Developing a **R**esearch base for **I**ntravenous **P**eripheral catheter dwell times. The DRIP Trial.

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ABSTRACT

Objective: To assess the safety of changing peripheral venous cannulas only when complications occur.

Design: Randomised controlled trial

Setting: A tertiary referral hospital in Brisbane, Australia

Participants: 206 hospitalised patients from surgical, medical and orthopaedic wards

Interventions: Peripheral intravenous cannulas were re-sited only when complications occurred (intervention group) or every 3 days (control group).

Main outcome measures: The primary endpoint was a composite measure of complications leading to an unplanned cannula removal, the secondary outcome was cost.

Results: Forty six patients had unplanned removals in the intervention group compared with 41 in the control group [relative risk 1.12, 95% confidence interval 0.81 to 1.55 (p = 0.286)]. Total duration of peripheral cannulation was similar in both groups (mean 123.3 hours in the intervention group and 125.9 hours in the control group: P = 0.82) but significantly more re-sites occurred in the control group (167 in intervention group, 202 in the control group: p = 0.022). Cost of cannula replacements in the intervention group was AUD$3,183.62 and in the control group AUD$3,837.56 (p = 0.006). After adjustment for other risk factors, frequency of cannulation [odds ratio (OR) 0.78. 95% confidence interval (CI) 0.27 – 0.22], total duration of cannulation (OR 1.01. CI 1.00 – 1.02) and irritability of IV medications other than antibiotics (OR 0.45, CI 0.21 – 0.97) were positively associated with unplanned cannula removal.

Conclusion: It is safe for competent staff to re-site peripheral venous cannulas when a complication occurs rather than changing them routinely every 3 days.

Introduction

Among hospitalised patients, intravenous therapy is the most common invasive procedure. It is associated with a phlebitis rate of between 1.1% and 63% [1-7] and a intravenous catheter related bacteraemia rate of approximately 0.8%.[8] Current guidelines recommend that peripheral intravenous catheters should be re-sited every 72-96 hours[9] to restrict infection potential, and most hospitals follow this recommendation. However, recent observational studies have challenged the need for such frequent re-sites. [6, 10-13] In fact there is some evidence to suggest that the risk of infection may be higher with 3-day changes compared with longer dwell times because skin integrity is breached more often. [11]

Most of the studies in this area to date have used retrospective or prospective observational designs. Our primary objective was to assess the safety of prolonging the time between intravenous cannula re-sites using more rigorous methods.

Method

Study population

Human Research Ethics Committee gave approval to conduct the trial. Participants were eligible for the DRIP trial if they were inpatients at the Royal Brisbane and Royal Women's Hospital, were at least 18 years of age and expected to have a peripheral venous catheter indwelling for at least 4 days. The trial was controversial as it contravened existing guidelines, so we restricted entry to those who had their cannula inserted by a nurse from the IV Therapy Team. This enabled us to standardise insertion methods and closely monitor insertion sites. We excluded patients with an existing bloodstream infection and those receiving immunosupressive treatment. At the time of peripheral catheter insertion, all potentially eligible participants were given a trial information leaflet outlining the study. Within 72 hours they were asked for their written consent.

