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Successful intravenous catheterization by medical students

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Abstract

Background—Intravenous (IV) catheter placement is one of the most basic and essential medical procedures. However, IV placement can be a source of anxiety for medical students as it is often their first procedural patient care. We sought to investigate the factors that impact the success rate of this skill and to determine at what rate students improve.

Materials and methods—A confidential web-based survey was distributed to a total of 367 third and fourth year students at Virginia Commonwealth University School of Medicine. The responses were collected over a 2-week period in July 2015.

Results—The response rate was 49.0% (180/367). 65.5% of the M3s and 21.8% of the M4s have never had an opportunity to place an IV. The success rate was higher in students with prior experience as laboratory researchers (86.6%, $p=0.014$) as well as Emergency Medical Technicians (81.4%, $p=0.038$) when compared to students with no experience. Prior preparation such as reading, watching videos or even lectures did not increase the success rate. Success rates rapidly improved from 47% for the first attempt to 86% for the fifth attempts.

Conclusion—A significant percentage of students did not have opportunities to attempt IV catheter placement. We found prior experience, not only as an EMT but also as a lab researcher, significantly increased the success rate. Prior preparations did not improve success rate and most of the students were successful after only 5 attempts.

Keywords

Medical student education; intravenous cannulation; venous access; survey; procedural experience; surgical education

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IAW and KT conceptualized the survey and prepared the manuscript. IAW distributed the survey and analyzed data.

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1. Introduction

The third and fourth years of medical school are often students' first foray into the world of clinical medicine and patient care. This is often the first time students are required to take their knowledge out of the classroom and apply it to patients in the hospital. In addition to the clinical knowledge that must be developed, understanding of and continued refinement of technique must be practiced across a wide range of procedures [1-4].

Placement of Intravenous (IV) catheters is one such procedure. It is frequently one of the first procedures that must be mastered and is critically important in patient care for the delivery of medication and other therapeutic interventions [4]. Peripheral IV catheter placement is the most common procedure performed in the emergency department with over 40% of its patients requiring blood tests and 25% receiving IV fluids [5]. It is essential for a wide variety of therapeutic interventions including hydration, electrolyte replacement, antibiotic therapy, parenteral nutrition, delivery of contrast agents, and anesthesia [5-6].

In 1998 the American Association of Medical Colleges outlined eight basic procedures that each medical student is expected to be proficient in upon graduation [7]. IV catheter placement was named along with venipuncture, arterial puncture, thoracentesis, lumbar puncture, nasogastric tube placement, Foley catheter insertion and suturing of lacerations [8]. However, even 10 years after that report was published it was found that students are not becoming proficient in these basic procedural skills and are either simply not performing them or do not feel confident in their skills [1-3]. It was reported that 30% of third year medical students (M3s) and 23% of fourth year medical students (M4s) have never placed IV catheters, which suggests that almost one quarter of the M4s, soon to be intern physicians, are not proficient in this basic skill [1]. This is especially disheartening given the fact that it takes time and many repetitions to hone one's skill. This lack of experience becomes even more critical as physicians, more likely to be interns, are often the final stop in gaining IV placement in difficult patients, such as those with a history of fragile veins or IV drug use [4]. If the physician fails to place a peripheral IV during life saving measures, a central venous catheter is often placed instead, which is associated with a 5-10% complication rate [6-8].

The purpose of this study was to explore the factors that impact the success rate of IV placement and to determine how quickly students become proficient in this skill. We also investigated student perceptions and training experiences regarding the critical skill of IV cannulation.

2. Materials and methods

2.1 Human Subject Protection

No identifying information was collected in order to protect anonymity and ensure that no motivation for false reporting was present. The students were informed as to the purpose and goal of the survey and participation was completely voluntary without any compensation. The Virginia Commonwealth University Institutional Review Board (IRB) Human Subject granted this study an exemption due to the fact that no identifying information was collected,

no interventional action was taken and the disclosure of this information does not place the subjects at any risk of harm or penalty.

