

1 **Ease of intravenous catheterisation in dogs and cats: a comparative study of**
2 **two peripheral catheters**

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15

16 **Abstract**

17 Objectives: To evaluate animal comfort and ease of placement of a veterinary specific
18 intravenous catheter compared to a catheter manufactured for human use.

19 Methods: Fifty-nine veterinary undergraduates were recruited to perform intravenous
20 catheterisations with two brands of over-the-needle catheter (Smiths Medical Jelco[®] (human
21 use) and Abbott Animal Health catheter[®] (veterinary use)) in 69 healthy cats (n = 28) and
22 dogs (n = 41) requiring general anaesthesia. After a standardised pre-anaesthetic medication,
23 each animal was randomly allocated to have one of the two brands of catheter placed. Each
24 student was allowed a maximum of three attempts to achieve cephalic vein catheterisation.
25 The student and a single experienced observer evaluated each attempt. Observations related to
26 ease of placement and to the animal's reaction were recorded.

27 Results: Human use catheters were placed in 34 and veterinary use in 35 animals. There was
28 no difference in weight, sex, or sedation score between the two groups. The number of failed
29 attempts was similar between the two groups. There was no difference between groups for the
30 number of animals reacting to catheter insertion.

31 Clinical significance: The two types of catheters evaluated are equally suitable for intravenous
32 catheterisation of sedated animals by veterinary undergraduate students.

33 **Keywords**

34 Anaesthesia, Fluid therapy, Canine, Feline, Catheter placement

35 **Introduction**

36 Placement of short-term peripheral intravenous catheters is common practice in veterinary
37 medicine. It is well recognised that catheterisation is an unpleasant procedure for both humans
38 and animals, and therefore can be stressful for the staff involved (Dutt-Gupta *et al.* 2007; Van
39 Cleve *et al.* 1996; Flecknell *et al.* 1990; Hellyer *et al.* 2007; Jacobson 1999). Despite being a
40 routine procedure, there is limited published research on methods to decrease the discomfort
41 and stress associated with intravenous catheter placement.

42 Multiple failed attempts at intravenous catheterisation have been reported to increase
43 complication rates in human patients including infection, haematoma formation, thrombosis
44 or extravasation of fluids or drugs (Johnson *et al.* 1998; Karapinar & Cura 2007; Mansfield &
45 Hohn 1994). It is reasonable to assume that any catheter design feature that reduces the
46 number of failed attempts would decrease morbidity associated with catheterisation.

47 A new catheter for peripheral intravenous access has recently been introduced to the
48 veterinary market. It has a sharp needle (Abbott Animal Health 2010), which is claimed to
49 reduce tissue trauma and pain (Suzuki & Tanaka 2004). As the Smiths Medical Jelco[®]
50 catheter it is an over-the-needle non-winged catheter. But shape and length of the plastic
51 handling and connection parts are different. It is also fitted with additional features such as a
52 transparent hub and an asymmetric stylet handgrip to aid awareness of the bevel's orientation.

53 The aim of the present study was to determine if the design of the catheter makes it easier to
54 place for undergraduate veterinary students and whether is associated with less insertional
55 discomfort in cats and dogs, compared to a commonly used brand designed for human use.

56 **Materials and Methods**

57 This study was designed as a prospective, randomised, clinical trial and received approval of
58 the University of Cambridge Department of Veterinary Medicine Ethics and Welfare
59 Committee (CR34).

60 Students

61 Veterinary undergraduate students were recruited on a voluntary basis from the fourth and
62 final years. Clinical training starts in the fourth year at the University of Cambridge and so the
63 fourth year students were considered to have no or minimal experience in catheterisation as
64 compared to final year students who are in their third year of clinical training. Students were
65 asked if they had already attempted venous catheterisation or not. All fourth year students
66 taking part in the study watched a video demonstrating a percutaneous technique as described
67 elsewhere (Beal & Hughes 2000). The video was also made available for final year students
68 requesting a teaching supplement.