Intervention

The intervention group had their peripheral venous catheter re-sited when clinically indicated by either phlebitis, local infection, bacteraemia, infiltration or blockage. The control group had a new peripheral venous catheter re-located to a different site every 3 days (or if clinically indicated if less than 3 days). A member of the IV Unit was responsible for inserting all initial and replacement catheters. Choice of catheter type and gauge was at the discretion of the nurse inserting the catheter. Catheter insertion sites were inspected daily by a nurse from the IV Unit and by ward nurses according to usual practice as part of their usual practice (eg during 'routine observations' and when IV solutions were changed or when medications added). For all study participants the following characteristics were collected at baseline: age, sex, diagnosis at hospital admission, ward in which the patient was being treated, severity of risk of infection based on Tagar et al's classifications, [3] any co-morbid medical conditions, whether or not the patient was immunosupressed (defined as an absolute leucocyte count of less than 1,000/uL on the day of insertion, [12] presence of infection at any site (as noted in the medical record), type of surgery (if applicable), antibiotic therapy, presence of any other vascular device or presence of an indwelling urinary catheter. At the time of the original cannula insertion and for each re-site the following information was collected: type of infusate and any additives, names of all medications injected into the IV set, type and size of catheter used and insertion site. All medications and infusates were graded on an 'irritability scale'. [13] The scale, which was modified for the study by our hospital pharmacist to include medications received by patients during the study, ranged between 1 (least irritable) and 4 (most irritibale). If the patient was receiving more than one additive, we recorded the one with the highest irritability score. Vein quality was classified by IV Unit staff on a 6-point scale from 'extremely limited' to 'good' in line with their usual practice. Participants were monitored for the total infusion period and followed until 48 hours after catheter removal or until discharge. Times and dates of insertion and removal were recorded. Unexpected serious adverse events occuring during the period of hospitalisation were notified to the Chief Investigator within 24 hours and a report prepared for the Human Research Ethics Committee.

Primary outcome measure

We used a composite measure of any unplanned reason for cannula removal. That is, if the cannula was removed for any of the following reasons, the patient was considered to have had an 'unplanned' cannula removal i) leakage around the cannula; ii) infiltration (defined as permeation of non-vesicant IV fluid into the interstial compartment, causing swelling of the tissue around the site of the catheter); iii) erythema; iv) occlusion/blockage; v) pain; vi) accidental removal; vii) local infection at the site of the catheter (defined as erythema with cellulitis at the site or pus); viii) phlebitis (defined as the presence of two or more of the following: pain, tenderness, warmth, erythema, swelling, and a palpable cord [8, 11, 14] during the course of the infusion and up to 48 hours after peripheral venous catheter removal) or ix) catheter-related blood stream infection (based on the isolation of a phenotypically identical organism from a catheter segment and a blood culture). [12]

Secondary outcome Measure

Cost

Cost was calculated in two ways, costs associated with cannulas inserted for the administration of intermittent IV medication and cost associated with IV cannulas inserted for continuous infusion. For the first group, which we estimated to be 25% of the population we calculated a total cost of AUD $14.26. This included 20 minutes nursing time @ AUD $9.00 (locating patient, preparation and insertion), a cannula @ $1.20AUD, a 3 way tap @ AUD $2.15, a basic dressing pack @ AUD $0.54c, a syringe @ AUD $0.13c, transparent adhesive dressing @ AUD $0.74c, skin disinfection AUD $0.05c and local anaesthetic AUD $0.34c per insertion. For patients receiving a continuous infusion we calculated a total cost of AUD $21.26 per insertion. This included all the above costs plus the additional cost of replacing all associated lines, solutions and additives which are discarded when a cannula is changed (ie intravenous administration set @ AUD $5.50 and 1 litre Sodium Chloride 0.09% @ AUD $1.50.

Sample size

We based our sample size on an estimated 40% rate of unplanned cannula removals (estimate from the IV Unit leader). We calculated that a sample size of 105 in each arm of the study would be needed to detect a 50% reduction in the primary outcome measure (two tailed, α = 0.05, power 80%).

Randomisation and blinding

Randomisation was by a computer generated random number list, stratified by oncology status. Allocation to the control or treatment group was made by phoning a person who was independent of the recruitment process and blind to baseline clinical data. The person assessing the outcome (a nurse from the IV Unit) was not blinded to the study group but was unassociated with the the study.

Microbial analysis

In line with hospital policy, microbiological evaluation of catheters was not undertaken routinely, due to the extremely rare incidence of peripheral vein catheter-related blood stream infection. [3, 15] However, if a catheter was removed for phlebitis or a suspected catheter-related infection and there was pus at the site, staff were asked to take a skin culture around the puncture site and cut a 3cm segment from the catheter tip. Specimens collected according to hospital protcol were to be forwarded to the laboratory for standard testing,

Statistical analysis

We conducted an intention to treat analysis. We analysed the primary outcome using the 2-sided Fisher's Exact test and results are presented as relative risks with 95% confidence intervals. A Student's *t*-test comparison of intervention versus control was used for the secondary outcome. In further analyses, results from all participants were combined and divided into two groups, those requiring an unplanned re-site and those not requiring an unplanned re-site, to test for risk factors associated with unplanned cannula removal.