2.2 Development and distribution of survey

We developed a confidential Internet-based survey. It was distributed via email to a total of 367 M3 (third year) and M4 (fourth year) medical students at Virginia Commonwealth University School of Medicine in Richmond, VA. The survey was open to responses for a two-week period in July of 2015. The M3 class had completed 12 weeks of clinical rotations at the time the survey was closed for responses. Students in their clinical years of training were invited to participate while the first and second year students were excluded due to their lack of opportunity for procedural care. The survey contained a total of 12 questions pertaining to medical students' experience with the placement of IV catheters. A single email was sent out to all students and individuals were targeted for one follow-up email if unresponsive to the initial message.

2.3 Contents of the survey

The survey was a mix of free response and multiple-choice questions. It was developed to collect information such as perceived barriers to IV placement as well as quantify the numbers of IVs students are placing. A free response question asked students to estimate the exact number of IVs they have placed while in medical school and a second question asked them to estimate the exact number of IVs they failed to place. From these results a success rate was estimated for each student. Students were then asked about the most common reason they miss IV placements and what were the general barriers faced while they have been in the clinical realm. Students were then queried on if they had prior experience as an Emergency Medical Technician (EMT), nurse, lab technician or researcher. An option or "Other" was also provided where respondents could define their specific experience. Students were also asked how they had prepared while learning to place IVs. Options included reading, watching video, getting a lecture/lesson from a more experienced healthcare professional or simply not preparing at all beforehand. Students were then asked to state their preferred location for placement of IVs, with options including forearm, antecubital fossa, dorsal hand or respondent definable "Other." We also wanted to know which rotations were providing students the opportunity to place IVs among Anesthesia, Internal Medicine, Surgery, Obstetrics and Gynecology and respondent definable other. Demographic information was also gathered from respondents, which included gender, age and year of graduation. A copy of the complete survey is available in the Appendix.

2.4 Data analysis

In the analysis of prior experience three groups were created: EMTs, lab researchers and those without prior experience. Those who noted both lab research and EMT experience were assigned the EMT group due to the fact that they likely had more IV skill specific training, which provided an advantage over the research group. We also excluded one nurse, two scribes and a retinal ophthalmologic technician from the analysis because their training was likely to be dissimilar in content and duration compared to the EMT or lab researcher training.

Additionally, during the analysis of the method of preparation for IV placement we excluded those who noted any prior healthcare experience in order to ensure that previous educational techniques did not impact our results. In this way we limited our analysis and commentary only to the educational methods taught during medical school.

During the construction of the survey and the creation of Question 12 (See Appendix) we decided to limit the upper response to 5 due to our skepticism that students would be able to reliably recall their IV placements individually beyond that number.

Data were analyzed using unpaired t tests with two-tailed P values reported for all tests. P values < 0.05 were considered statistically significant. All of the data were organized and analyzed with Microsoft Excel 2011. (Microsoft Corporations, Redmond, WA)

3. Results

3.1 Research subject demographics

A total of 180 of 367 M3 and M4 students at Virginia Commonwealth University School of Medicine completed the electronic questionnaire, resulting in a response rate of 49% (180/367). Table 1 depicts the demographic information of the respondents. The mean age was 25.4 years old and 55% of respondents were male. The majority of respondents (51%) were between 20 and 25 years old with 43% 26-30 years old. Only about 6% were over the age of 30. The third year students made up 64% of the responses, likely due to the fact that many of the fourth years were on away rotations. Surprisingly, 22% of the rising M4 class had not placed an IV after almost a year in the hospital, whereas 34% of the M3 class had placed an IV after only 3 months on clinical rotations (Figure 1). Additionally, most M3s had placed between one to five IVs. The experience of the M4s varied much more broadly with most students placing between one to ten IVs (Table 2). Finally, medical students placed the most IVs (52%) during the surgical rotation. (Table 3)