69 Each student was allowed a maximum of three attempts to place the catheter in an allocated
70 animal. The first and second attempts were made on the right cephalic vein if the students
71 were right-handed and on the left cephalic vein if they were left-handed. The third attempt
72 was made on the opposite side. The second attempt was also performed on the opposite side if
73 the initial site was rendered unsuitable after unsuccessful attempt (e.g. haematoma formation).

74 Animals

75 Animals enrolled in the study were cats and dogs admitted for elective surgery between
76 October 2011 and April 2012 at the Queen's Veterinary School Hospital Cambridge and
77 classified as ASA I or II (American Society of Anesthesiologists' classification) after clinical
78 examination. These animals required the placement of an intravenous catheter prior to
79 anaesthesia. Owners or animal caretakers were asked for written consent prior to enrolment.

80 Animals were included in the study only if the single study investigator (AC) was available to
81 assess the attempt.

82 Sex, weight, body condition score (BCS) (LaFlamme 1997) and baseline demeanor using a
83 descriptive scale (Table 1) were recorded before pre-anaesthetic medication by AC
84 throughout the study.

85 Pre-anaesthetic medication was administered intramuscularly in the epaxial cervical or lumbar
86 muscles. Dogs received methadone (0.2 mg/kg - Comfortan; Eurovet Animal Health),
87 medetomidine (0.01 mg/kg - Sedator, Eurovet Animal Health) and acepromazine (0.02 mg/kg
88 - ACP Injection 2 mg/ml; Novartis Animal Health). Cats received buprenorphine (0.02 mg/kg
89 - Vetergesic; Alstoe), medetomidine (0.01 mg/kg - Sedator; Eurovet Animal Health) and
90 acepromazine (0.02 mg/kg - ACP Injection 2 mg/ml; Novartis Animal Health).

91 Following pre-anaesthetic medication, the degree of sedation was scored every 10 to 15
92 minutes for 30 minutes by the assessor (Table 1). The highest score obtained was recorded for
93 the study. If profound sedation (sedation score of five) was achieved before the end of the
94 thirty-minute period, catheterisation was attempted at this time. Cats and dogs that did not
95 reach a sufficient level of sedation to allow catheterisation with minimal restraint (sedation
96 score equivalent to three or less) within 30 minutes were excluded from the study.

97 Animals were excluded if their temperament did not allow a complete clinical examination or
98 an intramuscular injection without simple restraint. They were also excluded if their cephalic
99 veins were not suitable for catheterisation (such as presence of phlebitis or dermatitis).

100 Catheters

101 A block randomisation process was designed with four blocks to ensure homogenous
102 distribution of catheters between species (cats or dogs) and students' year (4th year or final
103 year).

104 Within each block and using the randomisation function of the Excel software (Microsoft,
105 Redmond, USA) animals were assigned to one of two groups: the Jelco group (receiving the
106 Jelco catheter - Smiths Medical Company, Ashford, UK) and the Abbott group (receiving the
107 Abbott catheter - Abbott Animal Health, Illinois, USA). Both catheters have the same general
108 design and could be handled in the same manner.

109 Only 20 and 22 gauge catheters were used in this study. In dogs, the size of the catheter was
110 determined for each attempt by the size of the animal based on the investigator's experience.
111 In cats only 22 gauge catheters were used.

112 Catheterisation attempt

113 The hair was clipped over the antebrachial cephalic vein area. The insertion site was then
114 disinfected using a routine standardised protocol.

115 A single investigator (AC) assessed each attempt throughout the study. This person had
116 experience in teaching intravenous percutaneous catheterisation to students but had limited
117 experience with either catheters.

118 Each attempt was timed using a stopwatch from the insertion of the catheter through the skin
119 until the catheter was removed in case of unsuccessful catheterisation or after successful
120 placement confirmation. Successful intravenous placement was confirmed after fixation of the
121 catheter with medical tape by palpating the intravenous flow of an injected isotonic
122 crystalloid solution (Vetivex 1, Dechra Veterinary Products).