Categories of some variables (eg site of cannula insertion, vein quality and level of irritability of solutions and medications) contained small numbers and were collapsed into 2 categories for the analysis. The two groups were first compared using univariate statistical tests, *t*-test, χ^2 test or Fisher's exact test when applicable. Following this, logistic regression analysis was used to determine the strength of association of each variable after adjusting for the rest of the variables. Only those variables that were significant in the univariate analysis, and were felt to be clinically reasonable were included into the logistic model. The enter method was used to determine the effect of each factor in the presence of all other factors. Odds ratios and 95% confidence limits are reported. All statistical data were analysed using SPSS (Version 12.0, SPSS, INC, Chicago, IL). The CONSORT guidelines were followed from the point of eligibility. Statistical results are all 2-tailed.

Results

Between April 2004 and November 2004 we assessed 1,240 patients who were potentially eligible for the study. Amost half (n = 533) did not meet eligibility criteria and a further 501 were excluded for other reasons (Fig 2). Table 1 shows the characteristics of the groups at baseline. Patients enrolled were mostly elderly and over half had at least 2 co-morbid medical conditions. Characteristics associated with IV cannulation are shown in Table 2. There were no statistically significant differences between groups at baseline.

Primary outcome

A total of 368 cannulas were inserted in the 206 participants. Forty six patients (44.6%) in the intervention group had an unplanned cannula removal compared with 41 (39.8%) in the control group [relative risk 1.12, 95% confidence interval 0.81 to 1.55 (p = 0.286)]. The total duration of peripheral cannulation was similar in both groups (mean 123.3 hours, SD 88.9 hours in the intervention group and 125.9 hours, SD 73.0 hours in the control group: p = 0.82) but significantly more re-sites occurred in the control group (intervention group 103, control

group 161: p = 0.022). Infiltration was the most frequent reason for removal (n = 89) and erythema the least frequent (n = 4). Phlebitis was diagnosed on only 3 occasions, twice in the control group and once in the intervention group with each of these patients having a concurrent infection (one wound infection and two with cellulitis), they were all on antibiotic therapy and their cannulas had been in situ for an average of 48.7 hours (range 25 – 77 hours). Despite instructions in the study protocol, none of the cannula tips from these patients were sent for microbiological examination. There were no reported cases of bacteremia or local infection during the study.

Secondary Outcome

There was a significant difference in cost between the two groups (p = 0.006). The total cost of cannula changes for the 103 patients in the control group was AUD$3,837.56 compared with the total cost for the 103 patients in the intervention group of AUD$3,183.62.

Other analysis

When we combined all of the data a number of variable s were associated with unplanned cannula removal, these are shown in Tables 3 and 4. When these variables were included in a logistic regression model, only frequency of cannula change (p = < 0.000), longer duration of cannulation (p = 0.008) and the irritability of IV medications other than antibiotics (p = 0.042) remained statistically associated with unplanned cannula removal.

Discussion

Primary outcome

The prospective randomised controlled design of the study has allowed us to compare the effects of re-siting intravenous peripheral cannulas when clinically indicated, with the standard practice of re-siting them every three days. Results show that outcomes are similar in both groups. This concurs with several other prospective, but not randomised studies in which the authors were unable to demonstrate any increased risk of phlebitis beyond the

second day of cannulation. [10, 11] Conversely, our results are at odds with a recent randomised study where 42.3% of participants in a 'change when clinically indicated group' developed phlebitis compared with 4.8% in a 2-day change group.[16] However there were a number of methodological flaws with that study. It was very small; only 47 participants were included with no indication of how the sample size was determined. In addition, the principal investigator, who was not blinded to group allocation, was responsible for classifying the outcome, providing a potential for reporting bias. Additionally, the phlebitis rate in the 'change when clinically indicated group' was much higher than those reported in well conducted clinical studies.

