Continuous Flush Devices for Vascular Pressure Monitoring

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Abstract. Six different types of continuous flush devices have been assessed for accuracy in vitro and ease of use in vivo. Only two types of device matched the manufacturers’ specifications of performance. The other four gave higher flow rates than expected.

Key words: Flush device – Pressure monitoring – Accuracy

Monitoring of arterial and venous pressure is common practice in patients receiving intensive care. It may be required for relatively long periods of time, up to several days, therefore prevention of clot formation by continuous flushing of the indwelling vascular cannula is indispensable for obtaining good quality recording wave forms and pressures [1, 3]. “Flush” devices have been used in large numbers in many centres since their development by Sorenson Research Company over a decade ago [4]. The working principle of this original device is simple: its main component is a fine bore glass capillary tube allowing approximately 3 ml/h of fluid to flow when attached to a pressurized source of 300 mm Hg. A manual valve, which only operates when actively held open, is provided for the rapid flushing of the catheter when the pressure wave form appears damped or for filling the transducer dome and catheter when setting the system.

These disposable plastic units are relatively inexpensive and the demand for them has been increasing whilst at the same time differences in design have been made. There is very little information available, from any of the manufacturers, as to the accuracy, reliability and ease of use of the different types.

This study evaluates and compares those types of continuous flush device that can be currently obtained commercially.

Methods and Materials

Laboratory and clinical tests were carried out on six different flush devices (Fig. 1); the Pharmaseal (AHS/International, Herstal, Belgium), the Critiflo (Gould, California), the Intraflo (Sorenson Research, Utah), the Angio-Flo (the Deseret Company, Utah), the Steriflo (Cobe Monitoring, Colorado) and the Norton (Norton Health Care Products, Ohio).

Twenty-five samples of each device were tested: 10 in vitro and 15 in vivo. The in vitro testing was 24 h and the in vivo ranged from 10 to 38 h (mean ± S. D., 23 ± 7). For all tests the fluid used was a heparinized solution of 0.18% NaCl and 4.0% Dextrose (Viaflex-Travenol Laboratories Ltd.). An intravenous admin-

Fig. 1. Continuous flush devices: a Pharmaseal; b Critiflo; c Intraflo; d Angio-Flo; e Steriflo; f Norton
Table 1. Comparative performance of continuous flush devices

<table>
<thead>
<tr>
<th>Device model</th>
<th>Angio-Flo</th>
<th>Critiflo</th>
<th>Intraflo</th>
<th>Norton</th>
<th>Pharmaseal</th>
<th>Steriflo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Deseret Company</td>
<td>Gould</td>
<td>Sorenson Research</td>
<td>Health Products</td>
<td>AHS/International</td>
<td>Cobe Monitoring</td>
</tr>
<tr>
<td>Price (£)</td>
<td>2.56</td>
<td>2.80</td>
<td>2.77</td>
<td>3.65</td>
<td>3.31</td>
<td>3.80</td>
</tr>
<tr>
<td>Flow rate/h (ml)</td>
<td>4.1 (±1.3)</td>
<td>3.1 (±0.3)</td>
<td>2.9 (±0.2)</td>
<td>5.7 (±1.3)</td>
<td>3.6 (±0.9)</td>
<td></td>
</tr>
<tr>
<td>Mean error (%)</td>
<td>36.7</td>
<td>3.3</td>
<td>-3.3</td>
<td>90.0</td>
<td>43.3</td>
<td>20.0</td>
</tr>
<tr>
<td>Range of error (%)</td>
<td>-6.6–96.7</td>
<td>-10.0–30.0</td>
<td>-13.3–6.7</td>
<td>26.6–153.3</td>
<td>26.7–60.0</td>
<td>-26.6–73.3</td>
</tr>
<tr>
<td>Mean variability (%)</td>
<td>55.0</td>
<td>12.7</td>
<td>8.0</td>
<td>35.7</td>
<td>11.0</td>
<td>37.7</td>
</tr>
<tr>
<td>Fast flush rate/s (ml)</td>
<td>0.6</td>
<td>1.1</td>
<td>0.6</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

a Exclusive of VAT

It is easy to set up and air bubbles can be easily cleared from the system. The accuracy of the Critiflo is very good. When the fast flush mechanism is activated the device provides a flow rate of 1.1 ml/s.

**Critiflo**

This device is the first to be marketed and has been available for nearly 10 years [5]. Most other flush devices are based on its working principle. The rate of flow is controlled by the in-line resistance of fine bore glass tubing. Each unit is available with or without a 10 micron filter attached to the inlet line.

Despite many good features, such as clear plastic construction, reliability and accuracy of infusion rates, the Intraflo has several limitations. Priming a new device requires meticulous care to remove air bubbles and can cause considerable wastage of fluid. The fast flush valve must be released with a “snap” to ensure that it subsequently closes properly.

**Angio-Flo**

This lavender coloured plastic device has no moving components. The fast flush valve is activated by pressure between the forefinger and thumb on the silicone sleeve. All units are provided with six micron particulate filters.

Bonding of the silicone sleeve to the main body of the device is poor. Three out of 15 devices leaked during clinical use. One additional unit was rejected when the transducer port cracked during assembly.

**Pharmaseal**

This continuous flush device is a part of Pharmaseal’s invasive monitoring kit. A simple one-handed squeeze activates the fast-flush mechanism and a 10 micron filter is provided for additional filtration. It has a long male Luer-Lock connector at the catheter port which can firmly secure a stopcock.

Because of its light blue colour and translucent flush chamber entrapped air bubbles are difficult to detect. The mean flow rate, at a bag pressure of 300 mm Hg, is slightly higher than that specified by the manufacturers (2–4 ml/h).

**Steriflo**

This is one of the components of Cobe’s haemodynamic monitoring system. Its transparent clear plastic construction facilitates visualization of air bubbles. A spring-loaded push-button is used for fast flush operations.