123 Conditions of insertion site (quality of clipped area, visibility of vein, palpability of vein,
124 stability of vein) were described by the student and the assessor in a binary fashion (“good” or
125 “bad”). Ease of the different steps of placement (skin introduction, vein puncture, catheter
126 threading, fixation, overall difficulty) were assessed using “easy” or “difficult” as subjective
127 modalities. The reaction of the animals to catheterisation was scored by the assessor using a
128 descriptive scale for each attempt (Table 2).

129 Students had the opportunity to express any comments during the self-evaluation following
130 each attempt.

131 Statistical analysis

132 Data were analysed using SPSS 20 (IBM, Armonk, USA). Recorded variables were
133 summarized as frequencies (percentage) for categorical variables; means and standard
134 deviations (\pm sd) for continuous normally distributed variables, or medians (inter-quartile
135 range) for skewed data. Univariable analysis were undertaken to evaluate the association of
136 catheter factors with outcome variables (e.g. ease parameters, success, time, animals’
137 reaction) using Chi-squared or Fisher’s Exact tests for categorical data and Student’s T-tests
138 or Mann-Whitney U-tests for quantitative data as appropriate. A p-value below 0.05 was
139 considered significant.

140 **Results**

141 Demographic results

142 Fifty-nine students took part in the study. Thirty-two were fourth year students; the remaining
143 27 were final year students. Six fourth-year students and two final-year students participated
144 in the study twice. One final-year student participated in the study three times. Fourteen
145 (44%) of the fourth year students already had previous experience in catheterisation. All final

146 year students had previously attempted intravenous catheterisation before taking part in the
147 study. Eighteen (31%) students had no experience with catheterisation prior to the study.

148 Thirty-four cats and 42 dogs were originally recruited for the study. Five cats (one from the
149 Jelco group and four from the Abbott group) and one dog from the Jelco group were excluded
150 due to insufficient sedation. One cat from the Jelco group was excluded for a skin condition
151 present on the forelimbs (dermatitis and phlebitis from previous blood sampling). In total 28
152 cats (14 in each group) and 41 dogs (20 in the Jelco group and 21 dogs in the Abbott group)
153 were included in the study.

154 No differences were found between treatment groups regarding cat weight ($p=0.73$), dog
155 weight ($p=0.53$), body condition score ($p=0.1$), sedation score before premedication ($p=0.23$)
156 or sedation score after premedication ($p=0.87$). There was no statistical difference in the
157 number of females and males between groups ($p=0.54$). The use of different catheter sizes in
158 dogs (20 or 22 gauge) was similar between the two groups ($p=1$).

159 Success rates

160 In total 111 catheterisation attempts were recorded during the study, including all successful
161 and failed ones. Students managed to successfully place a catheter within the three allowed
162 attempts in 65 (94%) animals. A catheter could not be inserted after three attempts in one
163 (3%) of 34 animals in the Jelco group, and three (9%) of 35 animals in the Abbott group
164 (Figure 1). There was no difference in success rate between groups ($p = 0.61$).

165 Catheter placement was successful at first attempt in 23 (68%) animals in the Jelco group and
166 18 (51%) in the Abbott group. The second attempt was successful for six (18%) cases in the
167 Jelco group and eight (23%) cases in the Abbott group. A third attempt was required for four
168 (12%) animals in the Jelco group and six (17%) in the Abbott group (Figure 1). There was no

169 difference in the number of attempts required for successful catheterisation between the two
170 groups ($p=0.53$).

171 There was no difference in success rate between groups when considering only students with
172 no experience at all ($p=0.22$) or students with previous experience ($p=0.46$).

173 Timing

174 The median duration for successful attempts in the Jelco group was 169 (142-190) seconds
175 and it was 177 (144-215) seconds in the Abbott group ($p=0.48$). The median duration of failed
176 attempts for the Jelco and the Abbott groups respectively were 95 (69-145) and 100 (72-139)
177 seconds ($p=0.94$).

178 Ease of placement

179 The parameters assessing insertion site quality (quality of clipping area, vein visibility, vein
180 palpability, vein stability) were similar between groups, as evaluated by the students and the
181 assessor (Table 3).