Secondary outcome

Costings used in our study indicate that changing cannulas only when complications occur would reduce peripheral IV related expenditure by at least 17%. We project an annual cost benefit of approximately AUD $60,300 if cannulas re-sited by the IV Unit are replaced only when clinically indicated. Cost savings would be much higher if this policy were to be adopted in other areas of the hospital, where the IV Unit are not currently responsible for cannula changes. Our estimates were very conservative, derived from the cost of a basic saline infusion and not including the cost of any other IV additives, IV analgesics or IV antibiotics, which may need replacing along with the re-site. In trials where there are no differences between intervention and control outcomes, the option with a lower cost should be chosen. In this case, the weight of evidence from recent studies along with our own findings indicates that the practice of routine 3-day peripheral cannula changes should be re-considered, at least in settings where well trained staff operating in an IV service exists. Further research is required to test if these benefits are sustained when a cannula is inserted by other hospital staff.

Other outcomes

None of the participants in the study developed bacteremia and our phlebitis rate for cannulas inserted by the IV Unit was extremely low at 1.5%. The revised Intravenous Nurses Society Standards of Practice [17] states the incidence of peripheral vein infusion thrombophlebitis should be no more than 5% in any population but most studies have cited higher rates. [2-7] Our low phlebitis rate prevents any meaningful correlations with risk factors but it was interesting to note that each of those with a documented phlebitis had a co-existing infection which was being treated with antibiotics. We could find only one other study reporting an association between phlebitis and an infected site remote from the cannula but, in that study, only 5.9% of potential sources of catheter related infections were attributed to a co-existing infection.[18] However there is very good evidence from the infection control literature of the relationship between wound infection and remote site infections [19] and this adds plausibility to the finding. Future research in the area should include information about existing infections.

After adjustment, three risk factors remained associated with unplanned cannula removal in our study. Of these the total number of cannulas inserted during the period of hospitalisation was the most predictive. This was independent of the effect of the total cannulation period or any other risk factor. We also found that each of the participants who developed phlebitis did so within 77 hours of cannula insertion. Our finding is consistent with other investigators who have shown that the risk of phlebitis is highest on the second day after insertion and the day specific infection rate does not increase thereafter. [10, 11] This supports the notion that each time the skin integrity is broken there is a further opportunity for organisms to be introduced and cause local or systemic infection.

Taken together, results from recent studies, including our own, challenge the most recent recommendation for the prevention of intravascular catheter- related infections which states that "peripheral intravenous catheters should be replaced at least every 72-96 hours in adults to prevent phlebitis". [9, p762] When we reviewed the source of this recommendation we found that it was supported by only one study, published in 1998 and based on data collected in

1992.[15] It is at odds with recommendations for central venous catheters, peripheral arterial catheters or peripheral venous catheters in children where current guidelines read "Leave peripheral venous catheters in place in children until intravenous therapy is completed, unless complications (eg phlebitis and infiltration) occur." (p762).[9] In light of recent evidence, it is perhaps timely for guidelines recommending the frequency of changes in adults to be re-visited.

Although a large number of patients were ineligible for the study, approximately half of these were because it was not anticipated that their cannula would remain in situ for more than 3 days, or because the cannula had been in place for more than 48 hours before they were able to be enrolled. Neither of these reasons should have affected the results. Of the other reasons for exclusion, having an existing blood stream infection, being immunosuppressed or being too ill to consent would be the only conditions that may impact on results being generalised. However, a large proportion of the patients we studied were quite elderly and many had a number of co-morbidities, making them a vulnerable but typical tertiary hospital population, so we believe our findings remain quite robust. A further study is about to commence in which patients excluded in the current study will be involved.

Cannulation of peripheral veins is a painful yet necessary component of modern medical care. Frequent re-sites are distressing for patients, have a significant cost component and may lead to future venous access difficulties. The present study has shown that the risk of an adverse outcome is unaffected when cannulas are re-sited based on clinical parameters and not on routine and that cost savings may be considerable if cannulas are re-sited only when complications occur.

