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BRIEF REPORT

Evaluation of Fluid Bolus Administration Rates Using Ruggedized Field Intravenous Systems

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Objective.—The purpose of this study was to evaluate 2 ruggedized field intravenous (IV) systems currently in use by US military medics and to determine their effect on fluid bolus administration rates.

Methods.—A series of 500 mL fluid boluses consisting of either Lactated Ringer's solution or Hextend were delivered to 2 artificial intravenous training arms using a standard 18G catheter (control) and 2 separate ruggedized field IV systems. Fluid boluses were delivered under both gravity force and pressure infusion (constant 300 mm Hg), and total bolus times were recorded.

Results.—Using Lactated Ringer's solution, the standard IV system took a mean time of 9:33 minutes (95% CI: 9:13–9:54) to deliver a 500 mL fluid bolus whereas the 2 ruggedized field systems took mean times of 14:50 minutes (95% CI: 14:00–15:40) and 12:20 minutes (95% CI: 11:54–12:45). Using Hextend, the mean bolus time for the control system was 24:39 minutes (95% CI: 22:47–26:32). The 2 ruggedized field systems required an average of 49:32 minutes (95% CI: 48:07–50:58) and 39:46 minutes (95% CI: 37:30–42:01) to deliver an equivalent bolus. Pressure infusion significantly increased flow rate in all systems.

Conclusions.—Ruggedized field IV systems can significantly delay fluid bolus rates. In instances where ruggedized field systems are deemed necessary, pressure infusion devices should be considered to overcome the constrictive effects of the ruggedized system.

Key words: ruggedized field IV, Ranger IV, saline lock, tactical combat casualty care (TCCC), fluid resuscitation, pressure infusion

Introduction

Under current tactical combat casualty care (TCCC) guidelines, the rapid delivery of fluid bolus challenges is a cornerstone of resuscitation for the hypovolemic trauma patient in the tactical and austere environment. Recommendations for the treatment of casualties who have massive hemorrhage and are displaying signs of shock include a 500 mL bolus of Hextend (6% hetastarch in lactated electrolyte injection) delivered as quickly as possible.[1,2] Moreover, rapid fluid bolus administration within the tactical and austere medical arena is not simply limited to instances of massive hemorrhage. Entrapped crush-injured patients can require large volumes of crystalloid fluid over short periods, often before extrication.[2,3] In instances when rapid fluid administration is required, a significant rate-limiting factor is often the junction between patient and the administration line: the catheter. Although civilian recommendations typically involve the initiation of 1 or more 14G to 16G catheters for trauma resuscitation, smaller 18G catheters are favored in the tactical and field settings because of their higher rate of successful placement.

To prevent accidental dislodgement of intravenous catheters during transport, 2 variants of ruggedized field IV systems, or "Ranger IVs" (so called because of their development by the US Army Rangers), have become increasingly common in the past several years (Figures 1 and 2). Whereas traditional IV systems involve connecting the fluid administration line directly to the peripheral catheter hub, these ruggedized field systems involve first connecting a *pro re nata* (PRN) adapter to the catheter and then covering the catheter and PRN adapter with a transparent dressing, creating a saline lock. The next step is what differentiates the 2 variants of ruggedized field systems. Variant 1, currently taught to US military

