

CATHETER FLOW RATES AND RAPID INFUSION

CLINICAL BEST PRACTICES – JULY 2020

Internal Use Only



WHAT FACTORS IMPACT FLOW RATE?

- Poiseuille's Law
 - The flow of fluids through an IV catheter can be described by Poiseuille's Law. It states that the flow (Q) of fluid is related to several factors: the viscosity (η) of the fluid, the pressure gradient across the tubing (P), and the length (L) and the inner diameter (r) of the tubing.
- Important points:
 - Tubing diameter: an important and frequently cited relationship is that of the tubing's radius. Doubling the inner diameter of a catheter increases the flow rate by 16-fold (r^4). The larger the IV catheter the greater the flow.
 - Fluid Viscosity: flow is inversely proportional to the viscosity of the fluid. Increasing viscosity decreases flow through a catheter.

Q	Flow Rate
P	Pressure
r	Radius
η	Fluid Viscosity
l	Length of Tubing

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



IMPORTANT TIPS

- Catheter IV Size dictates flow rate
- Shorter catheters of the same gauge will run faster than longer ones



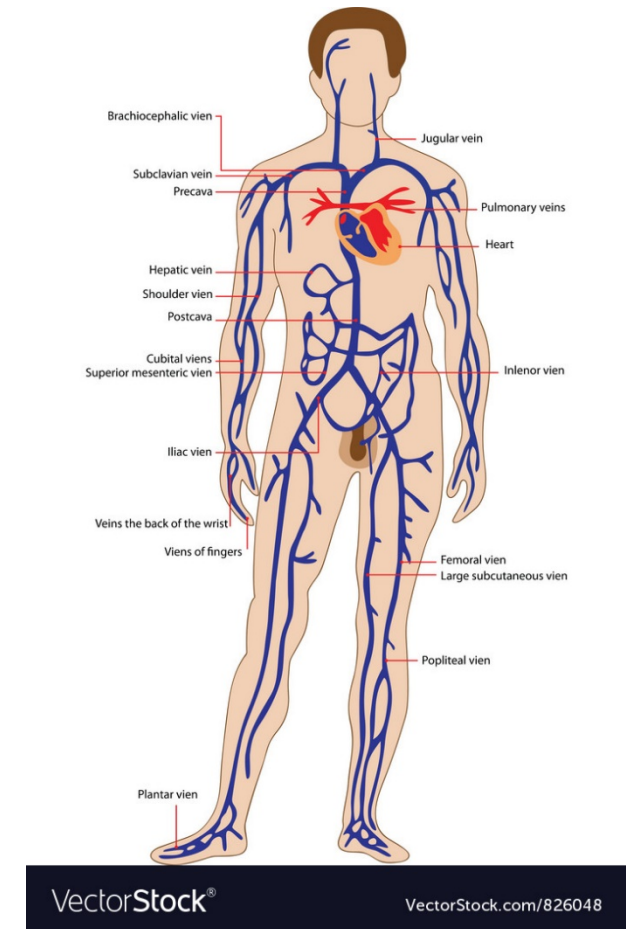
CATHETER SPECIFIC TERMS

- **Needle Gauge:** The gauge refers to the outer diameter of the needle. Needles are routinely available in a variety of gauge sizes, including 18, 21, 23, and 25 gauge. The needle gauge becomes a consideration when the vein of the patient is narrow, fragile, or superficial. *The higher the gauge size, the smaller the outer diameter.*
- **French:** The French catheter scale or "French units" (Fr) is commonly used to measure the outside diameter of needles as well as catheters. 1 "French" or "Fr" is equivalent to $0.33 \text{ mm} = .013" = 1/77"$ of diameter. The **size in French** units is roughly equal to the circumference of the **catheter** in millimeters. *The smaller the French size, the smaller the outer diameter.*
- **Lumen:** Simply put the "inner" spaces of tubes



VENOUS SYSTEM AND LOCATIONS

- Lines are placed in the venous system
- Catheters can be placed in the central venous system or peripheral system



PERIPHERAL INTRAVENOUS CATHETERS

- Peripheral catheters are color coded to enable a quick visual on size
- Note there are several systems for color coding of gauge size. Always refer to the manufacturer's labeling and packaging for information.