References

1. Tripepi-Bova KA, Woods KD, Loach MC. A comparison of transparent polyurethane and dry gauze dressings for peripheral i.v. catheter sites: rates of phlebitis, infiltration, and dislodgment by patients. Am. J. Crit. Care. 1997;6(5):377-381.

2. Chee S, Tan W. Reducing infusion phlebitis in Singapore hospitals using extended life end-line filters. J. Infus. Nurs. 2002;25(2):95-104.

3. Tager IB, Ginsberg MB, Ellis SE, Walsh NE, Dupont I, Simchen E, et al. An epidemiologic study of the risks associated with peripheral intravenous catheters. Am J Epidemiol 1983;118(6):839-851.

4. Martinez JA, Fernandez P, Rodriguez E, Sobrino J, Torres M, Nubiola A, et al. Intravenous cannulae: complications arising from their use and analysis of their predisposing factors. Med. Clin. (Barc). 1994;103(3):89-93.

5. Lipsky BA, Peugeot RL, Boyko EJ, Kent DL. A prospective study of Staphylococcus aureus nasal colonization and intravenous therapy-related phlebitis. Arch. Intern. Med. 1992;152(10):2109-2112.

6. White SA. Peripheral intravenous therapy-related phlebitis rates in an adult population. J. Intraven. Nurs. 2001;24(1):19-24.

7. Shimandle RB, Johnson D, Baker M, Stotland N, Karrison T, Arnow PM. Safety of peripheral intravenous catheters in children. Infect Control Hosp Epidemiol. 1999;20(11):736-740.

8. Maki DG, Ringer M. Risk factors for infusion-related phlebitis with small peripheral venous catheters. A randomized controlled trial. Ann. Intern. Med. 1991;114(10):845-854.

9. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. Infect Control Hosp Epidemiol 2002;23(12):759-769.

10. Homer LD, Holmes KR. Risks associated with 72- and 96-hour peripheral intravenous catheter dwell times. J. Intraven. Nurs. 1998;21(5):301-305.

11. Bregenzer T, Conen D, Sakmann P, Widmer AF. Is routine replacement of peripheral intravenous catheters necessary? Arch. Intern. Med. 1998;158(2):151-156.

12. Cornely OA, Bethe U, Pauls R, Waldschmidt D. Peripheral Teflon catheters: factors determining incidence of phlebitis and duration of cannulation. Infect Control Hosp Epidemiol 2002;23(5):249-253.

13. Catney MR, Hillis S, Wakefield B, Simpson L, Domino L, Keller S, et al. Relationship between peripheral intravenous catheter Dwell time and the development of phlebitis and infiltration. J. Infus. Nurs. 2001;24(5):332-341.

14. Monreal M, Oller B, Rodriguez N, Vega J, Torres T, Valero P, et al. Infusion phlebitis in post-operative patients: when and why. Haemostasis. 1999;29(5):247-254.

15. Lai KK. Safety of prolonging peripheral cannula and i.v. tubing use from 72 hours to 96 hours. AJIC 1998;26(1):66-70.

16. Barker P, Anderson AD, MacFie J. Randomised clinical trial of elective re-siting of intravenous cannulae. Ann R Coll Surg Engl 2004;86(4):281-3.

17. Intravenous Nurses Society. Phlebitis:59 [Standards: Infusion-related complications]. J Intraven Nurs 2000;23:S56-57.

18. Diener JR, Coutinho MS, Zoccoli CM. Central venous catheter-related infections in critically ill patients. Rev Assoc Med Bras 1996;42(4):205-14.

19. Edwards LD. The epidemiology of 2056 remote site infections and 1966 surgical wound infections occurring in 1865 patients: a four year study of 40,923 operations at Rush-Presbyterian-St. Luke's Hospital, Chicago. Ann Surg 1976;184(6):758-66.

