The MaxPlus® Needleless IV Connector Flow Rate Performance

Introduction

Ninety percent of all hospitalized patients receive intravenous therapy. From a bolus of fluid delivered in the ER to reduce the complications of dehydration, to the delivery of medications and nutrition in the ICU, providing intravenous therapies in the correct dose depends in part on the flow rate of therapeutic fluid delivered to the patient through a catheter. Fluid delivery rates will vary significantly based on the type of therapy, patient size and fluid requirements. For example, critical care of neonatal patients require extremely low flow rates often maintained by accurately calibrated infusion pumps, sometimes as little as 0.5 ml per hour. Fluid delivery to catheterized patients in the ICU may vary from as low as 10 ml per hour for maintaining an open line, to higher flow rates required for fluid replacement. Ninety percent of the patients receiving IV therapy, including surgical patients receiving IV sedation, will receive fluid delivery at a rate of less than 2 liters per hour. The remaining ten percent of patients will require flow rates greater than 2 liters per hour. Approximately two percent of these will be trauma patients who may require fluid delivery rates nearing 1 liter per minute to maintain circulation and blood pressure.

It is well documented that the fluid flow rate to the patient can be dramatically altered based on the types of intravenous fluid delivery devices used. A long administration set or a catheter with a small inner diameter will create restrictions to flow rate that may substantially reduce fluid delivery. The use of large bore tubing sets and catheters will facilitate higher fluid delivery rates. Needleless access devices are commonly used to cap intravenous catheters and are accessed to administer fluids to the patient. It has been suggested that these devices add restriction to the IV administration set and may further decrease flow rate.

Objective

To determine the flow rate of needleless connectors and their effect on catheter flow rate in order to provide clinicians with an accurate assessment of needleless access device flow rates and capabilities with regard to intravenous fluid delivery.

Procedure

ISO Standards establish the guidelines for infusion set performance and methods to test performance characteristics. The testing procedure in this study was designed utilizing the ISO standard to accurately determine flow rate. The test measures the flow rate of a device accessed by a male luer lock through a standard bore IV administration set at a 39" head height. The flow rate is determined based on time required to collect 60 ml of solution. This measurement is then converted to L/hr. Measurements reflect an average flow rate of a sample size of five devices.

In addition to testing the flow rate of needleless connectors, testing was performed to determine the flow rate of two catheter sizes commonly used in clinical settings and the effect of a connector on catheter flow rate. A Becton Dickenson Insyte 22 gauge catheter was selected as the test catheter most representative of peripheral intravenous catheter use. The Bard PowerPicc Solo Dual Lumen 6 French catheter was selected as representative of central venous catheter use. Fluid flow rate was measured at gravity and at a pressure of 300 mm/HG, created using a standard pressure infusion cuff, simulating the infusion rate required for massive transfusions and rapid fluid replacement.

