Vascular access: always central line?

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Hospital Universitari

Introduction

Vascular access in therapeutic apheresis

- **Usual**
  - Peripheral vascular access (PVA)
  - Central venous catheter (CVC) →
    - Infection
    - Thrombosis
    - Insertion complications
    - ...
- **Less common**
  - Venous Access Ports
  - Arteriovenous Fistulas & Grafts

Experts widely agree that **peripheral venous access** should be the first option

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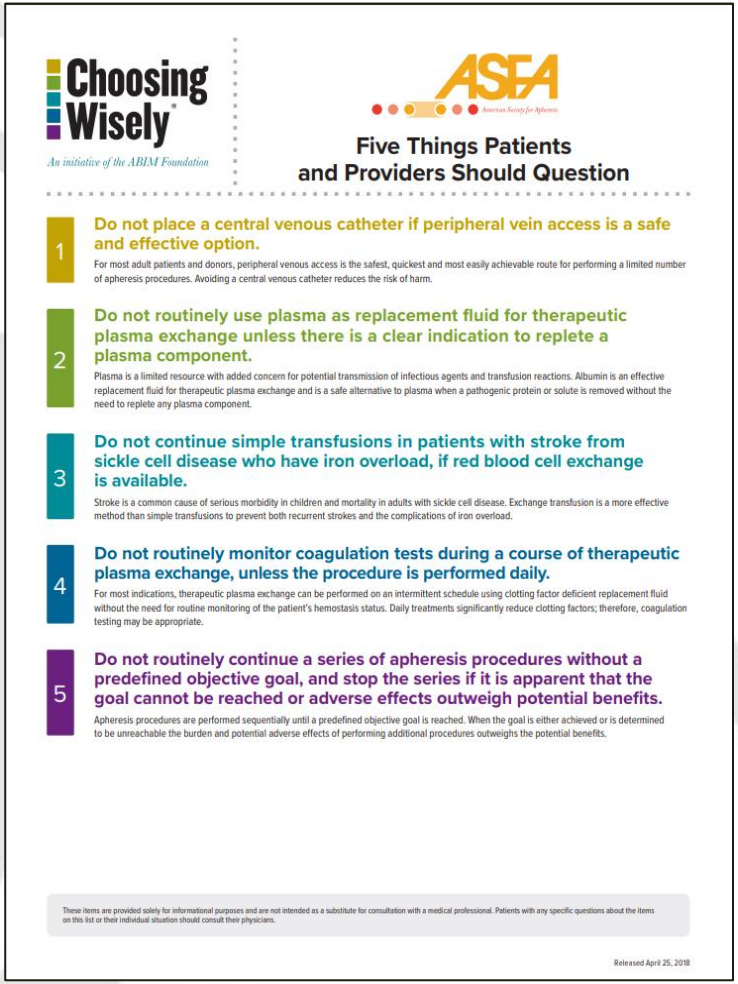

Choosing Wisely®

An initiative of the ABIM Foundation

ASFA

American Society for Apheresis

Five Things Patients and Providers Should Question

1. **Do not place a central venous catheter if peripheral vein access is a safe and effective option.**
   For most adult patients and donors, peripheral venous access is the safest, quickest and most easily achievable route for performing a limited number of apheresis procedures. Avoiding a central venous catheter reduces the risk of harm.

2. **Do not routinely use plasma as replacement fluid for therapeutic plasma exchange unless there is a clear indication to replete a plasma component.**
   Plasma is a limited resource with added concern for potential transmission of infectious agents and transfusion reactions. Albumin is an effective replacement fluid for therapeutic plasma exchange and is a safe alternative to plasma when a pathogenic protein or solute is removed without the need to replete any plasma component.

3. **Do not continue simple transfusions in patients with stroke from sickle cell disease who have iron overload, if red blood cell exchange is available.**
   Stroke is a common cause of serious morbidity in children and mortality in adults with sickle cell disease. Exchange transfusion is a more effective method than simple transfusions to prevent both recurrent strokes and the complications of iron overload.

4. **Do not routinely monitor coagulation tests during a course of therapeutic plasma exchange, unless the procedure is performed daily.**
   For most indications, therapeutic plasma exchange can be performed on an intermittent schedule using clotting factor deficient replacement fluid without the need for routine monitoring of the patient's hemostasis status. Daily treatments significantly reduce clotting factors; therefore, coagulation testing may be appropriate.

5. **Do not routinely continue a series of apheresis procedures without a predefined objective goal, and stop the series if it is apparent that the goal cannot be reached or adverse effects outweigh potential benefits.**
   Apheresis procedures are performed sequentially until a predefined objective goal is reached. When the goal is either achieved or is determined to be unreachable the burden and potential adverse effects of performing additional procedures outweighs the potential benefits.