Figure 1. Patient flow through the trial

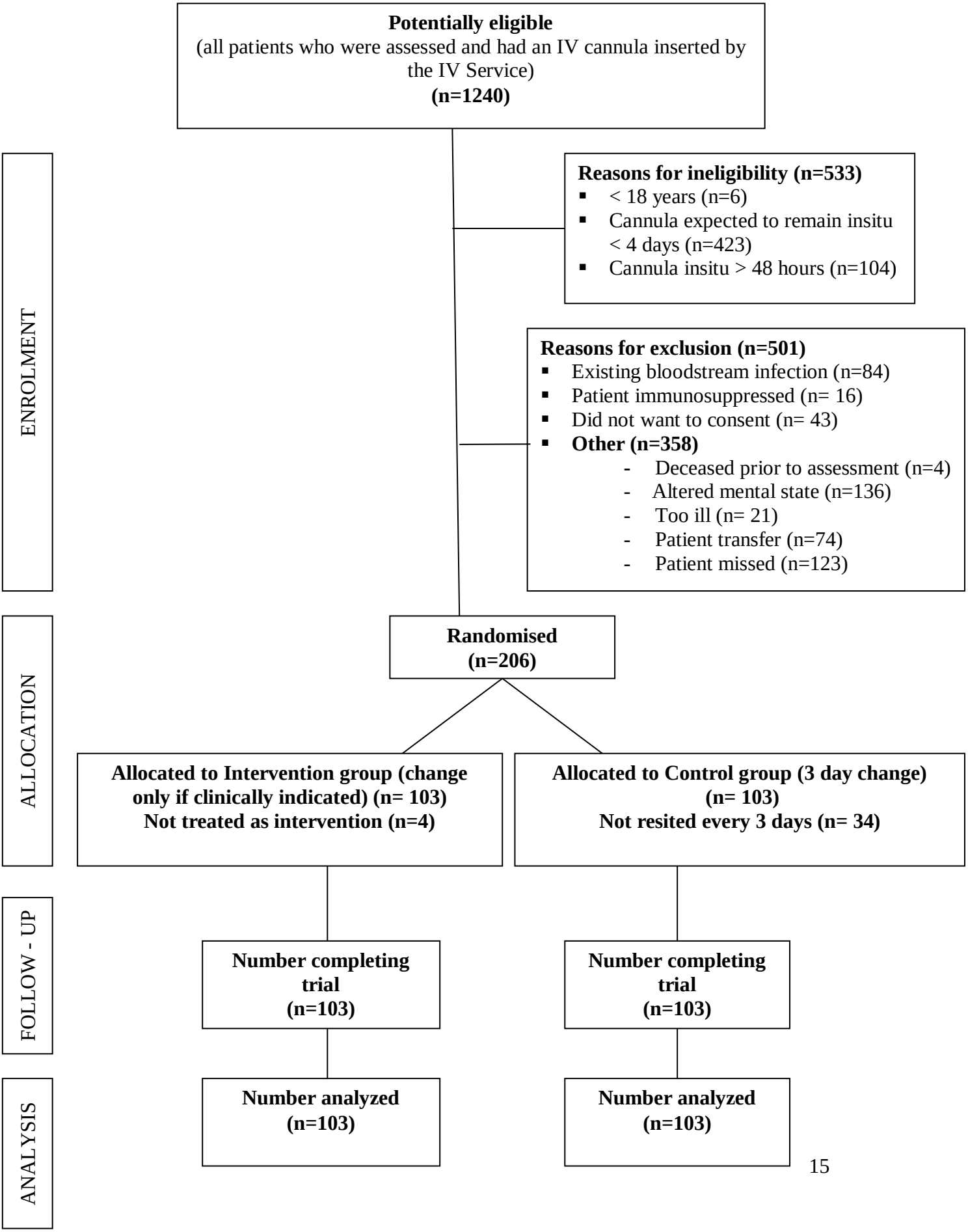

Table 1 – Baseline characteristics of study participants

	No-change (n=103)	3-Day (n=103)	*P*‡
Sex*			
Male	50 (48.5)	49 (47.6)	0.500
Female	53 (51.5)	54 (52.4)	
Mean age in years†	60.22 [16.15]	63.06 [17.30]	0.225
Reason for admission*			
Gastrointestinal	49 (47.6)	47 (45.6)	0.993
Vascular	23 (22.3)	24 (23.3)	
Oncology	12 (11.7)	12 (11.7)	
Other	19 (18.4)	20 (19.4)	
Past medical history*			
Nil	11 (10.7)	6 (5.8)	0.381
1 co-morbid medical condition	27 (26.2)	28 (27.2)	
2 co-morbid medical conditions	36 (35.0)	31 (30.1)	
> 2 co-morbid medical conditions	29 (28.2)	38 (36.9)	
Has current infection*			
Urinary tract	2 (1.9)	7 (6.8)	0.085
Respiratory tract	9 (8.7)	9 (8.7)	0.597
Wound/cellulitis	20 (19.4)	23 (22.3)	0.366
Type of surgery*			
Nil	46 (44.7)	41 (39.8)	0.913
Gastrointestinal	30 (29.1)	31 (30.1)	

Vascular	13 (12.6)	17 (16.5)	
Other	8 (7.8)	7 (6.8)	
> 1 operation	6 (5.8)	7 (6.8)	
Most recent Hb – mean (g/dL) †	119.98 [19.08]	119.13 [17.04]	0.426
Past history of phlebitis*	5 (4.9)	3 (2.9)	0.361
Indwelling urinary catheter*	24 (23.3)	19 (18.4)	0.247

* Results expressed as number and (percent)

† Results presented as mean and [standard deviation]

‡ Chi square for proportions or Student's *t* test for continuous variables

Table 2. Infusion related characteristics of study participants

	No-change (n=103)	3-Day (n=103)	*P*‡
IV cannula gauge*			
20 gauge	61 (59.2)	59 (57.3)	0.789
22 gauge	40 (38.8)	43 (41.7)	
Other	2 (1.9)	1 (1.0)	
Vein assessment*			
Poor	39 (37.9)	43 (41.7)	0.335
Fair/good	64 (62.1)	60 (58.3)	
