

AccuVein Vein Illumination Device (AV400) Improves First Attempt Success Rate for IV Placement in Obese Patients

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Establishing fast and effective peripheral venous (PV) access is essential in clinical practice. The clinician's goal is to achieve venous access rapidly, with the fewest attempts and without causing pain and discomfort to the patients. This study investigates the success rate of a vein illumination device (AccuVein AV400) in establishing peripheral venous access in obese patients presenting to the Emergency Room. Our study demonstrates that the use of AccuVein AV400 improves the single stick success rate of vein cannulation by 3.5 times in BMI 30+ patients. This effect increases in BMI 40+ patients showing an improvement from 50% to 96% in starting PV access (in 2 attempts or less). Clinician satisfaction was high with 85% stating that the AccuVein device is a helpful tool for patients with difficult IV placement.

1. INTRODUCTION

Fast and effective peripheral venous (PV) access is essential for patient's safety and care: for rehydration, in emergency situations, delivering of systemic drugs and for every anesthesia-related procedure. While inhalational anesthesia induction in pediatric patients has been standard care throughout the world for many years, the prerequisite of peripheral venous access in adults prior to anesthesia induction is standard part of clinical practice. The goal is to establish the venous access rapidly, with few attempts and without causing pain and discomfort to the patients.

For patients admitted to the Emergency Department (ED), venous catheterization is essential for immediate medical care, allowing intravenous administration of fluids, medications and contrast agents if required for imaging.

Depending on the clinical setting and patient's characteristics, PV access can at times prove to be difficult for even highly qualified health care personnel. Difficult PV access is classically responsible for increased cannulation attempts, delaying patient management, and increasing both adverse events and patient dissatisfaction. Very few studies have investigated the clinical conditions and risk factors associated with PV access difficulty. Some patient characteristics, such as chronic medical conditions or a history of intravenous drug abuse, are commonly acknowledged to impair PV access.

Obesity can be responsible for PV access difficulty due to pathophysiologic changes associated with this condition. Fat accumulation in the subcutaneous tissue could lead to deeply located peripheral veins that are difficult to catheterize. PV access difficulty has been described in morbidly obese patients (body mass index BMI ≥ 40 kg/m²) in both the operating room and in out-of-hospital emergency medicine conditions. However, obesity was not found to be a risk factor for PV access difficulty in other studies of obese patients (BMI ≥ 30 kg/m²).

Several trials in pediatric patients have been performed using different methods for vein identification with overall consensus that vein illumination is helpful to successfully start an IV in children and in particular in patients age 2 and younger. However, there are very few studies that address the issue of vein identification in adults in particular in patient populations who are known to have difficult veins: cancer and IV drug patients, older and chronically ill patients and patients affected by morbid obesity.

In this study we address the use of a vein illumination device (AccuVein AV400) in obese patients presenting to the Emergency Room Department at the University of Massachusetts Medical Center. The aim of the study was to investigate the efficacy of the device in allowing peripheral vein cannulation at the first attempt in this particular patient population.

Table 1 - Study Design

Title:	Utilization of AccuVein Vein Illumination Device (AV400) To Enhance First Attempt Success Rate for IV Placement in Obese Patients
Study Design:	This portion of the Pilot Clinical Study is to analyze the impact of using a vein illumination device (AccuVein AV400) on the first attempt success rate in starting an IV line in the Obese patient population and investigate staff's perception of device utility.
Description of Study Population:	Obese
Study Objectives:	Analyze the impact of using a vein illumination device (AccuVein AV400) on the first attempt success rate in starting an IV line in the Obese patient population
Study Hypothesis:	Use of the AV400 vein illumination device will enhance the nurse's ability to successfully place an IV line on the first attempt
Study Endpoint:	Success rate for first attempt of IV Line placement
Study Follow-Up:	Clinical follow-up for all subjects is not required
Sample Size:	One hundred and fifty patients
No. of Investigational Sites	UMass Medical School
Inclusion Criteria:	BMI \geq 30

2. HYPOTHESIS AND METHODS

We report on a prospective, randomized, open label trial in 150 consecutive obese patients who presented to the Emergency Department at the University of Massachusetts Medical Center and required an intravenous peripheral line. All patients signed a written consent form and the study was approved and followed by the local Institute Review Board (IRB). The description of the clinical trial is summarized in Table 1.

The patients were randomized (1:1 ratio) to either the use of AV400 for finding an appropriate vein or to a control group where nurses used traditional techniques for identifying peripheral veins.

The AccuVein AV400 (Figure 1) is a vein illumination system that helps to locate veins so they can be accessed or avoided for a variety of procedures including IV starts, blood draw, sclerotherapy, general and cosmetic surgery. It does this by providing a map of the patient's vasculature on the skin's surface. procedures.

AccuVein is a handheld, laser camera/projector and it works by using hemoglobin's infrared absorption and an arrangement of scanned lasers to detect and re-project a vein map directly on the patient's skin.

The hypothesis for the study is that AccuVein AV400 vein illumination device would allow an easier peripheral vein identification in adult obese patients, giving nurses the ability of starting an IV at the first try with less discomfort for the patients.

Obesity was defined as BMI $>$ 30.

Data was collected by a study coordinator and included: patient demographic information, BMI, hip/waist ratio, mean forearm diameter, skin color, hydration state, vein characteristics (visible, palpable etc.), nurse experience (years), numbers of attempts for establishing an IV and needle gauge.

A brief questionnaire regarding the nurse's feedback was also used collecting information on the level of satisfaction with using AccuVein and the usefulness of the device.