These items are provided solely for informational purposes and are not intended as a substitute for consultation with a medical professional. Patients with any specific questions about the items on this list or their individual situation should consult their physicians.

Released April 25, 2018

Choosing Wisely for apheresis
Laura Connelly-Smith et al.
J Clin Apher. 2018;33:576–579.

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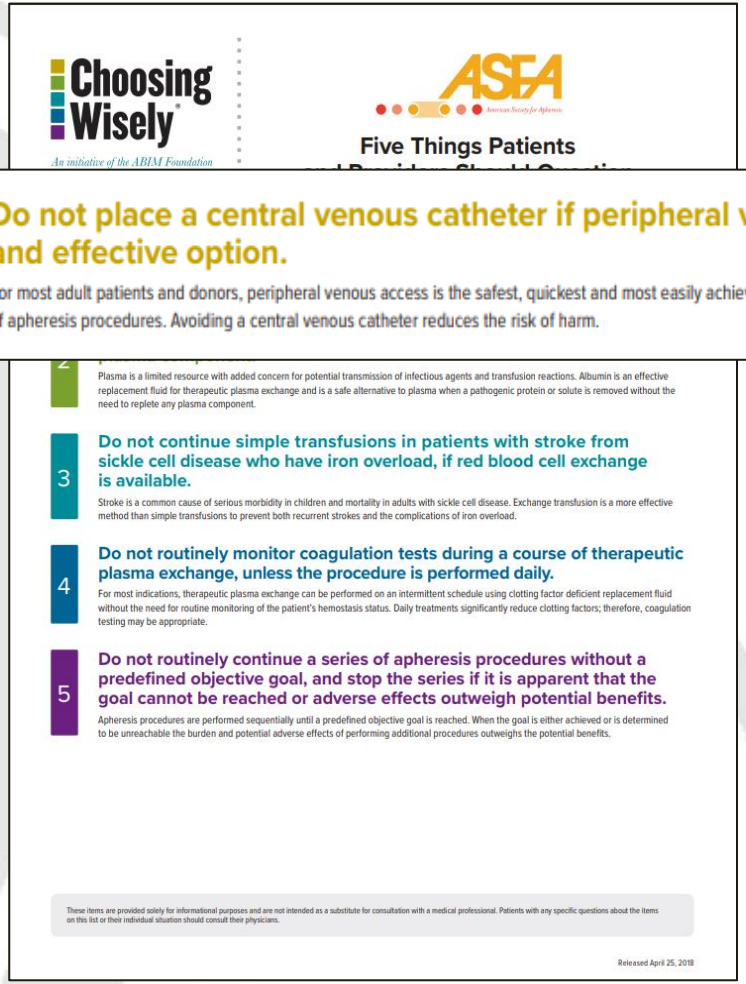

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Five Things Patients

1

Do not place a central venous catheter if peripheral vein access is a safe and effective option.

For most adult patients and donors, peripheral venous access is the safest, quickest and most easily achievable route for performing a limited number of apheresis procedures. Avoiding a central venous catheter reduces the risk of harm.

Plasma is a limited resource with added concern for potential transmission of infectious agents and transfusion reactions. Albumin is an effective replacement fluid for therapeutic plasma exchange and is a safe alternative to plasma when a pathogenic protein or solute is removed without the need to replete any plasma component.

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5

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TABLE 3 Type of vascular access