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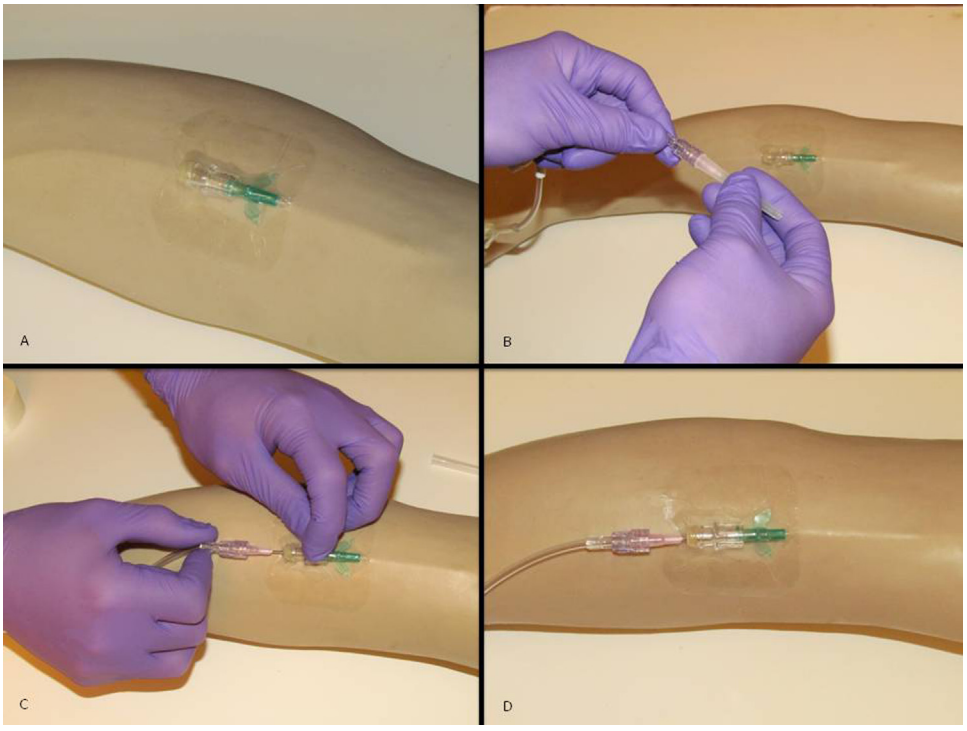

Figure 1. Steps for initiating a ruggedized field IV variant 1: (A) A peripheral 18G IV catheter and saline lock are established and covered with a transparent dressing; (B) an 18G hard needle is connected to the administration line; (C) the hard needle is inserted through the transparent dressing into the saline lock; and (D) the completed system.

Special Operations combat medics, requires that the IV administration line be connected to an 18G hard needle and that the needle be inserted into the saline lock (Figure 1).[4] Variant 2, the type more commonly found in medical references, requires that a second 18G catheter be inserted into the saline lock and that the IV administration line be connected to this secondary catheter (Figure 2).[1,5]

Both of these field ruggedized systems allow for 2 advantages over a standard IV system. First, they provide for the most efficient use of supplies in low resource environments. The initial saline lock provides critical vascular access without committing limited fluids to a patient who may not require volume resuscitation. Second, when used to deliver IV fluid, they prevent accidental catheter dislodgment and the loss of IV access. If the IV line were to become snagged or placed under sudden tension, the secondary catheter or hard needle inserted into the PRN adapter would simply be pulled out, leaving the original saline lock in place and thus preserving IV access. Although these ruggedized field systems have the obvious benefit of preventing accidental loss of IV access and minimizing waste in resource-critical environments, they also limit fluid flow rate under circumstances in which rapid administration is the goal. This paper attempts to determine what impact the use of ruggedized field IV systems has on the rate of fluid bolus administration.

Methods

A series of 500 mL fluid boluses were administered to 2 IV catheterization training arms (Life-form Injectable Training Arm LF00698, Nasco, Fort Atkinson, WI) using the systems described in the following text. Both training arms were set up identically.

STANDARD IV, CONTROL

The arms were cannulated in identical locations with 18G 1.25-inch (Introcan safety winged-FEP, B Braun, Melsungen, Germany) peripheral venous catheters. Fluid administration sets (IV administration set with universal spike and spin-lock connector, B-Series set, 15 drops per mL, B Braun Medical, Bethlehem, PA) were connected directly to the catheters.

RUGGEDIZED FIELD (RANGER) IV, VARIANT 1

The administration set was removed from the existing peripheral catheter and a PRN adapter was connected (Baxter interlink injection site 2N3379, Baxter Healthcare Corp, Deerfield, IL) (Figure 1). An 18G hard needle