Illustrative Example Only

Color	Gauge
Yellow	24
Blue	22
Pink	20
Green	18
Gray	16
Orange	14

Adapted from:

1. BD Insyte™ Autoguard™ BC Shielded IV Catheter with Blood Control Technology Brochure 3229 (01/20) BD-0635
2. B Braun PATIENT ACCESS IN INFUSION THERAPY SAFE AND EFFICIENT FROM START TO FINISH Date of last revision: 06.2018



CENTRAL VENOUS CATHETER: LUMEN OPTIONS

Triple, dual and single lumen catheter configurations

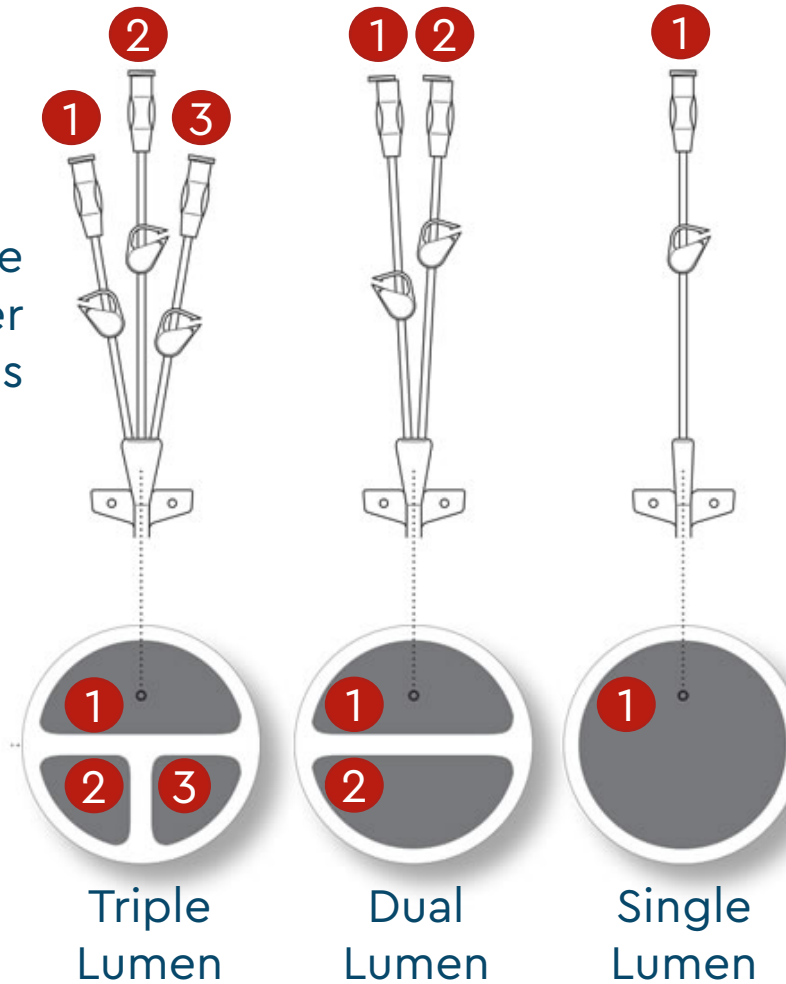


Image Source: <https://www.crbard.com/Peripheral-Vascular/en-US/Products/POWERLINE-Central-Venous-Catheter>



EXAMPLE OF CATHETERS



Single Lumen



Dual Lumen



MAC Catheter
(Multi-Lumen Access Catheter)



Triple Lumen

CENTRAL LINES AND RAPID INFUSION

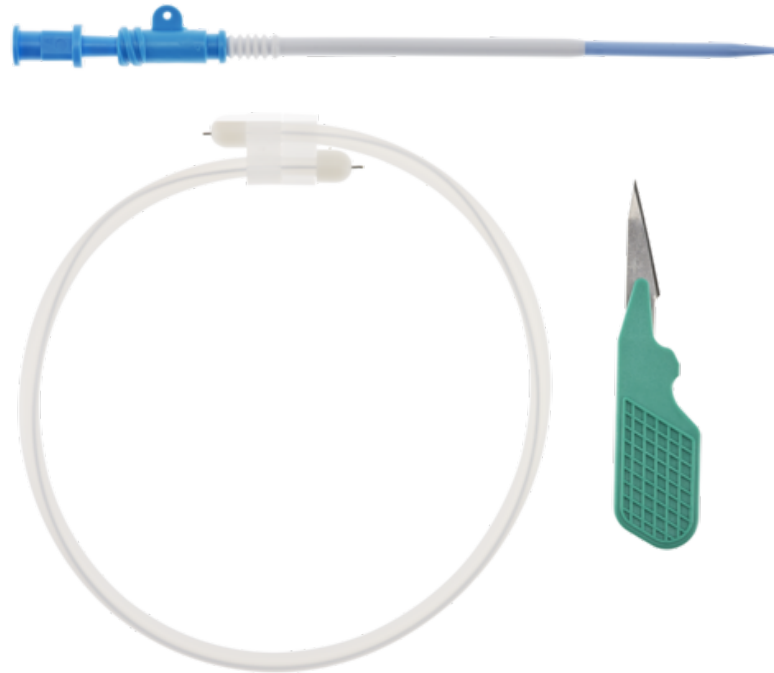
- Central venous catheters (combined with sensors) allow measurement of hemodynamic variables that cannot be measured accurately by noninvasive means, allow delivery of medications that cannot be given safely through peripheral venous catheters, and can provide an access site for fluid delivery in patients where peripheral access is difficult.¹
- When discussing central lines versus peripheral lines, the most important point is that the French size and length of the catheter play a major role in the way the catheter will perform.
- A single dedicated intravenous access should be used exclusively for infusing blood components and solutions compatible with blood.