Type of vascular access site (n = 144)	Patient location	Frequency of use described as a percent of total patients: Never	Rarely (≤10% of patients)	Occasionally (11-50% of patients)	Often (51-90% of patients)	Always (≥ 91% of patients)
Peripheral veins	Inpatient	22 (15.3%)	72 (50.0%)	35 (24.3%)	12 (8.3%)	3 (2.1%)
	Ambulatory	16 (11.1%)	29 (20.1%)	49 (34.0%)	39 (27.1%)	11 (7.6%)
Tunneled, internal jugular or subclavian central venous catheters	Inpatient	7 (4.9%)	35 (24.3%)	48 (33.3%)	40 (27.8%)	14 (9.7%)
	Ambulatory	15 (10.4%)	33 (22.9%)	45 (31.3%)	39 (27.1%)	12 (8.3%)
Nontunneled, internal jugular or subclavian central venous catheters	Inpatient	7 (4.9%)	14 (9.7%)	49 (34.0%)	62 (43.1%)	12 (8.3%)
	Ambulatory	48 (33.3%)	48 (33.3%)	34 (23.6%)	13 (9.0%)	1 (0.7%)
Femoral central venous catheter	Inpatient	14 (9.7%)	74 (51.4%)	39 (27.1%)	16 (11.1%)	1 (0.7%)
	Ambulatory	102 (70.8%)	33 (22.9%)	7 (4.9%)	1 (0.7%)	1 (0.7%)
Intravenous access devices (eg, cutaneous ports)	Inpatient	40 (27.8%)	46 (31.9%)	36 (25.0%)	19 (13.2%)	3 (2.1%)
	Ambulatory	33 (22.9%)	21 (14.6%)	45 (31.3%)	40 (27.8%)	5 (3.5%)
Graft/fistula	Inpatient	39 (27.1%)	71 (49.3%)	30 (20.8%)	3 (2.1%)	1 (0.7%)
	Ambulatory	35 (24.3%)	62 (43.1%)	37 (25.7%)	9 (6.3%)	1 (0.7%)
Arterial lines	Inpatient	137 (95.1%)	6 (4.2%)	0 (0%)	0 (0%)	1 (0.7%)
	Ambulatory	140 (97.2%)	3 (2.1%)	0 (0%)	0 (0%)	1 (0.7%)
Peripherally inserted central catheter	Inpatient	129 (89.6%)	9 (6.3%)	3 (2.1%)	2 (1.4%)	1 (0.7%)
	Ambulatory	132 (91.7%)	5 (3.5%)	2 (1.4%)	4 (2.8%)	1 (0.7%)

Survey to ASFA annual meeting attendees (2018).
Type of vascular access and frequency of use

Tanhehco, YC, Zantek, ND, Alsammak, M, et al. Vascular access practices for therapeutic apheresis: Results of a survey. *J Clin Apher*. **2019**; 34: 571-578. https://doi-org.sire.ub.edu/10.1002/jca.21726

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2 in 3 respondents Never/Rarely used peripheral veins in apheresis to inpatients

1 in 3 respondents Never/Rarely used peripheral veins in ambulatory patients

Survey to ASFA annual meeting attendees (2018).
Type of vascular access and frequency of use

Tanhehco, YC, Zantek, ND, Alsammak, M, et al. Vascular access practices for therapeutic apheresis: Results of a survey. *J Clin Apher*. **2019**; 34: 571-578. https://doi-org.sire.ub.edu/10.1002/jca.21726

Vascular access in general

↓

As small as possible

↓

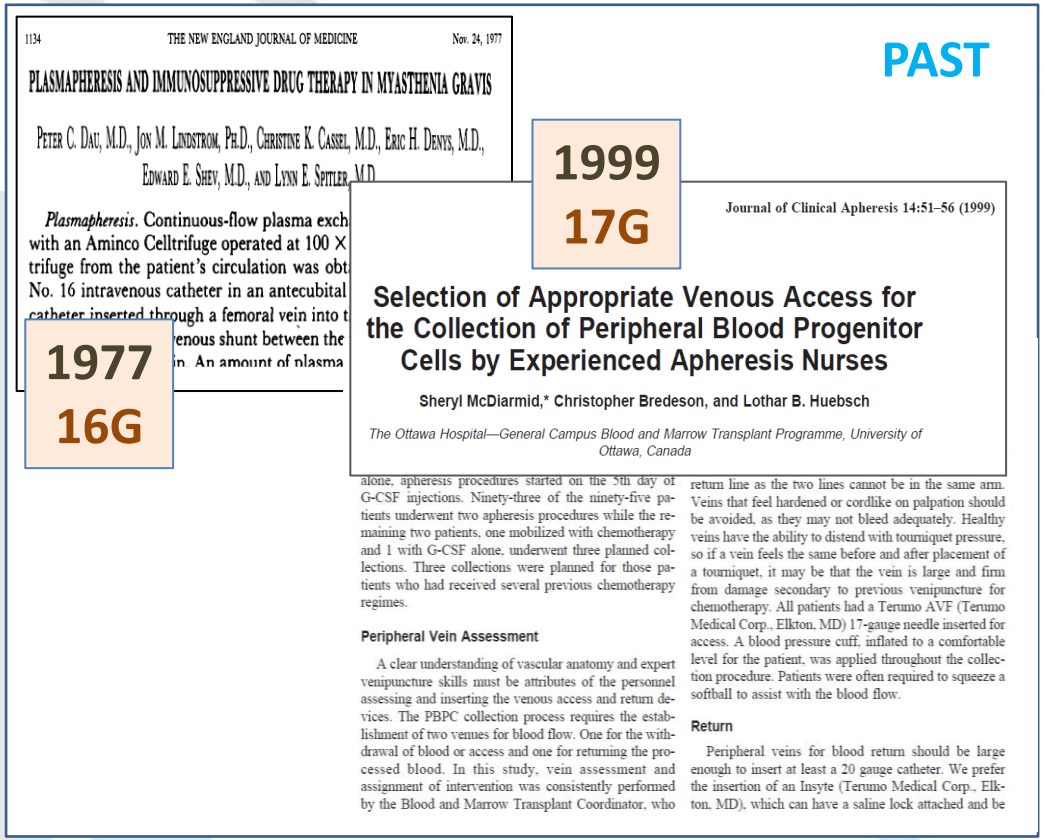
Less
- Phlebitis / Thrombosis
- Vein / Skin damage
- Pain