Receiving infusate*	82 (79.6)	81 (78.6)	0.500
Mean irritability rating of infusate†	1.77 [0.92]	1.78 [0.91]	0.663
Receiving IV antibiotics*	64 (62.1)	56 (54.4)	0.161
Mean irritability rating of antibiotics†	2.51 [0.73]	2.34 [0.74]	0.615
Receiving other IV medications*	70 (68.0)	68 (66.0)	0.441
Mean irritability of IV medications†	1.42 [0.58]	1.41 [0.64]	0.845
Insertion site of IV cannula*			
All in hand	26 (52.0)	24 (48.0)	0.079
All in forearm	57 (57.0)	43 (43.0)	
Combination of sites	17 (34.7)	32 (65.3)	
Other	3 (42.9)	4 (57.1)	
Other vascular device in situ*	21 (20.4)	18 (17.5)	0.361

* Results expressed as number and (percent)

† Results presented as mean and [standard deviation]

‡ Chi square for proportions or Student's *t* test for continuous variables

Table 3. General risk factors for unplanned cannula removal

	Unplanned removal (n = 87)	No unplanned removal (n = 119)	*P‡*
Sex*			
Male	35 (35.4)	64 (64.6)	0.067
Female	52 (48.6)	55 (51.4)	
Mean age in years†	66.20 [14.37]	58.31 [17.61]	0.001
Reason for admission*			
Gastrointestinal	38 (39.6)	58 (60.4)	0.122
Vascular	26 (55.3)	21 (44.7)	
Oncology	11 (45.8)	13 (54.2)	
Other	12 (30.8)	27 (69.2)	
Medical history*			
Nil	6 (35.3)	11 (64.7)	0.914
1 co-morbid medical condition	23 (41.8)	32 (58.2)	
2 co-morbid medical conditions	28 (41.8)	39 (58.2)	
> 2 co-morbid medical conditions	30 (44.8)	37 (55.2)	
Urinary tract infection*			
Yes	5 (55.6)	4 (44.4)	0.498
No	82 (41.6)	115 (58.4)	
Respiratory tract*			
Yes	11 (61.1)	7 (38.9)	0.132
No	76 (40.4)	112 (59.6)	
Wound/cellulitis*			
Yes	27 (62.8)	16 (37.2)	0.003
No	60 (36.8)	103 (63.2)	