Test Results

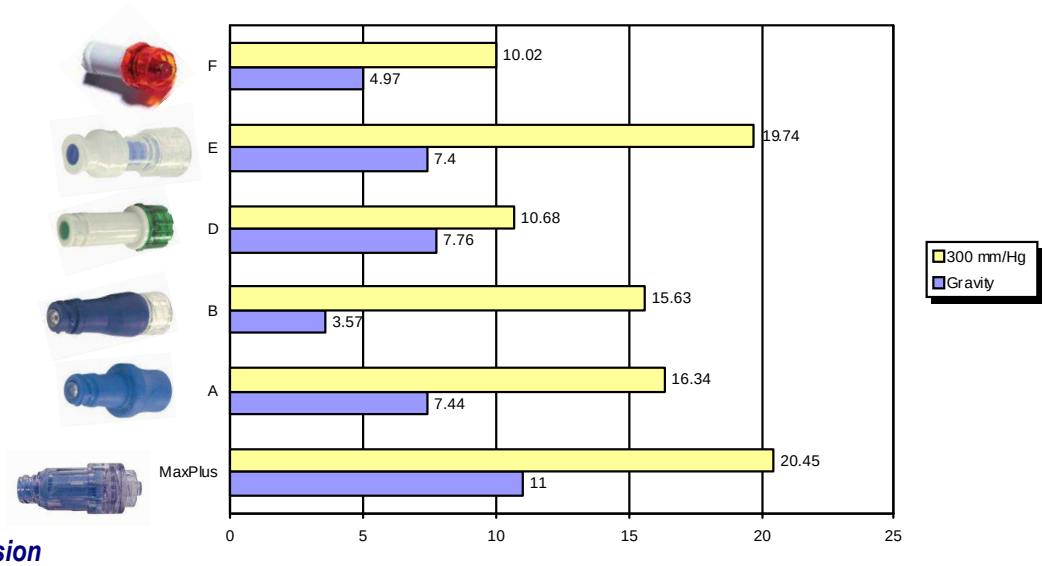
Connector Type	Flow Rate through Admin Set	Flow Rate through Admin Set & Catheter	Δ from Catheter	Flow Rate through Admin Set Catheter & Connector	Δ from Needle-less Connector	Needleless Connector Effect on Flow Rate
Gravity Flow Rate in Liters per Hour						
Results with Bard PowerPicc 6 Fr						
MaxPlus Clear 	16.65	.86	-15.79	.87	+.05%	Insignificant
A 	16.65	.86	-15.79	.83	-.15%	Insignificant
B 	16.65	.86	-15.79	.85	-.12%	Insignificant
C 	16.65	.86	-15.79	.86	0	Insignificant
D 	16.65	.86	-15.79	.85	-.11%	Insignificant
E 	16.65	.86	-15.79	.88	+.16%	Insignificant
F 	16.65	.86	-15.79	.85	-.10%	Insignificant
Results with BD InSyte 22 Gauge						
MaxPlus Clear	16.65	3.66	-12.99	3.66	0	Insignificant
A	16.65	3.66	-12.99	3.45	-.14%	Insignificant
B	16.65	3.66	-12.99	3.33	-.22%	Insignificant
C	16.65	3.66	-12.99	3.67	+.13%	Insignificant
D	16.65	3.66	-12.99	3.07	-4.65%	Insignificant
E	16.65	3.66	-12.99	3.54	-.92%	Insignificant
F	16.65	3.66	-12.99	3.23	-.28%	Insignificant
300 mm/Hg Flow Rate in Liters per Hour						
Results with Bard PowerPicc 6 Fr						
MaxPlus Clear	25.44	3.05	-22.39	3.09	+.19%	Insignificant
A	25.44	3.05	-22.39	3.04	-.01%	Insignificant
B	25.44	3.05	-22.39	3.00	-.20%	Insignificant
C	25.44	3.05	-22.39	3.05	+.04%	Insignificant
D	25.44	3.05	-22.39	2.95	-.33%	Insignificant
E	25.44	3.05	-22.39	3.07	+.13%	Insignificant
F	25.44	3.05	-22.39	2.98	-.22%	Insignificant
Results with BD InSyte 22 Gauge						
MaxPlus Clear	25.44	7.71	-18.34	7.65	-2.28%	Insignificant
A	25.44	7.71	-18.34	7.38	-2.83%	Insignificant
B	25.44	7.71	-18.34	7.12	-4.36%	Insignificant
C	25.44	7.71	-18.34	7.88	+1.29%	Insignificant
D	25.44	7.71	-18.34	6.20	-8.09%	Decreased Flow Rate
E	25.44	7.71	-18.34	7.70	-.58%	Insignificant
F	25.44	7.71	-18.34	6.53	-5.99%	Decreased Flow Rate

Test Results Discussion

The results in the preceding Tables illustrate that needleless connectors in most cases do not significantly impact fluid flow rate through the catheter. The variable exerting the most impact on flow rate is the catheter itself, which causes restriction to fluid delivery when compared to the free flow rate of a simulated IV administration set.

The MaxPlus delivers a flow rate of 180 ml per hour, equivalent to a 16 gauge catheter, substantially higher than most other connector designs. One study found that a 140 ml per minute flow rate was sufficient to stabilize most patients in trauma situations requiring massive transfusions[1]. Common practice in trauma cases is to establish two patient IV lines, or to insert a large catheter into a large vein and connect the administration set directly to the catheter hub in order to establish a high rate of infusion[2]. Trauma requirements such as these are infrequent, far outnumbered by more common intravenous delivery requiring lower administration rates.

Connector Flow Rate Comparison through Standard Bore Administration Set



Conclusion

The MaxPlus delivers a high flow rate providing clinicians increased options for therapy delivery, which can assist in enhancing patient care. The MaxPlus connector accommodates a comprehensive range of intravenous administration requirements and is suited to virtually all clinical applications. From the low fluid requirements of neonatal and KVO ("keep the vein open") therapy to infusions requiring a high rate of delivery, the MaxPlus can facilitate optimal intravenous fluid administration.

References:

1. Rieger, Armin MD DEAA, et al, "Safe and Normothermic Massive Transfusions by Modification of an Infusion Warming and Pressure Device" Journal of Trauma-Injury Infection and Critical Care, 39(4): 686-688, October 1995
2. Iserson, Kenneth V., et al, "Comparison of Flow Rates for Standard and Large-Bore Blood Tubing" The Western Journal of Medicine, 143(2): 183-185, August 1985

Maximus

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