Two aims

Peripheral veins as 1st option

Needles as small as possible

Needle size in apheresis



1134 THE NEW ENGLAND JOURNAL OF MEDICINE Nov. 24, 1977

PLASMAPHERESIS AND IMMUNOSUPPRESSIVE DRUG THERAPY IN MYASTHENIA GRAVIS

PETER C. DAU, M.D., JON M. LINDSTROM, PH.D., CHRISTINE K. CASSEL, M.D., ERIC H. DENYS, M.D., EDWARD E. SHEV, M.D., AND LYNN E. SPITLER, M.D.

Plasmapheresis. Continuous-flow plasma exch
with an Aminco Celltrifuge operated at 100 ×
trifuge from the patient's circulation was obt
No. 16 intravenous catheter in an antecubital
catheter inserted through a femoral vein into t
enous shunt between the
in. An amount of plasma

1977
16G

PAST

1999
17G

Journal of Clinical Apheresis 14:51–56 (1999)

Selection of Appropriate Venous Access for the Collection of Peripheral Blood Progenitor Cells by Experienced Apheresis Nurses

Sheryl McDiarmid,* Christopher Bredeson, and Lothar B. Huebsch

The Ottawa Hospital—General Campus Blood and Marrow Transplant Programme, University of Ottawa, Canada

alone, apheresis procedures started on the 5th day of G-CSF injections. Ninety-three of the ninety-five patients underwent two apheresis procedures while the remaining two patients, one mobilized with chemotherapy and 1 with G-CSF alone, underwent three planned collections. Three collections were planned for those patients who had received several previous chemotherapy regimes.

Peripheral Vein Assessment

A clear understanding of vascular anatomy and expert venipuncture skills must be attributes of the personnel assessing and inserting the venous access and return devices. The PBPC collection process requires the establishment of two venues for blood flow. One for the withdrawal of blood or access and one for returning the processed blood. In this study, vein assessment and assignment of intervention was consistently performed by the Blood and Marrow Transplant Coordinator, who

return line as the two lines cannot be in the same arm. Veins that feel hardened or cordlike on palpation should be avoided, as they may not bleed adequately. Healthy veins have the ability to distend with tourniquet pressure, so if a vein feels the same before and after placement of a tourniquet, it may be that the vein is large and firm from damage secondary to previous venipuncture for chemotherapy. All patients had a Terumo AVF (Terumo Medical Corp., Elkton, MD) 17-gauge needle inserted for access. A blood pressure cuff, inflated to a comfortable level for the patient, was applied throughout the collection procedure. Patients were often required to squeeze a softball to assist with the blood flow.

Return

Peripheral veins for blood return should be large enough to insert at least a 20 gauge catheter. We prefer the insertion of an Insyte (Terumo Medical Corp., Elkton, MD), which can have a saline lock attached and be

TODAY

Included in disposable kits:

Amicus MNC→ two **17G** needles

Optia CMNC → one **17G** needle

Haemonetics MCS+ → one **17G** needle

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Our experience in Hospital Clinic of Barcelona

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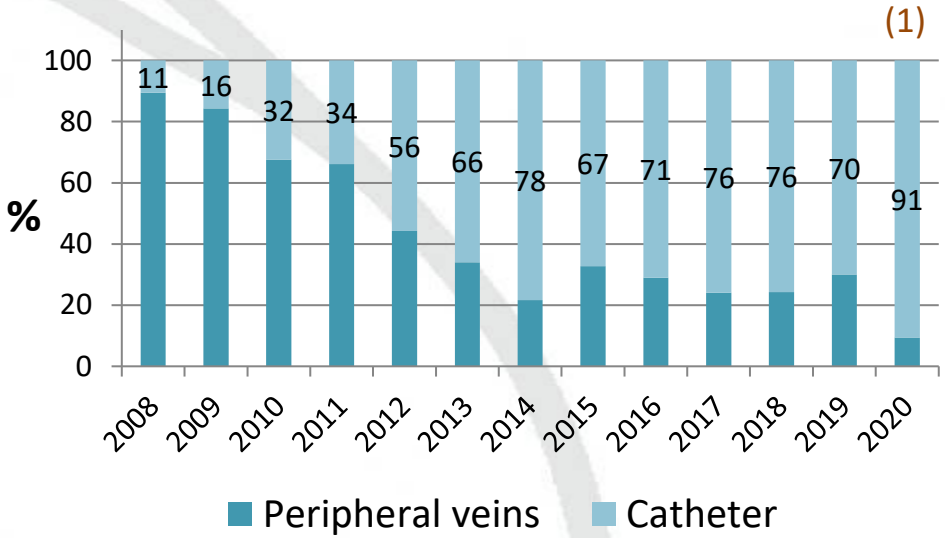
Catheters placed stem cell collections (autologous donors)