3.2 Prior research laboratory experience is associated with a higher IV placement success rate

We examined the effect of prior experience before medical school on successful IV catheter placement. During this analysis we excluded four individuals who reported placing IVs, including a nurse, two scribes and a retinal technician, due to differing content and duration of training. Figure 2A demonstrates the distribution of prior experience of the respondents among those who have placed IV catheters. The majority of students (62%) did not have any relevant prior experience. 21% of respondents had healthcare field related prior experience. Emergency Medical Technician (EMT) was the most commonly cited type of such experience. Others included medical scribe, ICU technician, medical assistant, pharmacist, pathology lab technician, retina technician, EKG technician and procurement technician. The other group with research experience made up 17% of those who placed IVs, which includes researchers that handled human/animal specimens and lab technicians. The students with no experience had a mean success rate of $67.8\% \pm 3.3\%$ (Figure 2B). As we expected the success rate was significantly higher in the group with EMT experience ($81.4\% \pm 3.3\%$, $p=0.028$) when compared to the group with no experience. Interestingly, the success rate of

IV placement was also significantly higher in the research experience group ($86.6\% \pm 4.2\%$, $p=0.009$).

Figure 2C depicts the distribution of students according to their prior experience and the number of IVs they have placed. Additionally, there were no significant differences between the mean numbers of IVs placed among the subgroups. (Figure 2D) This leads us to infer that even though some students, such as EMTs (mean = 5.4 attempts per person), have prior experience they are not placing more IVs than the inexperienced or lab researcher group. It also indicates that the lab researchers (mean = 3.3 attempts per person) do not have an improved success rate because they are placing significantly more IVs.

3.3 Prior group didactic lecture and individual preparation does not significantly improve IV placement success rate

Contrary to our expectation, the method of prior preparation such as reading, watching videos or didactic lectures did not increase the success rate of IV placement. Students were grouped into the following three categories according to the method used to prepare for IV placement: received a lecture lesson from a more experienced healthcare professional; watch a video/read; no individual preparation. We included only students who reported no prior experience for this analysis. Most students, 66%, had some lecture or lesson, 21% prepared individually by reading or watching a video and only 13% of students did not prepare at all (Figure 3A). There was no significant difference in the success rates among these groups (Figure 3B). This was contrary to our expectation that some level of preparation would have improved outcomes.

3.4 Success rate was not different among preferred puncture locations

We investigated whether students who declared a single preferred anatomical puncture location had a higher success rate. 49% of respondents choose antecubital fossa as a preferred location. The second most popular location was the dorsal hand with 32% of responses followed by the forearm with 19% (Figure 4A). The success rates among the students who preferred the forearm ($80.3\% \pm 7.4\%$), dorsal hand ($68.7\% \pm 4.4\%$) or antecubital fossa ($73.5\% \pm 3.4\%$) for IV insertion were not significantly different (Figure 4B). The students who had chosen multiple sites were excluded.

3.5 Technique, patient variables, and personal factors were identified as reasons for failure

Students were then queried about the most common reasons that they are not successful in placing IVs. Surprisingly, one fifth of responders were unable to identify the reason for failure. Among the respondents who were able to identify, the largest percentage, 53%, cited reasons related to proper technique as the major factor (Figure 5). This included improper positioning of the needle and difficulty choosing the appropriate site. The second most prevalent category selected, 26%, included patient variables such as dehydrated state, dark skin color, advanced age, rolling veins and fat filled fascial planes. 19% of respondents cited systemic failures such as finding opportunities, willingness of practitioners to allow student participation, primacy of resident training and lack of concrete supervision and feedback. 2% of respondents cited personal factors such as inexperience, nervousness and anxiety.

3.6 Increase in the percentage of successful students in IV catheter placement

Figure 6 depicts the strikingly steep increase in percentage of students who were successful in IV placement. On the first IV placement only 47% of students were successful. The percentage of the successful students increased with each successive attempt and by the fifth attempt 86% of students were successful.

