17% for OLEs (Table 4). Heterogeneity in definitions of line associated infection and OLEs, and heterogeneity of inclusion criteria between OPAT studies, causing numerator and denominator inconsistencies respectively, may account for much of this variability. Observational studies of individual IV access devices in a variety of settings [12–18] and comparative studies of IV catheter devices [19–22] tend to show higher rates of complications than those reported in OPAT cohorts.

A previous UK based study by Matthews et al. compared line complication rates between self-administered and health care professional administered OPAT as part of a large observational study looking at many aspects of their OPAT cohort [6]. Matthews et al. found self-administration was associated with twice as many line complications, but because the complication incidence in the two groups was so low (1.0% and 0.5% of patient episodes respectively), the study was not powered to show a statistically significant difference. In addition, this difference in rates is not controlled for confounding variables, and considers infection / other line events as a single outcome variable for the statistical analysis.

**Table 3** Comparison of independent variables for line episodes with or without other line event (OLE)

| Categorical Variables | Odds OLE | Probability OLE | Univariate analysis | | | Multivariate analysis | |
|---|---|---|---|---|---|---|---|
| | | | OR | 95% CI for OR | P value | OR | P value |
| Male | 64 / 402 | 13.7% | 0.85 | 0.5837 to 1.2478 | 0.4135 | – | – |
| Female | 61 / 327 | 15.7% | | | | | |
| Diabetic | 11 / 114 | 8.8% | 0.52 | 0.2717 to 0.9974 | 0.0627 | – | – |
| Non-diabetic | 114 / 615 | 15.6% | | | | | |
| Any comorbidity | 97 / 622 | 13.5% | 0.60 | 0.3733 to 0.9515 | 0.04 | 0.7491 | 0.2662 |
| No comorbidity | 28 / 107 | 20.7% | | | | | |
| S-OPAT | 91 / 452 | 16.8% | 1.62 | 1.0604 to 2.4643 | 0.0318 | 1.3174 | 0.2215 |
| C-OPAT | 34 / 273 | 11.1% | | | | | |
| No flucloxacillin use | 112 / 701 | - | 2.24 | 1.0569 to 4.7279 | 0.065 | 3.0054 | 0.0105 |
| Flucloxacillin use | 10 / 28 | 26.3% | | | | | |
| No vancomycin use | 120 / 720 | - | 3.00 | 0.5435 to16.56 | 0.460 | – | – |
| Vancomycin use | 2 / 4 | 33.3% | | | | | |
| **Multilevel categorical variable** | **Odds OLE** | **Probability OLE** | **Univariate analysis** | | | **Multivariate analysis** | |
| | | | **Chi squared statistic for rxc** | | **P value** | **OR** | **P value** |
| Midline (reference) | 120 / 540 | 18.2% | | | | – | – |
| TCVC | 2 / 149 | 1.3% | 30.074 | | < 0.0001 | 0.0631 | 0.0001 |
| PICC | 3 / 40 | 7.0% | | | | 0.2428 | 0.0272 |
| **Continuous Variables** | **No OLE** | **OLE** | **Univariate analysis** | | | **Multivariate analysis** | |
| | | | **P value** | | | **OR** | **P value** |
| Age in years, median (IQR) | 56.1 (43.1 to 66.9) | 50.9 (46.8 to 56.7) | 0.0536 | | | 0.9972 | 0.6519 |
| Length IV course in days, median (IQR) | 38.0 (35.0 to 41.0) | 40.0 (34.0 to 42.0) | 0.6012 | | | – | – |
| OPAT experience in years from 2001, median (IQR) | 6.4(4.4 to 8.7) | 6.9 (5.1 to 8.8) | 0.1154 | | | – | – |

*S-OPAT* self or carer administered infusions in patient's home, *C-OPAT* infusions administered in OPAT clinic by staff, *TCVC* tunnelled central venous catheter, *PICC* peripherally inserted central catheter, *IQR* interquartile range, *OR* odds ratio, *95% CI* 95% confidence interval

Univariate analysis of all variables; selected variables entered into multivariate analysis (logistic regression model)

In the present study we attempt to examine the effect of self-administration of IV antibiotics in the home on line complication rates after controlling for confounding by other significant variables. To our knowledge this is the first OPAT study to assess effect of self-administration on risk of line complications using a multivariate model. We observed different variables associated with line infections compared to other line events suggesting these two sets of complications do have different aetiologies, and we have investigated them as separate dependent variables.

On univariate analysis, line infections were associated with length of line use, female sex and TCVC lines (compared to midlines). However, only length of line use remained significant on multivariate analysis as a predictor of line infections. This fits with meta-analysis data which suggests that midlines are associated with much lower rates of infection per *number of devices* used compared to central lines, but that this effect is markedly reduced or nil when rates per *days* of catheter use are considered (thus controlling for length of use as a confounder) [19, 22].

There was a trend towards lower rates of line infection in patients self-administering OPAT in the home environment compared to those attending hospital (OPAT clinic) for administration, but this trend did not reach statistical significance. Infusion of outpatient IV therapy outside of home environment (i.e. in a clinic or physician office) has been associated with higher rates of blood stream infection in a previous multisite prospective cohort study from North America [23]. In that study a significantly higher rate of infection was found than in the Glasgow OPAT cohort; this raises the possibility that the low rate of infection resulted in insufficient power to detect a real reduction in IV catheter infection with self-administration of OPAT in the home setting.

In addition to the limitation posed by this risk of type 2 error, the low incidence of catheter associated infection found in this cohort may limit the validity of the multivariate (logistic regression) analysis in more unpredictable ways [24]. A larger study, which included H-OPAT patients (with OPAT administered in the home by health care professionals) as a control group is needed to assess the importance of home environment in reducing risk of vascular access device infection.

