

# References - Catheter Flow Rates

Dave Berman

DaveBerman@jhmi.edu

## Published papers:

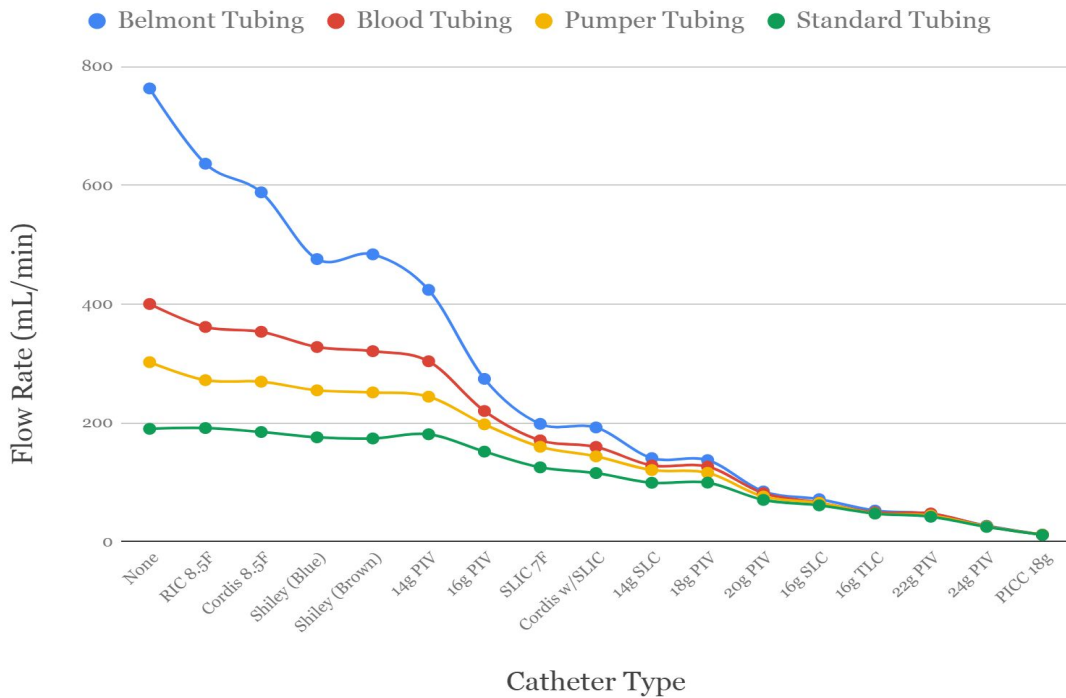
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## Images from publication currently in submission, the author's own work:

*Figure 1* - Configuration for testing catheters of various sizes.



*Figure 2 - Catheter flow rate versus infusion set type. Flow rates through each catheter were measured with all four infusion sets regularly used at our institution. The data show the influence of both catheter selection and infusion set type on flow rate. CVC, central venous catheter; PICC, peripherally inserted central catheter; PIV, peripheral intravenous catheter; RIC, rapid infusion catheter; SLC, single-lumen catheter; SLIC, single-lumen infusion catheter*



*Figure 3 - An inset of the slower catheters from figure 2.*

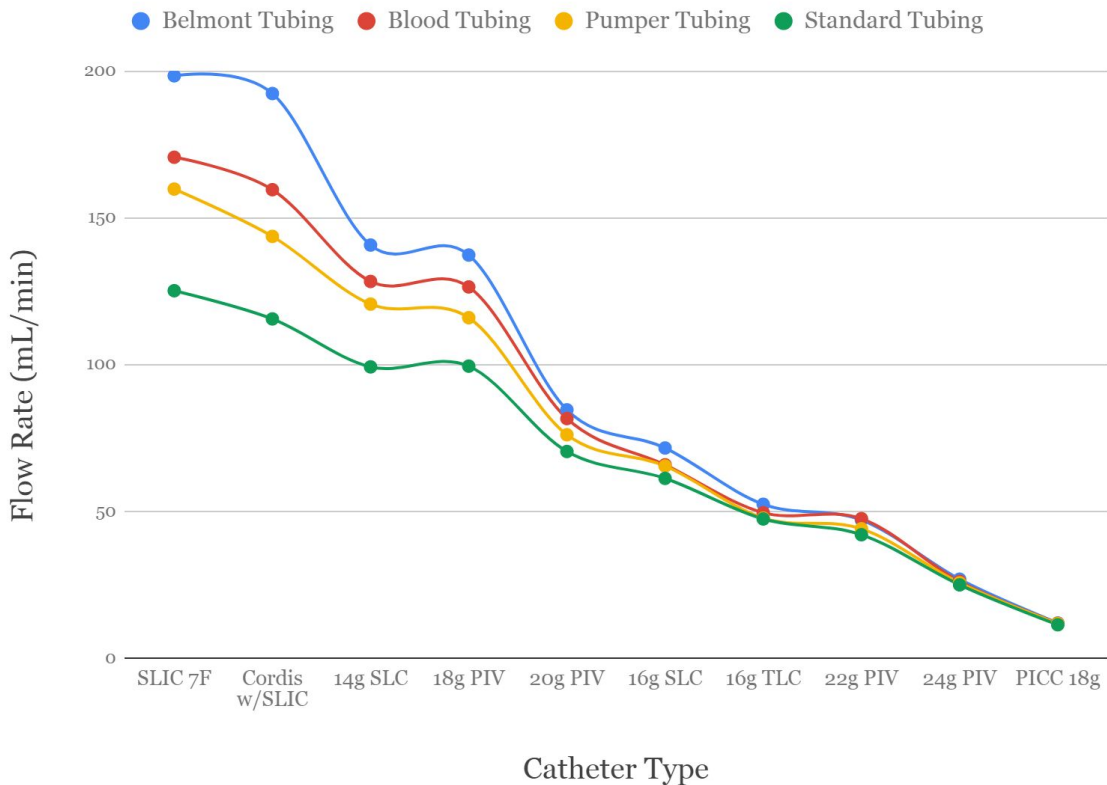


Figure 4 - Flow rate vs. infusion set and added equipment.