4. Discussion

The purpose of our study was to identify the factors that are associated with success rates and the difficulties students encounter in learning a single procedural technique, IV catheterization. We found that students with prior experience as Emergency Medical Technicians (EMTs) as well as laboratory researchers had significantly higher success rates of IV placement when compared to students with no prior experience. While data describing MCAT scores and GPAs of matriculating students is abundant, little data exists describing the distribution of medical students that enter with prior employment in a healthcare related field. We found that about one-third of medical students had prior training in a healthcare related field, and their experience successfully transfers to clinical practice in the M3 and M4 years.

For the first time to our knowledge, prior experience as a laboratory researcher was shown to be associated with improved procedural patient care. 17% of students in our survey had spent some time working in a research lab, and to our surprise, these students also had a higher success rate similar to the rate of success seen with EMTs. Dedicated basic science research is renowned for requiring high levels of proficiency and precision in numerous fine motor tasks. They were likely able to apply the same level of precision and attention to detail in performing IV cannulation which led to their higher success rates. Taken together our data indicates that it may be wise to target those without prior experience for additional training in order for competency to be achieved by the entire cohort.

We also showed in Figure 2D that there is not significant difference between the average number of IVs placed by EMTs, lab researchers and those without any prior experience. This indicates that students with certain educational backgrounds are not getting increased opportunities to practice this skill. It appears that upon entering medical school the opportunities to practice IV placement become uniform regardless of ones prior experience. This was surprising, as we would expect those with increased experience would volunteer to perform the skill more often. However, the mindset of the student may work in an alternative manner and they may not place great importance on it because they already deem themselves proficient and do not feel the need to seek out opportunities to practice. We also see that the students who have no experience in this skill appear to not try to overcome this deficit by placing an increased number. Of course these subtle findings could have been limited by the small sample size but it provides an interesting glimpse into the characteristics and priorities of current medical students.

Also to our surprise, we found that prior preparation does not have any effect on the success rates of IV cannulation. In our study we excluded those with any prior training in this analysis in order to ensure those with extensive practice in this skill, likely represented by

prior EMT experience, introduced no bias. In this way we can be sure that our data reflects the efficacy of training in undergraduate medical education and is not confounded by additional outside training.

When compared to other medical professionals, particularly nurses or dentists, physicians acquire their procedural knowledge in a much more haphazard way which leads to decreased satisfaction overall with training [9]. With expanding enrollment at the undergraduate medical level it is critically important to determine the most effective and feasible way to teach students these procedures. The limitation of our study is that our survey only looked at basic methods of instruction such as reading, viewing video and a lecture from a healthcare professional and found no increase in the success rate. We did not investigate the prevalence nor effectiveness of simulation or laboratory-based training. Other more sophisticated methods of teaching have been previously investigated including virtual reality simulation and didactics including laboratory practice. It was found that improved skill in the simulation environment did not transfer to improved skill in real patient care [10], however, those trained in a laboratory had higher success rates and shorter time to complete the task [14]. Of course the particular method of training continues to be a source of debate as education directors seek the most efficient and cost effective way to train students. Together with our results, it appears that students benefit not from didactic lecture alone, but from a combination with practical laboratory training.

At a time when medical school enrollment is expanding and opportunities to practice procedural skills are being lost due to increasing oversight and changes in patient expectations it will be important to hone in on procedural education and make sure that this fundamental aspect of patient care is not being lost amid the milieu of other critical clinical skills [12]. Previous research over the past 10 years has found that a significant fraction of students (30% of rising M4s) have never even attempted to place an IV despite the fact that it is one of eight basic procedures that all medical students are expected to be proficient in upon graduation [1-3, 7] In order to delineate these trends we should carry out larger, prospective, longitudinal studies.

Given the fact that the vast majority of IVs are placed by nurses or “IV placement teams” and most physicians do not routinely place IVs in their daily practice in the US, one may argue that IV placement may no longer be a basic skill necessary for modern medical students. This is a valid argument that warrants further discussion. However, there is no disagreement that IV placement is an essential technique for resuscitation and drug administration. Additionally, nurses are not always readily available. Thus, we believe that IV placement remains a basic skill for all surgeons. Because surgeons are the ultimate person responsible for the care of the patient, we believe that all students should have basic expertise in the procedures necessary for resuscitation.