182 The Jelco catheter was easier to slide off the stylet according to the students ($p=0.02$). The
183 difference was not statistically significant ($p=0.08$) in the assessor's evaluation (Table 3).

184 There was no statistical difference between the two groups for all other parameters used for
185 ease of placement assessment.

186 Reaction of the animals

187 Ten (29%) animals in the Jelco group and seven (20%) in the Abbott group reacted to the first
188 attempt at catheterisation ($p=0.41$). Animals reacted slightly to catheterisation in 19 (17%)
189 attempts (eight (7%) in the Jelco group and 11 (10%) in the Abbott group). Moderate reaction
190 was detected in two (2%) and five (5%) attempts, for the Jelco and the Abbott groups

191 respectively. Only one (1%) dog reacted strongly during a successful catheterisation in the
192 Jelco group. There was no difference in the occurrence and intensity of animal reaction
193 between groups ($p=0.60$). There was no difference in the intensity of animal reaction between
194 the first and the second attempt ($p=0.30$ for the Jelco group, $p=0.43$ for the Abbott group).

195 Students' comments

196 Twenty-two comments were recorded during the study. One student with previous
197 catheterisation experience stated comfort with the Abbott catheter. Fourteen comments
198 offered an explanation for a failed attempt, with five attributed to difficulties to puncture the
199 vein (one in the Jelco group and four in the Abbott group). A student stated that 'threading
200 (was) not possible' in one failed attempt using the Abbott catheter. Six comments highlighted
201 difficulties after successful catheterisation to secure the catheter in place, four of those were
202 from the Abbott catheter group.

203 **Discussion**

204 Intravenous catheterisation performed by undergraduate veterinary students with a veterinary
205 specific catheter did not result in an improved successful placement rate and did not decrease
206 animals' discomfort when compared to a non-veterinary product.

207 Success rates at catheterisation can vary depending on the type of catheter used (Jacobson &
208 Winslow 2005). The authors hypothesised that experienced nurses accustomed to a certain
209 type of catheter were performing better with this brand of catheter than with another. In our
210 study undergraduate veterinary students with no or minimal experience were recruited to
211 minimise pre-existing bias for one or other catheter. In addition both catheters had a similar
212 design, being over-the-needle catheters without wings with a transparent hub and were both
213 made of fluorinated ethylene propylene (FEP-Teflon®).

214 The lack of students' experience in catheter insertion may have been a greater factor in
215 determining success of placement, outweighing any positive difference in catheter design.
216 However, the success rates at first attempt in this study were 68% in the Jelco group and 51%
217 in the Abbott group. These are comparable to success rates obtained by medical interns or
218 nurses with reported success rates ranging from 52% to 77% (Jacobson 1999; Jacobson &
219 Winslow 2005; Chang *et al.* 2002; Kessler *et al.* 2013).

220 Subtle variations during the placement process would be more difficult to describe by non-
221 experienced people. For example, problems in threading off the catheter may be difficult to
222 describe for someone placing their first intravenous catheter. This lack of comparison points
223 might explain the difference between assessor and student's evaluation in threading properties
224 between catheters. This point can also be highlighted through the students' comments where a
225 majority of the comments were reflecting on the student's technique more than the catheter
226 used. Moreover the assessor was only evaluating a visual impression of the ease of catheter
227 placement, which is different from the feeling people experience when physically placing a
228 catheter.

229 Cats and dogs included in the study were sedated to decrease the impact of temperament on
230 the difficulty of the attempt. Medetomidine could potentially increase the difficulty of
231 intravenous catheter placement due to venous vasoconstriction (Civantos & de Artiñano
232 2001) as α_2 -adrenergic receptors are widely encountered in venous systems such as large
233 veins of canine limbs (Long & Kirby 2008). To the authors' knowledge clinical significance
234 of this phenomenon has never been evaluated. The pre-anaesthetic medication protocol used
235 in the present study is routinely used in the study facility to enable placement of intravenous
236 catheters in healthy patients. In the authors' experience, the use of medetomidine at this dose
237 range, associated with the use of acepromazine, does not reduce venous distension once
238 occluded. This is supported by the fact that the vein was easily visible for the majority of

239 attempts, as evaluated by students and the assessor respectively. The combination of drugs
240 used may reduce the animals reaction to catheter placement but also provides analgesia,
241 which may reduce the degree of discomfort perceived (Murrell & Hellebrekers 2005;
242 Samantaray 2014). The incidence of reactions in approximately 25% in either group and their
243 intensities suggest that the premedication did not totally mask these signs.