Positive microbiology in line infection cases showed a high proportion of gram negative organisms. This may reflect colonisation in the context of predominant gram positive therapy in OPAT patients.

Other line events—including chemical or mechanical phlebitis, external leakage, extravasation, occlusion (thrombotic or non-thrombotic), and if the line fell out or was removed non-electively—occurred more frequently. While not generally as potentially serious as infection, other line events can be associated with significant morbidity, increased health care costs, interruption in treatment, and unscheduled hospitalisation. Use of flucoloxicillin and type of intravenous catheter used were found to be independent predictors of other line events

**Table 4** Intravenous access device complications reported for other OPAT cohorts. Where necessary proportions and rates have been calculated from published figures. 95% confidence intervals have been calculated post-hoc in all cases, i.e. they are not reported in original publications

| Reference | Delivery model | Number: patient episodes | Line infections / 100 patient episodes (95%CI) | OLE / 100 device or patient episodes (95%CI) | Number: patient or device days | Line infections / 1000 patient or device days (95%CI) | OLE / 1000 patient or device days (95%CI) |
|---|---|---|---|---|---|---|---|
| Amodeo et al. 2009 [25] | H-OPAT in 75%; S-OPAT in 25% | 100 | 1.0 (0.03–5.5) | 10 (4.9–17.6) | n/a | n/a | n/a |
| Bernard et al. 2001 [26] | H-OPAT and S-OPAT, both using infusion pumps | 39 | 0 (0.0–9.0) | 7.7 (1.6–20.8) | n/a | n/a | n/a |
| Fisher et al. 2006 [27] | C-OPAT in 99%, with use of infusion pump in half of these; S-OPAT in 1% | 225 | 0 (0.0–1.6) | 0.9 (0.1–3.2) | 4050 | 0 (0.0–0.9) | 0.5 (0.06–1.8) |
| Hitchcock et al. 2009 [28] | 79.5% H-OPAT; 18.5% C-OPAT; 2% S-OPAT | 303 | 0.33 (0.01–1.8) | 1 (0.2–2.9) | 7349 | 0.16 (0.00–0.8) | 0.41 (0.08–1.2) |
| Hoffman-Terry et al. 1999 [29] | Predominantly S-OPAT | 291 | 3.4 (1.6–6.2) | 6.2 (3.7–9.6) | 11640 | 0.86 (0.4–1.6) | 1.5 (0.9–2.4) |
| Kieran et al. 2009 [4] | S-OPAT in 80%; H-OPAT in 20% | 60 | 3.3 (0.4–11.5) | 5 (1.0–13.9) | 1289 | 1.6 (0.19–5.60) | 2.3 (0.5–6.8) |
| Lin et al. 2005 [30] | n/a | 177 | 0.6 (0.02–3.2) | 1.7 (0.4–4.9) | n/a | n/a | n/a |
| Matthews et al. 2007 [6] | H-OPAT in 75%; S-OPAT in 25% approximate | 2059 | 0.1 (0.01–0.4) | 0.5 (0.2–0.9) | n/a | n/a | n/a |
| Nathwani et al. 2001 [31] | C-OPAT and S-OPAT | 125 | 0 (0.0–2.9) | 0 (0.0–2.9) | 665 | 0 (0.0–5.6) | 0 (0.0–5.6) |
| Upton et al. 2004 [3] | Predominantly S-OPAT | 100 | 5.0 (1.6–11.3) | 17 (10.2–25.8) | 4130 | 1.2 (0.4–2.8) | 4.1 (2.4–6.6) |

*OLE* other line event (any reported IV access device event not considered to be catheter associated infection by authors of reports, *95% CI* 95% confidence intervals for single proportion or single rate respectively, *C-OPAT OPAT* administered with patient visiting an OPAT clinic or 'infusion centre', *H-OPAT OPAT* administered in patients home by a visiting health care professional, *S-OPAT OPAT* self-administered at home (or by a carer), *n/a* not available

Line infection includes catheter-associated BSI and/or local infection at catheter site, defined by authors of reports

on multivariate analysis. Midlines have been found to have increased rates of line events—particularly occlusion and mechanical phlebitis—versus central access intravenous catheters in comparative studies, with similar hazard ratios to those found in this cohort [20, 21]. The association of flucloxacillin with OLEs may reflect the frequency of its administration (4 times daily) in our practice where continuous infusion of antibiotic therapy is currently not available. It was not possible to evaluate the role of frequency of administration *per se* as other multiply daily dosed antibiotic use excepting flucloxacillin was very infrequent in this cohort.

Self-administration of infusions in the home was found to be a risk factor for non-infection catheter complications (other line events) on univariate analysis, but this effect became non-significant after controlling for presence of comorbidity, age of patient and type of IV access device.

Limitations of the study include the retrospective observational design. Without randomisation there is a possibility of unrecognised confounding bias. Variables of potential interest which were not accurately recorded (for example, method of infusion, such as gravity versus pump) could not be included in the analysis. Also, as the design relies on historical diagnosis of line complications rather than prospectively and consistently applied definitions of line events, there is a risk of reporting bias, as well as underestimation of minor adverse events. However, the use of a prospectively and systematically maintained electronic database rather than case note review may have reduced the potential for these biases.

## Conclusion

There is no evidence that home-based self or carer administration of intravenous antimicrobial agents is associated with increased line complication rates in this cohort. This adds to the observational data suggesting self or carer administration of OPAT in the home environment is safe. Quality assurance in OPAT cohorts should consider line infections and other line complications separately when analysing and reporting outcomes.

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**Conflict of interest** The authors declare that they have no conflict of interest.

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