At this institution the eight-week surgical clerkship is the only rotation in which IV cannulation is a required component. One IV cannulation is required to be observed for clerkship completion. Even so, we found that 65% of M3s and 23% of M4s have never had an opportunity to place an IV. This striking lack of experience in the M3 class can at least partially be attributed to the timing of the distribution of the survey at the beginning of the

academic year when students had only been in the hospital setting for three months. We must also note and commend the 34% of M3 students that have taken full advantage of their time in the hospital and have begun to practice this skill.

With 1/3 of the students obtaining practice in this skill in the first quarter of the year it is surprising that 22% of the fourth year class had not performed this skill after a full year in the hospital. This result is in agreement with previous national reports [1]. This may have been partially attributed to the fact that some students still had to complete their third year surgery rotation due to overlap in the third and fourth year schedules. Alternatively, students may simply not fulfilling this requirement and inaccurately reporting participation. This is especially concerning as they move onto more advanced levels such as Acting Internships. It has also been reported that during fourth year only an average of 4 extra procedures were performed indicating that whatever skills you develop during the third year are going to be your baseline with which you start residency [1-2]. Our results also revealed that only 4.5% of IVs were placed in M4 Advanced internships, which indicates that rather than honing skills fourth year it would seem that the skills you begin to develop third year may either stagnate or decline due to disuse.

Students consistently recognize the importance of this skill [1-2] so we went on to investigate the difficulties surrounding attaining proficiency. The results of this survey yielded some expected answers. Issues surrounding personal technique were the most commonly cited reasons for IV placement failure followed by patient factors such as dehydration, dark skin tone or fat filled fascia, which inhibited the student from placing the IV with precision. Previous studies have found diabetes, IV drug use and sickle cell disease to be predictive of difficult venous access [6]. However, many students in our study cited obesity, which has not been found to be a significant factor in predicting difficult venous access [6].

A significant percentage (19%) of people cited systematic barriers such as lack of opportunity, which we suspect is the major reason why not all the students were given even a single chance to place an IV catheter. Students may not be offered the opportunity to practice due to the stereotype that students are not competent and often fail the placement that results in increased discomfort to the patient. Indeed, our data do show that less than half of the students were successful at the first attempt. However our data also shows that after only 5 attempts students' success rate rapidly improves up to 86%. Therefore, all supervising attendings, residents, nurses and midlevel providers should reconsider their stereotype and not hesitate to provide opportunities for students who we have shown can achieve success in this skill within 5 attempts.

Of note we limited the final question to five attempts due to our skepticism that students would be able to accurately recall the success of individual attempts beyond five and not confuse the order. However due to the self reporting nature of the survey it is possible that our data may have introduced an expectation that the survey responders should only take five attempts to have a successful IV placement. Furthermore, since our survey did not specify in our question whether those first five IV sticks were per patient or attempts on the same patient there is a possibility that it took five sticks to find a patient in whom it is easy to

place an IV rather than reflecting the students gaining experience and skill. However, knowing the clinical teaching in this institution it is unlikely to see supervising healthcare professionals allow students to continue past the first unsuccessful attempt in a single patient.

Currently, third year clerkship directors are taking notice of the paucity of opportunities for procedural skills on the wards and are constructing modules that dedicate time to their practice during third year core rotations as well as in fourth year electives [12,13]. Surgical departments and residency programs are also beginning to respond to this large deficit in procedural knowledge and are implementing Intern “Boot Camps” which attempt to address this with short concentrated instruction in common procedural and clinical skills prior to the July start of many interns [14,15].