244 Both catheters had backcut-grind inner needles which is the shape shown to generate less
245 trauma (Suzuki & Tanaka 2004). Despite being the same gauge and same material, catheters
246 used in our study have different diameters. The external diameter of the inner needle of the 22
247 gauge Jelco catheter is 0.56mm (Treuren & Galletly 1990) compared to 0.54mm for the
248 Abbott catheter (Abbott Animal Health 2010). An increase in the needle or the catheter
249 diameter has been shown to increase the force required to pass through experimental
250 membrane models (Abbott Animal Health 2010; Suzuki & Tanaka 2004; Thacker *et al.*
251 1989). This difference in diameter did not appear to be clinically significant as the level of
252 reaction was the same between the two catheter groups. Moreover skin penetration by the
253 Abbott catheter was not perceived to be easier than the Jelco catheter. Treuren & Galletly
254 (1990) reported that the 22 gauge Jelco catheter was favoured by experienced medical
255 anaesthetists when compared to 11 other different catheter models. The Abbott catheter was
256 not included in that study.

257 Catheters wider than 20 gauge were not available for the present study. Although the present
258 study did not reflect the whole range of catheters and experience required in daily veterinary
259 practise, 20 and 22 gauge catheters appear to be the most commonly used catheters in small
260 animals. Students are usually taught to place intravenous catheters in cats and dogs using
261 preferentially these two sizes.

262 One limitation of the study was that the students and assessor could not be blinded to the
263 catheter used. Even if both catheters had the same general specifications the shape and the
264 colour of the plastics were slightly different and could be identified by looking or handling
265 them. Technical solutions to allow blinding, which would not have increased the difficulty of
266 catheterisation or breached the catheter sterility were not found during the study design.
267 However, the inexperienced students should have provided no bias towards a particular brand
268 of catheter.

269 **In conclusion,** using the Abbott catheter or the Jelco catheter did not reduce the number of
270 attempts required by relatively inexperienced undergraduate veterinary students for successful
271 catheterisation. The intensity of animals' reactions to catheter placement was similar for both
272 catheters. The present study supports the use of either 20-22 gauge catheter to teach
273 catheterisation to undergraduate veterinary students. Further research is required to extend
274 the findings of the present study to other populations such as experienced practitioners or non-
275 healthy animals.

