Clinical and Translational Science Institute
UNIVERSITY of FLORIDA

Device for preventing air embolus when using pressurizing cuffs with air-containing IV bags

Gonsalves D, BS[1]; Lampotang S, PhD[1,2]; Gravenstein N, MD[1]

[1]Department of Anesthesiology, Center for Safety, Simulation & Advanced Learning Technologies, University of Florida College of Medicine,
[2]Clinical and Translational Science Institute Simulation Core

cssalt Center for Safety, Simulation & Advanced Learning Technologies

Introduction

Risk of administering a lethal dose of air (100-300 mL)[4] from intravenous (IV) fluid bags increases with pressurizing cuffs[1]. Risk mitigation ranges from de-airing IV bags during initial spike to expensive electronic[3] or mechanical devices. We evaluated in a bench model a shell placed between a pressurizing cuff and IV bag for efficacy in trapping air within emptied 1 liter IV bags.

Methods

A test system (Fig 1) was set up with and without the embolus prevention device (Fig 2), an IV pole, vented collecting container (p=1 atm), 1L IV bag (0.9% Sodium Chloride, Baxter, IL), tubing set (Gravity Set, #10793510, Cardinal Health, CA) and a pressurizing cuff (C-Fusor 1000, Smiths Medical, OH). 5 randomly selected pressure cuffs of the same model were used. A tourniquet machine (A.T.S 3000, Zimmer, IN) maintained 300 mmHg cuff pressure. The device was compared against control - no shell added - (n=5) with initial liquid and air volumes of 1000 mL and (55 or 105 mL)[2] respectively using an unpaired t-test (p=0.05). Air volumes in the bag were measured with a 60 mL syringe[3]. The internal volume of the tubing set, 28±1 mL, connecting the IV bag to the collection bag was measured by completely flooding it with water and measuring it with syringe (n=5). Air bubbling in the collection bag indicated 'patient' air embolism.

This translational work was inspired by Kayser Enneking, MD who made us all acutely aware of this patient safety issue.

Results

Air volume in full IV bags from the factory and after IV spike, was 52±3 and 66±5 mL respectively in accordance with Gravenstein[2]. With the embolus prevention device, more air was retained in the IV bag after it emptied ($p<0.05$). Air was never administered to the 'patient' in any of the trials with the device (Fig 3). At an initial air volume of 55 mL, air volume retained in the emptied IV bag was 33±1 and 25±3mL w/ and w/out the device respectively, a 23% decrease. At 105 mL initial air volume, retained air volume was 86±3 and 45±11 mL w/ and w/out the device respectively, a 91% decrease. With the shell in use, the difference between the initial and retained air volumes in the IV bag was always less than the IV tubing dead space; air exiting from the IV bag was totally trapped in the tubing dead space.

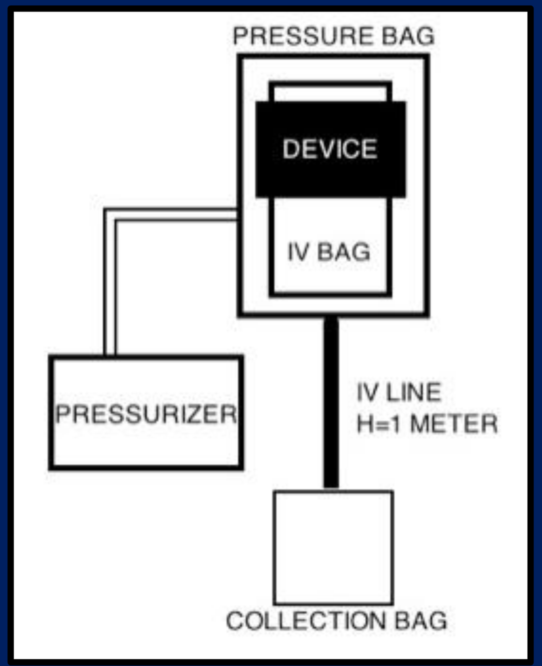

Fig 1: Test Setup

Fig 2: Device

Pressurized air embolus events

		Count
55mL	Device	0/5
	Control	1/5
105mL	Device	0/5
	Control	5/5

Fig 3: Incidence of bubbling in collection bag (simulated air embolus)

Conclusions

A rigid shell between a pressurizing cuff and IV bag is efficacious at preventing air embolus in a bench model. Further refinement lends itself to complete exclusion of air from the IV tubing.

References

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Samsun (Sem) Lampotang, PhD slampotang@anest.ufl.edu

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