Number of collections/year (median): 71 (Range:56-111)



(1)= Ultrasounds system

Peripheral veins as 1st option

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Peripheral venous access Type/Gauge

Years (aprox.)	
1975-2000	Metal needles 16-17G → Inlet and Return
2000-2016	Metal needles 16-17G → Inlet line Plastic cannulas → Return line

→ Always metal needles for inlet line
→ Same gauge for all patients
→ Whole blood donation= 16G
→ Not confident enough to change the patern

Needles as small as possible

2012: First chronic patients
(Photopheresis and Apheresis LDL-Cholesterol)

Classical standards didn’t work

Peripheral venous access review

Peripheral vascular access review

1st step: Knowing needles and cannulas

2nd step: Saving veins

3rd step: Veins assesment

4th step: Maximizing the vein response

Peripheral vascular access review

1st step: Knowing needles and cannulas

- When choosing the peripheral vascular access, sometimes we obtain the expected flow rate and sometimes we don't
- As veins response is not always "logical", we **analized needles**

Learning from Phisics.
Factors determining the flow rate

Hagen–Poiseuille equation

$$Q = \frac{\Delta P \, \pi \, r^4}{8 \, \eta \, l}$$

Q: Flow rate

ΔP : Pressure difference between the two ends of the needle

Large veins provide better flow rates

r : Needle radius

Doubling needle radius multiply flow rate by 16

l : Needle length

Doubling needle length decreases flow rate to half

η: Blood viscosity

Doubling blood viscosity decreases flow rate to half

Ideal situation

Needle:
- Large radius
- Short length

Patient:
- Large vein
- Not very high hematocrit

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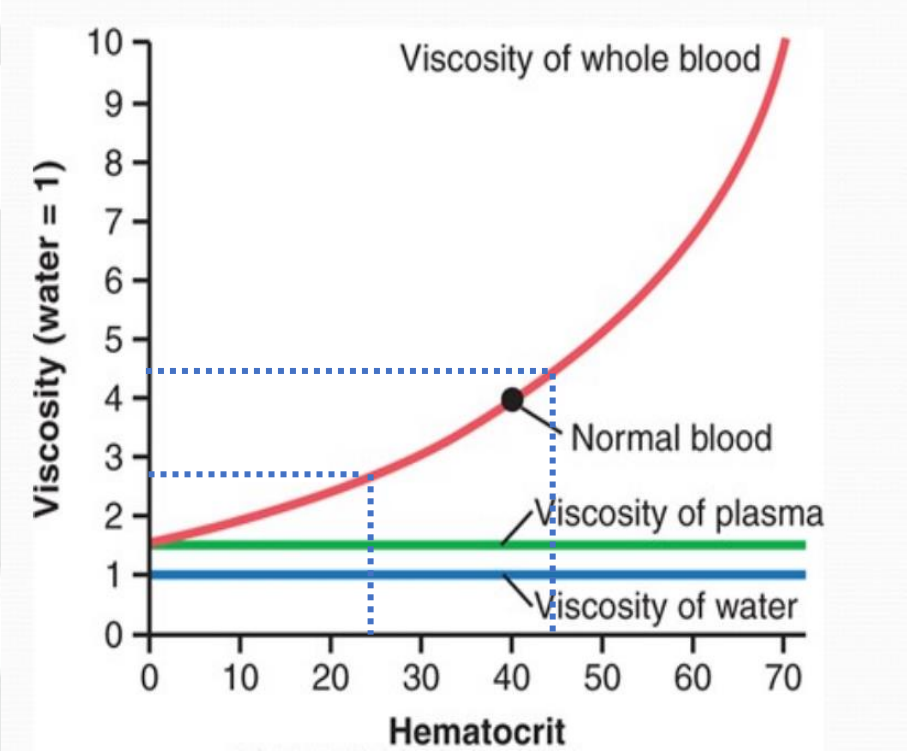
Hematocrit and blood viscosity