276

277 **References**

- 278 Abbott Animal Health (2010) Peripheral Catheter Needle Sharpness : Penetration testing and
279 Microscopy study. [http://www.abbottanimalhealth.com/veterinary-professionals/products/fluid-](http://www.abbottanimalhealth.com/veterinary-professionals/products/fluid-therapy/iv-sets-and-catheters.html)
280 [therapy/iv-sets-and-catheters.html](http://www.abbottanimalhealth.com/veterinary-professionals/products/fluid-therapy/iv-sets-and-catheters.html) [accessed 29 March 2012]
- 281 Beal, M. W., Hughes, D. (2000) Vascular access: theory and techniques in the small animal
282 emergency patient. *Clinical techniques in small animal practice* 15, 101–109
- 283 Chang, K. K., Chung, J. W., Wong, T. K. (2002) Learning intravenous cannulation: a comparison of
284 the conventional method and the CathSim Intravenous Training System. *Journal of clinical*
285 *nursing* 11, 73–78
- 286 Civantos, C. B., de Artiñano, A. A. (2001) Alpha-adrenoceptor subtypes. *Pharmacological research*
287 44, 195–208
- 288 Van Cleve, L., Johnson, L., Pothier, P. (1996) Pain responses of hospitalized infants and children to
289 venipuncture and intravenous cannulation. *Journal of pediatric nursing* 11, 161–168
- 290 Dutt-Gupta, J., Bown, T., Cyna, A. M. (2007) Effect of communication on pain during intravenous
291 cannulation: a randomized controlled trial. *British journal of anaesthesia* 99, 871–875
- 292 Flecknell, P. A., Liles, J. H., Williamson, H. A. (1990) The use of lignocaine-prilocaine local
293 anaesthetic cream for pain-free venepuncture in laboratory animals. *Laboratory Animals* 24,
294 142–146
- 295 Hellyer, P., Rodan, I., Brunt, J., *et al.* (2007) AAHA/AAFP pain management guidelines for dogs and
296 cats. *Journal of the American Animal Hospital Association* 9, 466–480
- 297 Jacobson, A. F. (1999) Intradermal normal saline solution, self-selected music, and insertion difficulty
298 effects on intravenous insertion pain. *Heart & Lung: The journal of Acute and Critical Care* 28,
299 114–122
- 300 Jacobson, A. F., Winslow, E. H. (2005) Variables influencing intravenous catheter insertion difficulty
301 and failure: an analysis of 339 intravenous catheter insertions. *Heart & lung : the journal of*
302 *critical care* 34, 345–359
- 303 Johnson, E. M., Saltzman, D. A., Suh, G., *et al.* (1998) Complications and risks of central venous
304 catheter placement in children. *Surgery* 124, 911–916
- 305 Karapinar, B., Cura, A. (2007) Complications of central venous catheterization in critically ill
306 children. *Pediatrics international* 49, 593–599
- 307 Kessler, D. O., Arteaga, G., Ching, K., *et al.* (2013) Interns' success with clinical procedures in infants
308 after simulation training. *Pediatrics* 131, e811–820
- 309 LaFlamme, D. (1997) Development and validation of a body condition score system for dogs. *Canine*
310 *Practice* 22, 10–15
- 311 Long, K. M., Kirby, R. (2008) An update on cardiovascular adrenergic receptor physiology and
312 potential pharmacological applications in veterinary critical care. *Journal of Veterinary*
313 *Emergency and Critical Care* 18, 2–25

- 314 Maddern, K., Adams, V. J., Hill, N. A. T., *et al.* (2010) Alfaxalone induction dose following
315 administration of medetomidine and butorphanol in the dog. *Veterinary anaesthesia and*
316 *analgesia* 37, 7–13
- 317 Mansfield, P., Hohn, D. (1994) Complications and failures of subclavian-vein catheterization. *The new*
318 *England journal of medicine* 331, 1735–1738
- 319 Michou, J. N., Leece, E. A., Brearley, J. C. (2012) Comparison of pain on injection during induction
320 of anaesthesia with alfaxalone and two formulations of propofol in dogs. *Veterinary anaesthesia*
321 *and analgesia* 39, 275–81
- 322 Murrell, J. C., Hellebrekers, L. J. (2005) Medetomidine and dexmedetomidine: a review of
323 cardiovascular effects and antinociceptive properties in the dog. *Veterinary anaesthesia and*
324 *analgesia* 32, 117–27
- 325 Samantaray, A. (2014) Effects of dexmedetomidine on procedural pain and discomfort associated with
326 central venous catheter insertion. *Indian journal of anaesthesia* 58, 281–287
- 327 Suzuki, T., Tanaka, A. (2004) Differences in penetration force of intravenous catheters: effect of
328 grinding methods on inner needles of intravenous catheters. *Tokai journal of experimental and*
329 *clinical medicine* 29, 175–181
- 330 Thacker, J. G., Rodeheaver, G. T., Towler, M. A., *et al.* (1989) Surgical needle sharpness. *American*
331 *journal of surgery* 157, 334–339
- 332 Treuren, B. C., Galletly, D. C. (1990) A comparison of intravenous cannulae available in New
333 Zealand. *Anaesthesia and intensive care* 18, 540–546
- 334