3. RESULTS

Table 2 - Multivariate Logistic model

	B	S.E.	Wald	df	P value	Odds Ratio	95% C.I.for EXP(B)	
							Lower	Upper
Step 1 ^a								
device_used	1.210	.469	6.661	1	.010	3.355	1.338	8.411
bmi	-.071	.029	6.099	1	.014	.931	.880	.985
vein_visible	.651	.476	1.868	1	.172	1.917	.754	4.876
vein_palpable	1.506	.550	7.504	1	.006	4.508	1.535	13.238
skin_color			5.318	4	.256			
skin_color(1)	-.299	.469	.408	1	.523	.741	.296	1.857
skin_color(2)	-.342	.862	.157	1	.691	.710	.131	3.845
skin_color(3)	1.100	.957	1.323	1	.250	3.006	.461	19.607
skin_color(4)	1.857	1.199	2.399	1	.121	6.407	.611	67.181
Constant	1.636	1.292	1.604	1	.205	5.134		

The AccuVein AV400 was used in 74 obese patients who presented at the ED requiring an IV to be started.

Results show that across both genders an adequate peripheral vein was successfully found and an IV started in 55 patients at the 1st attempt (74%) and only 16 patients required a 2nd attempt (22%), with an overall success of 96% in starting an IV within 2 attempts.

Table 2 summarizes a multivariate logistic model, attempting to quantify the relationship between the probability of producing a successful first stick and adjusting for as many confounders as possible. The result of this analysis says that people on whom AccuVein AV400 has been used are 3.5 times more likely to have a successful first stick, adjusting for BMI, “quality” of vein and skin color. All other variables did not have an influence on the Odds Ratio (OR) for AccuVein AV400 use. This OR is significant ($p=0.010$).

Despite the relative small number of patients in each of the subcategories of the multivariate analysis, some interesting trends were uncovered.

Gender has an effect on results with female patients benefitting more from the use of AccuVein AV400 when compared to controls: 1.4 average attempts vs. 2.4.

Age also shows an impact on the efficacy of AccuVein AV400 with a general tendency of older patients benefitting more than younger subjects: patients 30-40 years old required an average of 1.3 attempts to start an IV with AccuVein AV400 vs 2.4 attempts for controls. Similarly, in the 40-50 and 60-70 years old category, patients using AccuVein AV400 had a 30-35% improved likelihood to have a successful IV started at the first attempt than control subjects.

Skin Color also represents a variant where AccuVein AV400 shows a positive impact. In this study patients were divided into 5 categories of skin color and results show that the device improves the odds of starting a successful IV in patients with darker skin color with an increased benefit of about 50-60% vs. controls.

Increased BMI also is related to an improved success rate in starting an IV with AccuVein AV400. Patients with a BMI 35-40 require an average of 1.4 attempts vs. 2.2 for controls and for patients with a BMI > 40 the advantage for AccuVein AV400 went to 1.5 vs. 2.7 attempts.

The beneficial effect of AccuVein IV in patients with a BMI > 40 was particularly pronounced in female patients where 67% of subjects received a successful IV at the first attempt vs. only 19% in the control group. Furthermore, first or second stick success for this population was 96% with the use of AccuVein and 50% for the control group.

Overall, the response from the nurses who participated in the study was clearly favorable to the use of the vein identification device. 77% of the nurses agreed or strongly agreed with the statement: "The AccuVein device helped me find veins I did not see through routine inspection" and 85% of them also agreed or strongly agreed with the statement: "The AccuVein device is a helpful tool to use for patients with difficult IV placement".

4. DISCUSSION AND CONCLUSIONS

Several factors may underlie difficult PV access in obese patients. Superficial veins hidden in the subcutaneous fat is the most commonly reported factor in obesity. Peripheral vascular access is rendered difficult, as the veins are harder to see and palpate. In addition, excessive weight may have an effect on vein accessibility that is distinct and independent from the "vein visibility" effect. These elements seem also to be exacerbated in female obese patients where IV access can be particularly difficult as demonstrated by our study.

Peripheral vascular access difficulty is responsible for several needle sticks leading to repetitive cannulation attempts which increase the risk of both mechanical and infectious complications. External jugular intravenous lines, and peripherally or directly inserted central lines are common alternatives to standard methods of IV access when a peripheral IV cannot be rapidly established. Nevertheless, central venous lines are associated with a greater risk of complications, including bleeding and infections, even with ultrasound guidance. More recently, the use of ultrasound guidance by all emergency room providers, including nurses and ED technicians, has been advocated for ED patients with poor vascular access; this practice if implemented could increase the overall cost of emergency room care.

Figure 1 - The AccuVein AV400 Projection



Prospective identification of patients with vascular access difficulty such as in the obese population is important in the ED. Avoidance of repetitive unsuccessful cannulation attempts would allow for better time and procedure management. Furthermore, it would also contribute to reducing patient stress, discomfort, and dissatisfaction.

Our study demonstrates that the use of AccuVein AV400, a vein illumination device based on infrared technology, can significantly improve the success rate of vein cannulation at the first attempt in patients affected by obesity where obtaining vascular access is a well-known challenge.

Results from this clinical investigation show that using the device will improve the rate of rapidly starting a peripheral IV by more than 3 fold. Also, the beneficial impact of using this medical tool is increased in certain patient categories such as female gender, older subjects and patients with darker skin color as it is demonstrated by the Odds Ratios from a multivariate regression.

This pilot study presents some limitations due to the limited number of patients enrolled and also the lack of statistical power. However, this study helps in identifying certain patient subpopulations where further clinical investigation is warranted to better ascertain the clinical impact of vein illumination devices.

Finally, a significant high percentage of ED nurses who participated in the study clearly identify this vein illumination device as very helpful in cannulating veins that are difficult to visualize in patients with known difficult vascular accessibility. A rapid establishment of vascular access would free nursing time, allowing health care personnel to attend different tasks and ultimately would decrease cost.