Guyton and Hall Textbook of Medical Physiology

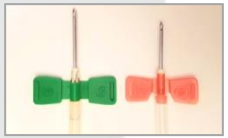
As the range of usual hematocrits (25-45%) is over 20 points, **changes in the flow rate due to hematocrit** can be significative

Avalaible peripheral vascular devices

made for **DIALYSIS**

↓

Flow rates >250 mL/min



made for **APHERESIS**

↓

?

made for **ADMINISTERING FLUIDS**

↓

- Usually low viscosity fluids
- Only in, not out
- Usually by gravity, not pumped fluid

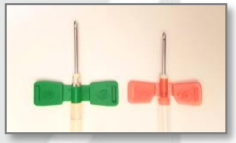
Measuring flow rates

How much flow rate will avalaible common peripheral vascular devices provide **without the intervention of a vein**?

Peripheral venous access devices for apheresis: 16-gauge is not always needed

María-Jesús Mustieles, Maria Acosta, Joan Cid, María Jiménez, Dolors Mateo, Bienvenida Andreu, Cristina Alba, Dolores Perea, and Miquel Lozano

- 2016. In a simulated TPE, we measured the flow rate provided by 2 needles and 6 plastic cannulas using blood at 25, 30, 35, 40, 45% hct.
- We made a table with the flow rates registered and try to follow it when choosing the peripheral vascular device



Flow rates table

Htc	needle 16G	needle 17G	Supercath 15G	Supercath 16G	Venflon 16G	Venflon 18G	Venflon 20G	Venflon 22G
45%	142	142	142	142	142	117	77	45
40%	142	142	142	142	142	119	83	51
35%	142	142	142	142	142	121	87	54
30%	142	142	142	142	142	123	88	55
25%	142	142	142	142	142	133	93	58

Inlet



Htc	needle 16G	needle 17G	Supercath 15G	Supercath 16G	Venflon 16G	Venflon 18G	Venflon 20G	Venflon 22G
45%	142	142	142	142	142	140	94	55
40%	142	142	142	142	142	142	104	62
35%	142	142	142	142	142	142	106	66
30%	142	142	142	142	142	142	109	68
25%	142	142	142	142	142	142	114	68

Return

Mustieles MJ, et al. TRANSFUSION March 2020; 60: 607-12

Changed after the flow rates mesurement

- We've been using the flow rates table for 5 years and now we trust cannulas even as inlet
- We stopped using metal needles and some of the cannulas as we had smaller options
- We use supercath (designed for dialysis) only when desired flow rate is higher than 90-100 **mL/min**
- We have into account hematocrit before choosing the cannula
- If flow rate is lower than expected, we look for the reason not in the cannula but in other factors

Peripheral vascular access review

2nd step: Saving veins

Asking for some external help to save the patient's veins

- Haematology
  - Using PICCs for chemotherapy
  - Sending patients for stem cell collections as 'early' as possible

- Cannulations /Blood tests
  - Avoiding "apheresis veins"

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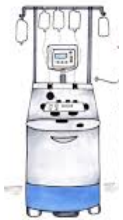
Peripheral vascular access review

3rd step: Veins assesment



Flow rate required by the apheresis device.
It depends on:

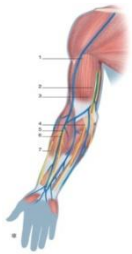
- PROCEDURE
- PACIENT

Demand

- Number of apheresis sessions
- During Days/months/years?
- Blood volume to process
- Is it acceptable a slower procedure?
- Others

Circumstances

Expected flow provided by the VEIN



Supply

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Different PATIENTS
↓
Different flow rate

Optia / Stem cell collection / ACD Rate= 1 mL/min/L / Ratio= 1:24

SAME PROCEDURE

	WB flow rate (mL/min)
Female 50 kg /1,60 m	79
Male 50 kg /1,60 m	89
Female 70 kg /1,70 m	101
Male 70 kg /1,70 m	111

Different PROCEDURES
↓
Different flow rate

Optia / male / 70 kg / 1,70 m / 30% Htc

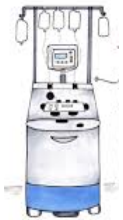
SAME PATIENT

	ACD rate (mL/min/L)	Ratio	Flow rate (mL/min)
Stem cell collections	1	1:24	111
Plasma exchange with albumin	0,6	1:10	94
Plasma exchange with plasma	1	1:10	52
Photopheresis	1	1:12	56

Peripheral vascular access review

3rd step: Veins assesment

1



Flow rate required by the apheresis device.
It depends on:

- PROCEDURE
- PACIENT

Demand

2

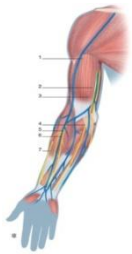
- Number of apheresis sessions
- During Days/months/years?
- Blood volume to process
- Is it acceptable a slower procedure?
- Others

Circumstances

FOLLOWING THE RIGHT SEQUENCE

3

Expected flow provided by the VEIN



Supply

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Expected flow rate from a vein

It's imposible predicting the flow rate that a vein will provide so that, we only can speak in terms of probability

We should have into account:

Is there only one appropriate vein?