1. McGee, David C., A Gould, Michael K. T Preventing Complications of Central Venous Catheterization 2003/03/20 J New England Journal of Medicine P 1123-1133; 348, 12; 10.1056 <https://www.nejm.org/doi/full/10.1056/NEJMra011883>



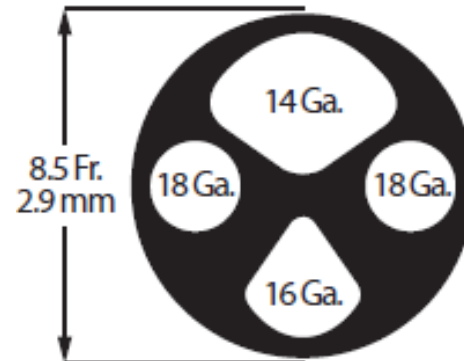
R.I.C. (RAPID INFUSION CATHETERS)

- The **rapid infusion catheter (RIC)** is a device used to convert standard peripheral intravenous (PIV) access into a large-volume resuscitation portal.



EASY WAY TO DETERMINE FLOW RATES

Expected flow rate with saline at gravity is listed on the packaging



Catheter Cross Section

Lumen	Priming Volume* (mL)	Flow Rate† (mL/hr)	MAX Pressure Injection Flow Rate‡ (mL/sec)
Distal (16 Ga.)	0.39	3350	5
Medial 1 (14 Ga.)	0.47	6000	10
Medial 2 (18 Ga.)	0.36	1750	not rated
Proximal (18 Ga.)	0.38	1950	not rated

* Priming volumes are approximate and are done without the injection cap.
 † Based on 100 cm head height.
 ‡ Pressure injection flow rates are determined using media of 11.8 centipoise viscosity, with 60" administration set tubing.

Source: https://www.teleflexvascular.com/products/cdc-42854-p1a?taxon_id=3 - Packaging label



HANDY IV GUIDE BY COMPANY

- Many catheter companies publish charts outlining the size and flow rates at gravity
- When used with the Belmont Rapid Infuser, higher flow rates will be achieved as the pump provides greater force than gravity alone
 - As stated in Poiseuille's law, in-line pressures will increase as the diameter of the catheter decreases
 - The in-line pressure increase may trigger pressure control or a high-pressure alarm in smaller catheters

BD Insyte™ Autoguard™ BC Shielded IV Catheter with Blood Control Technology¹

Color	Gauge	Catheter Length (in)	Outer Diameter (mm)	Gravity Flow Rate (ml/min)
Yellow	24	0.75	0.7	20
Blue	22	1.00	0.9	37
Pink	20	1.00	1.1	63
Pink	20	1.16	1.1	61
Pink	20	1.88	1.1	54
Green	18	1.16	1.3	95
Green	18	1.88	1.3	87
Gray	16	1.16	1.7	193
Gray	16	1.77	1.7	185

B Braun INTROCAN SAFETY® 3 Closed IV Catheter²

Color	Gauge	Catheter Length (in)	Outer Diameter (mm)	Gravity Flow Rate (ml/min)
Yellow	24	0.75	0.7	20
Blue	22	1.00	0.9	35
Pink	20	1.00	1.1	65
Pink	20	1.25	1.1	60
Pink	20	2.00	1.1	55
Green	18	1.25	1.3	105
Green	18	1.75	1.3	100
Gray	16	1.25	1.7	195
Gray	16	2.00	1.7	185
Orange	14	1.25	2.2	325
Orange	14	2.00	2.2	310

1. BD Insyte™ Autoguard™ BC Shielded IV Catheter with Blood Control Technology Brochure 3229 (01/20) BD-0635
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KEY TAKE-AWAYS

- IV Catheter Size dictates flow rate, bigger cannula tends to flow faster
- The Belmont Rapid Infuser RI-2 pressure control feature will adjust the flow rate to deliver fluid to the patient at the safest speed for that particular catheter.
- If customers have questions about a specific catheter always refer them to the packaging. Almost all IV packs will come with some form of volume delivery number.
 - Note: the number listed for average flow rate is usually for saline at gravity