The limitations of the study are primarily centered on the survey-based methodology and the reliance on the accuracy of recall of the respondents. We tried to overcome this by strengthening recruitment and ensuring a high response rate so that the trends would be more reflective of the true population average. We also blinded the system to the identities of the respondents with the hopes of collecting more accurate responses since the respondent has no incentive to skew his/her answers. The other limitation that was faced by our study was the generalizability of our findings, which included students at only one US allopathic medical school. In the future, multiple institution studies would be very valuable to compare schools in which this procedural experience is required to those who do not carry this requirement. The small sample size may have been the reason we were unable to detect subtle differences in the success rates at certain preferred puncture sites. The participants were volunteers and may have different dispositions, motivations and enthusiasm towards participating in procedural patient care than the population at large.

Bias may have been introduced by a higher response rate from dissatisfied students whom were possibly more inclined to respond to the survey than students who felt satisfied with their experience. We would have been unable to detect this bias, as no questions regarding satisfaction were included. However, we do know that only 19% of students cited systemic barriers as the reason for IV failure, which leads us to believe that the number of dissatisfied students is reasonably low in our sample. Additionally, we could have been more specific in our elicitation of previous experience and asked explicitly about IV placement prior to medical school to ensure that prior experience in the healthcare field correlated to prior experience placing IVs. And also to ensure the reverse, that researchers did not have prior experience placing IVs.

5. Conclusions

We found that prior experience not only as an EMT but also as a lab researcher significantly increases successful IV placement. We also confirmed that many students have not placed even one IV and most students identify factors such as poor technique and lack of opportunity to practice as the primary factors that impede successful placement. However, contrary to our predictions, students rapidly improve their proficiency after only 5 attempts. This data will hopefully clear the way for student involvement in this procedure. Additional

studies are warranted to better define and address these deficits in clinical training and ensure that medical schools and their students are aware of the problem and take measures to correct them.

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Appendix

- 1) To the best of your knowledge, how many IVs have you placed during your time as a medical student? ____
- 2) Of those, estimate how many were unsuccessful and ultimately required another professional to place them? ____
- 3) What do you think was the most common reason that you missed an IV placement? (Chose the single best answer)
 - Choosing the wrong site
 - Improper positioning of the needle
 - Dark skin ton of the patient
 - Previous history of IV drug use in the patient
 - Advanced age of the patient
 - Dehydration of the patient
 - Nervousness
 - Reason unidentifiable
 - Other:
- 4) What have you found to be a general barrier to placing an IV? Check all that apply.
 - ☐ Patient cooperation
 - ☐ Size of the patient
 - ☐ Finding/choosing the appropriate site
 - ☐ Organizing your supplies
 - ☐ Other: _____
- 5) Before medical school did you have prior training as a healthcare professional? Check all that apply.

- ☐ EMT
- ☐ Nursing
- ☐ Paramedic
- ☐ Lab technician
- ☐ Researcher collecting animal/human specimens
- ☐ No prior experience
- ☐ Other: _____
- 6) Did you read/view video or otherwise prepare about the technique for placing IVs before you had the chance to perform it? Check all that apply.
- ☐ Read
- ☐ Watch video
- ☐ No individual preparation
- ☐ *Lecture/lesson from more experienced professional.*
- 7) What is your preferred location to place an IV? Check all that apply.
- ☐ Forearm
- ☐ Antecubital Fossa
- ☐ Dorsal Hand
- ☐ Other: _____
- 8) **Age:**
- 20-25
 - 26-30
 - 31-35
 - 36-40
 - 41-45
 - 46-50
- 9) **What year will you graduate?**
- Class of 2016
 - Class of 2017
- 10) **Sex**
- Male
 - Female
- 11) In which rotation did you place IVs? Check all that apply?

- ☐ Anesthesia
- ☐ Internal Medicine
- ☐ Surgery
- ☐ OB/GYN
- ☐ Other: _____

12) For those that remember: Think back to your first 5 IV sticks. Please check which ones were not successfully placed. When you first started doing IVs? Did you miss the first one and never miss again? Or did you do some and then run into trouble after gaining more confidence and going for more difficult placements?