- More than one option to cannulate
- Changing cannulation place in following apheresis

If we think that the vein is not a good vein, what's the problem?

Difficult cannulation and probably **correct flow rate**

- Good option for treatments of 1-2 apheresis sessions
- Good option when using ultrasounds system

Easy cannulation and probably **low flow rate**

- Good option for chronic apheresis

Peripheral vascular access review

4th step: Maximizing the vein response

- Cannulation
- During procedure

CANNULATION
How to make the cannulation easier

Actions:

- Patient hydration (drinking or bolus IV fluid)
- Distraction to reduce stress
- Warming the arm some minutes before puncture:
  - Heating pad
- Marking the vein with dots following the vein anatomy
- Using ultrasounds for deep veins

The ability to insert a peripheral vascular access is not related to having good aim with the needle but being patient enough to make the vein appear

PROCEDURE
How to improve the flow rate

Flow rate will be mainly established by the draw vein response

- Remember that many times, veins need some minutes to recover from the puncture

Actions:

- Keeping the tourniquet placed
- Telling the patient to open and close his/her hand
- Using warmer / warming the patient's arm and hand / warming the room
- Pulling the needle/cannula back slightly
- Help the patient relax
  - Trying to avoid alarms sounding
  - Valium 5 mg
  - Nurse calm whatever happens

Examples

Chronic patient

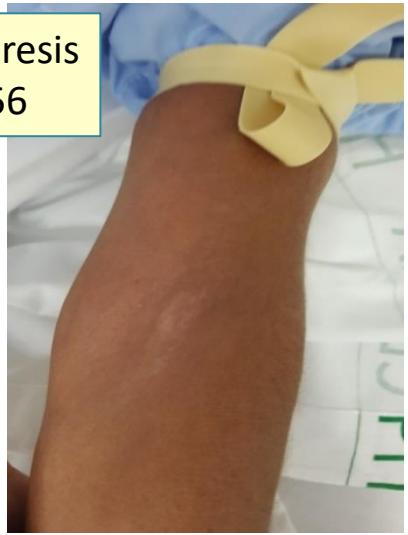
Female / 42 kg

Apheresis LDL cholesterol every 2 weeks

	Procedures	Inlet	Return	Flow rate mL/min	Apheresis System
Aug 2012	1-7	16*	16*	50	Spectra
Nov 2012	8-26	16*	18	50	Spectra
Nov 2013	27-50	18	18	50	Spectra
May 2014	51-92	18	18	70	Optia
Jan 2016	93-211	18	20	70	Optia

*metal needle

Apheresis 156



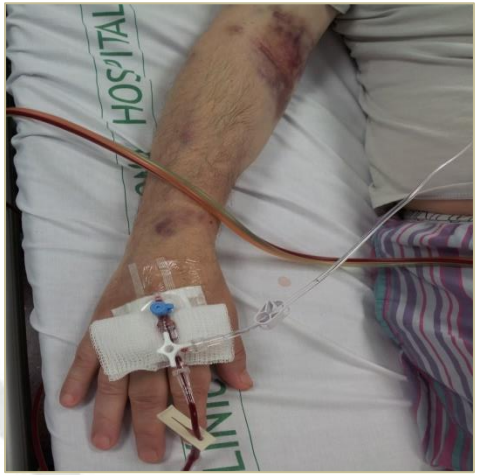
Large veins ⇨Large needle= WRONG
Inlet line requires metal needles= WRONG
If something works, don't change it= NOT ALWAYS RIGHT

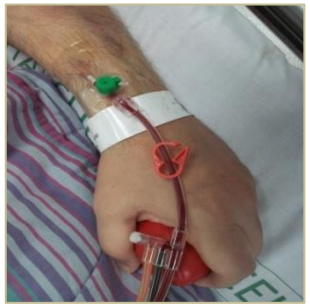
We reviewed vascular access for chronic patients but finally applied the same principles for **all patients**