Surgery*			
Yes	31 (35.6)	56 (64.4)	0.067
No	56 (47.1)	63 (52.9)	
Most recent Hb – mean (g/dL)†	117.33 [17.24]	121.18 [18.50]	0.169
Past history of phlebitis*			
Yes	4 (50.0)	4 (50.0)	0.458
No	83 (41.9)	115 (58.1)	
Indwelling urinary catheter*			
Yes	23 (53.5)	20 (46.5)	0.067
No	64 (39.3)	99 (60.7)	

* Results expressed as number and (percent)

† Results presented as mean and [standard deviation]

‡ Chi square for proportions or Student's *t* test for continuous variables

Table 4. Infusion related risk factors for unplanned cannula removal.

	Unplanned removal (n = 87)	No unplanned removal (n = 119)	*P‡*
IV cannula gauge*			
20 gauge	44 (36.7)	76 (63.3)	0.135
22 gauge	41 (49.4)	42 (50.6)	
Other	2 (66.7)	1 (33.3)	
Vein assessment*			
Poor	42 (51.2)	40 (48.8)	0.024
Fair/good	45 (36.3)	79 (63.7)	
Receiving infusate*			
Yes	70 (42.9)	93 (57.1)	0.411
No	17 (39.5)	26 (60.5)	
Mean irritability rating of IV infusate†	1.72 [0.87]	1.81 [0.95]	0.531
Receiving IV antibiotics*			
Yes	59 (49.2)	61 (50.8)	0.012
No	28 (32.6)	58 (67.4)	
Mean irritability rating of antibiotics†	2.34 (0.74)	2.52 [0.72]	0.166
Receiving other IV medications*			
Yes	63 (45.7)	75 (54.3)	0.102
No	24 (35.3)	44 (64.7)	
Mean irritability of IV medications†	1.55 [0.56]	1.31 [0.63]	0.024
Insertion site of IV cannula*			
Only in hand or wrist	13 (25.5)	38 (74.5)	0.000
Only in arm (includes cubital fossa)	37 (34.9)	63 (65.1)	
Combination of sites	37 (75.5)	12 (24.5)	
Mean number of cannulas†	2.52 [1.07]	1.26 [0.57]	0.000

Other vascular device in situ*			
Yes	24 (61.5)	15 (38.5)	0.006
No	63 (37.7)	104 (62.3)	
Total duration of cannulation†	160.36 [95.97]	98.5 [55.67]	0.000

* Results expressed as number and (percent)

† Results presented as mean and [standard deviation]

‡ Chi square for proportions or Student's *t* test for continuous variables

Table 5. Adjusted risk factors associated with unplanned cannula removal among hospital patients

	Crude OR*	95% CI†	Adjusted OR	95%CI
Age (years)	0.97	0.95-0.99	0.99	0.97-1.03
Vein assessment				
Fair/good	1			
Poor	0.54	0.31-0.96	0.47	0.18-1.26
IV antibiotics	0.50	0.28-0.88	1.05	0.38-2.87
Cannula insertion site				
Only in hand or wrist	1		1	
Only in arm or cubital fossa	0.64	0.30-1.35	0.69	0.21-2.28
Multiple sites	0.11	0.45-0.27	0.88	0.18-4.33
Mean number of cannulas	0.12	0.07-0.22	0.08	0.03-0.22‡
Other vascular device in situ				
No	1		1	
Yes	0.38	0.19-0.77	0.43	0.12-1.49
Total duration of cannulation	0.99	0.98-0.99	1.01	1.00-1.02‡
Mean irritability of IV medications (other than IV antibiotics)	0.52	0.29-0.93	0.45	0.21-0.97‡

* OR = odds ratio

† CI = 95% confidence interval.

‡ Statistically associated with unplanned cannula removal