- ☐ 1st
- ☐ 2nd
- ☐ 3rd
- ☐ 4th
- ☐ 5th

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Figure 1. Percentage of respondents who have or have not placed a single intravenous (IV) catheter

M3 is the third, and M4 is the fourth year class of medical school. Closed column (■) are the portion of students who never placed a single IV catheter, and open column (□) are the portion that placed more than one IV catheter. The maximum number of IVs placed for M3s was 20 while the maximum number for the M4s was 50.

A

B

Figure 2. Prior experience as EMT or Lab Researcher have higher success rate in placement of IV catheters

(A) Self-reported distribution of prior experience among 85 third and fourth year medical students who have placed Intravenous catheters. (B) Mean success rates according to prior experience demonstrates a significantly higher success rate in the group with experience as EMT or lab researchers when compared to the group without experience. Error bars depict Standard Error of the Mean. (C) The number and distribution of IVs students are placing according to their reported prior experience. The percent of each subgroup displayed according to the number of IVs placed. N = 151. The subgroups consist of 35 EMTs, 24 lab

researchers and 92 people who report no prior experience. The black column (■) represents the percent of the subgroup that have never placed IVs. The grey column (■) depicts the percent of the subgroup that placed between 1-10 IVs. The white column depicts (□) the percent of the subgroup that have placed over 11 IVs. (D) The means show no significant difference between the subgroups. Error bars depict Standard Error of the Mean.

A

B Method of Instruction Prior to First IV Placement

Figure 3. Preparation prior to IV placement has no significant impact on success rate
 (A) Self-reported method of preparation of 53 third and fourth year medical students who have placed IVs and report no prior experience. (B) Mean success rates of IV placement for different methods of preparation among those without prior experience. Error bars depict Standard Error of the Mean.

A

B

Student Preference in IV Placement

Figure 4. Success rate is not impacted by the location of preferred puncture site

(A) Self-reported distribution of 79 third and fourth year medical students according to preferred puncture location. (B) Mean success rates of IV placement according to medical students who claim a preference for a specific puncture site. Error bars depict Standard Error of the Mean.

Figure 5. Reasons cited by medical students for failure to successfully place IVs

Technique variables included finding and choosing the appropriate site and organizing supplies. Patient variables included cooperation, the size of the patient and presence of vasculopathy. Systemic factors included lack of opportunities, unwillingness of other practitioners to allow student involvement and the presence of too many learners in the environment.

The First Through Fifth IV Placement

Figure 6. Learning curve depicts rapidly improving success of IV placements within just five attempts

Success rates for the first five attempts of 61 medical students. Numbers in the columns are the percentage of students with successful IV catheter placement. The learning curve shows a steep increase in success from 47% on the first attempt to 86% by the fifth attempt.

Table 1
Demographic characteristics of third and fourth year medical students and one US
allopathic medical school. (n = 180)

Variable	Number of Responses (%)
Age (years)	
20-25	91 (50.5)
26-30	77 (42.8)
30+	12 (6.7)
Gender	
Male	97 (53.9)
Female	83 (46.1)
Class Year	
M4	64 (35.6)
M3	116 (64.4)

Table 2
The number of IVs that third and fourth year students attempted to place. (n = 180)

IVs Attempted	Number of Students (%)	Number of Students (%)
	<u>M3</u>	<u>M4</u>
Zero	76 (66)	14 (22)
One to Five	23 (20)	15 (23)
Five to Ten	12 (10)	16 (25)
Eleven to Fifteen	2 (2)	8 (13)
Sixteen to Twenty	3 (3)	5 (8)
Over Twenty	0 (0)	6 (9)

Table 3
Rotations in which third and fourth year students placed IVs. (n = 88)

Rotation	Number of Responses (%)
Surgery	46 (52.3)
Anesthesia	39 (44.3)
Internal Medicine	15 (17.0)
Emergency Medicine	6 (6.8)
Obstetrics/Gynecology	5 (5.7)
ICU Advanced Electives	4 (4.5)
Neurology	2 (2.3)
Family Medicine	1 (1.1)