Last TPE in a patient with hematoma in the draw arm

- TPE with plasma
- Last apheresis session

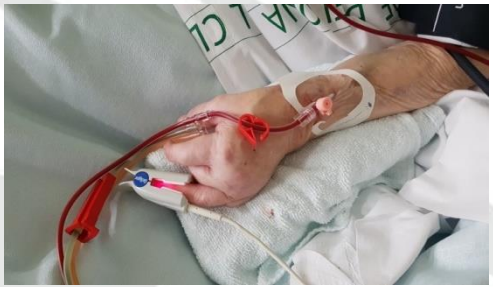
We used return cannula as inlet and a 22G cannula placed for fluids as return



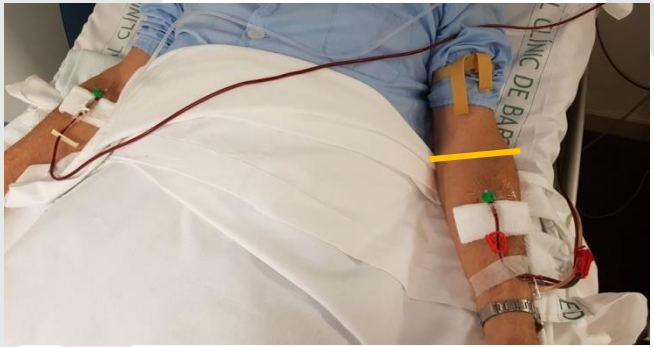


Flow rate: 55 mL/min
Ac Rate:1,0 mL/min/L
Time: 120 min (5 more than the previous TPE)

Other patients with Inlet line **not** in the cubital fossa



- Flow rate: 56 mL/min
- TPE Albumin
- Ac Rate: 0’5 mL/m/L
- Time: 78 min



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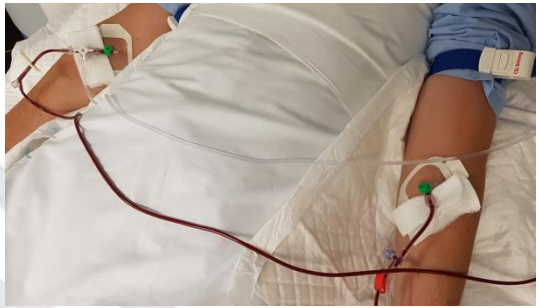
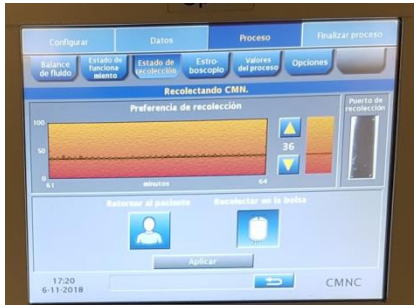
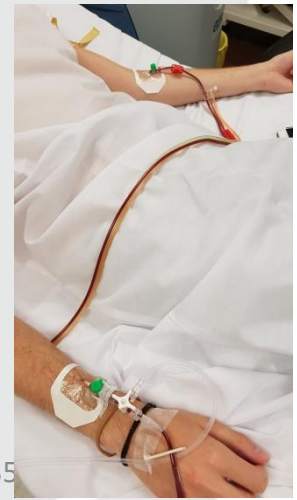




2x Venflon 18G / Stem cell collection
Htc. 37% / 83 Kg / 1.82 m / 'Medium' veins

90 mL/min
Stable interface



2x Venflon 18G / TPE albumin / Large veins

100 mL/min
ACD rate: 0.5 mL/m/L
Time: 63 min (1.2 plasma volumes processed)

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Patient in ICU with a small cannula placed

- TPE with plasma
- Male/ 55 kg / 1’70 m / 27% Htc.

50 mL/min
Ac rate 1,1 ml/m/L
Time: 104 min

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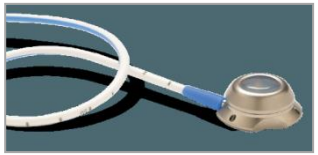
Implantable ports for apheresis



Vortex® Ports
(AngioDynamics, Latham, NY)

TidalPort ™ *(SportPort)*
(Norfolk Medical Products, Inc., Skokie, IL)

Standard use and apheresis

PowerFlow™ Implantable Apheresis IV Port
(Bard Access Systems, Inc., Salt Lake City, UT)

Titan-port APH
(PakuMed medical products gmbh, Essen Germany)

Specifically for apheresis

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Conclusion

- Vascular access are a **main factor** in therapeutic apheresis
- Due to complications associated with CVC, peripheral access should be the **first option**
- A better **knowledge of needles/cannulas** will allow us using vascular devices **as small as possible**, essential in patients on long-term apheresis treatments
- **Optimizing veins** response will allow us to increase flow rates
- Metal needle is **not always required** in the inlet line
- Vascular Access in apheresis: always central line? Certainly, **not always**

Thank you

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