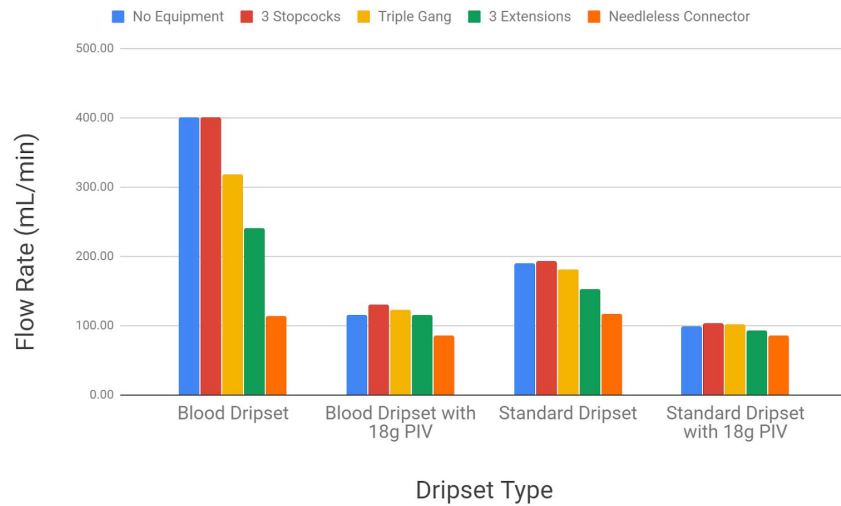


Figure 5 - Relative viscosity of colloids and crystalloids.

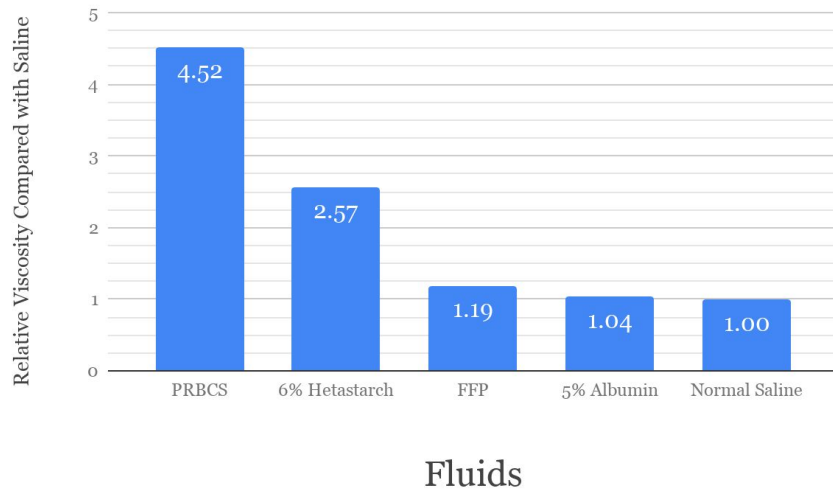


Table 1 - Catheters Tested

Catheter	French (Fr)	Gauge	Diameter (mm)	Length (cm)	Manufacturer-Rated Maximal Flow (mL/min)
RIC	8.5	11.8		6.4cm	Not rated
Cordis	8.5	11.8		10cm	Not rated
Cordis with SLIC	8.5 with 7-Fr catheter in lumen	11.8			Not rated
Shiley	13.5 dual-lumen	<10	4.5	20cm	Not rated
14g PIV	6.3	14	2.1	4.5	350
16g PIV	5	16	1.7	3	215
SLIC	7	13.3		20	Not rated
14g Single CVC	6.3	14	2.2	16	Not rated
18g PIV	3.8	18	1.3	3	105
20g PIV	2.7	20	1.1	2.5	65

16g Single CVC	5	16		16	Not rated
16g Triple CVC	5	16	2.4	20	Not rated
22g PIV	2.	22	0.9	2.5	35
Dual-lumen PICC	5 (each lumen 18g)	18	55	55	Not rated
24g PIV	1.7	24		1.4	26

CVC, central venous catheter; PICC, peripherally inserted central catheter; PIV, peripheral intravenous catheter; RIC, rapid infusion catheter; SLC, single-lumen catheter; SLIC, single-lumen infusion catheter

**Table 2 - Tubing and Adjuncts Tested**

<b>Equipment Nickname</b>	<b>Equipment Name</b>	<b>Manufacturer</b>
Standard infusion set	SmartSite Gravity Set	CareFusion, San Diego CA
Alaris infusion set	BD Alaris Pump Infusion Set	CareFusion, San Diego CA
Pumper tubing	Primary Y-Type Blood Set	ICU Medical Inc, San Clemente CA
Belmont tubing	The Belmont 3-Spike Disposable Set	Belmont Instrument Corporation, Billerica MA
Blood tubing	Primary Blood Set	Hospira Inc, Lake Forest IL
Extension set	Extension Set with 4-Way Stopcock & Spin-Lock	Codan USA Corporation, Santa Ana CA
Stopcock	Hi-Flo 4-Way Stopcock with Swivel Male Luer Lock	Smiths Medical ASD Inc, Dublin OH
Triple gang	Adult Set Carrier Gang Stopcocks	Smiths Medical ASD Inc, Dublin OH
Needleless connector	One-Link Needle-free IV Connector	Baxter Healthcare Corp, Deerfield IL