Advantages and disadvantages of colloid and crystalloid fluids

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Plasma volume expanders – crystalloid, colloid, or a mixture of both – are used as fluid replacement in patients who have postoperative hypovolaemia. Despite numerous clinical trials there is little evidence that either classification of plasma volume expander is more beneficial to mortality than the other.

The debate on colloid versus crystalloid intravenous infusions in fluid resuscitation remains inconclusive (Moretti et al, 2003) and has escalated recently, possibly due to the publication of several systematic reviews on the subject (Webb, 1999).

Recent meta-analyses have created uncertainties regarding the appropriateness of using colloid fluid resuscitation in patients who are critically ill (Schierhout and Roberts, 1998) and this has prompted changes in fluid-management practice.

Hypovolaemic shock
There are numerous clinical situations in which fluid resuscitation will be needed. The most common are:

- Trauma;
- Burns;
- Sepsis;
- Hypovolaemic shock.

Plasma volume expanders – crystalloid, colloid, or a mixture of both – are used to restore vascular volume, stabilise circulatory haemodynamics and maintain tissue perfusion (O’Neill, 2001). Hypovolaemic shock occurs when there is a reduction of intravascular volume by 15 per cent or more (O’Neill and Perrin, 2002).

The initial goal when treating hypovolaemia is to stop the volume loss and then restore the circulating volume. If fluid restoration is done too early it can promote bleeding (Webb, 1999). Loss of the circulating fluid decreases venous return and leads to decreased stretch of ventricular muscle. This reduces cardiac output and results in hypotension and poor perfusion. There are many factors to consider regarding fluid resuscitation.

Plasma volume expanders
Plasma volume expanders, in the form of colloid or crystalloid solutions, work to restore intravascular volume by increasing the oncotic pressure in the intravascular space.

Water moves into the intravascular space, increasing the circulatory volume, which subsequently increases central venous pressure, cardiac output, stroke volume, blood pressure, urine output and capillary perfusion.

These increased measurable values lead in turn to the decrease of heart rate, peripheral resistance and blood viscosity (O’Neill, 2001).

Crystalloid fluids
The more commonly used crystalloid solutions are:

- Normal saline;
- Hartman’s solution;
- Ringer’s solution.

O’Neill and Perrin (2002) describe crystalloid fluids as balanced salt solutions that freely cross capillary walls. They stay in the intravascular space for a shorter time than colloids, the half-life of crystalloids being 30 to 60 minutes (O’Neill, 2001).

Crystalloid fluids will demonstrate an early marked plasma expansion, which is short lived but can be maintained by using a colloid as well (Webb, 1999). Therefore crystalloids are shown to be useful for fluid replacement or maintaining fluid balance in the short term only.

The volume of fluid replacement to be given is a major consideration when replacing lost volume with a crystalloid solution. Three times the volume lost has to be administered (O’Neill, 2001). This is because only approximately one-third of the fluid administered will stay in the intravascular space, with two-thirds passing directly into the tissues (Bradley, 2001).

Advantages and disadvantages
The advantage of crystalloid fluid resuscitation is that volume has not only been lost from the intravascular space, but also extracellular water has been drawn to the intravascular space by oncotropic pressure.

Solutions with lower sodium concentrations distribute more evenly throughout the total body water. This means that crystalloid solutions with higher sodium concentrations are more effective as plasma expanders (Platt and Wade, 2002). Crystalloid therapy may, however, adversely affect microcirculatory blood flow and oxygenation when used in cases of shock, resulting in hypoxia even after resuscitation (Krau, 1998).

The main disadvantage of using a crystalloid fluid is that excessive use will cause peripheral and pulmonary oedema (Bradley, 2001).

Colloid fluids
Commonly used colloids include:

- Gelatins;
- Hetastarch;
- Albumin;
The selection of the type of fluid to use depends on the primary origin of the exact kind of fluid loss, the condition of the patient and the preference of the prescribing clinician (Krau, 1998).

It is generally agreed that colloid solutions act more promptly to secure homeostasis (Krau, 1998) but some studies did indicate that crystalloid solutions are adequate for volume replacement (Alderson et al, 2001; Schierhout and Roberts, 1998).

McIlroy and Kharasch (2003) concluded that rapid colloid infusion increased blood volume and therefore cardiac output more effectively than crystalloid infusion.

Krau’s (1998) study showed that patients who received colloids experienced reduced fluid requirements, superior haemodynamics performance and shortened intensive care requirements in comparison with those who received crystalloids.

However, the Cochrane Report (Alderson et al, 2001) states that there is no evidence to indicate that use of colloids, although effective at expanding the circulation, improves mortality in the critically ill patient. The same report goes so far as to suggest that there is little justification for the use of colloid outside the context of randomised controlled trials.

A systematic review by Choi et al (1999) highlights the need for further trials and indicates that insufficient data is available to suggest abandoning the use of colloids in practice. Schortgen et al (2001) assert that the little evidence that exists is contradictory.

It is important to remember that the choice of fluid for resuscitation is only one small part of measures taken in the quest for reduced mortality (Webb, 1999).

There is little conclusive evidence that mortality or morbidity outcomes are affected by the choice of either colloid or crystalloid fluid (Bradley, 2001) and mortality has not been found to be related to the specific fluid used for resuscitation (Moretti et al, 2003).

Limitations of the research

The research available is subject to major criticisms:

- First, analysis of tests that were carried out using one type of colloid only was presented as applicable to all colloids without sufficient justification;
- Second, a supposition that mortality is affected by the choice of fluid may have been implicit in the design of the recent meta-analyses.

Conclusion

Despite numerous and extensive clinical trial there remains little evidence that either classification of plasma volume expander, when used in fluid resuscitation of a patient with hypovolaemia, is more beneficial than the other.

Consequently there is wide agreement that more research is needed. In the meantime, in the absence of definitive data, critically ill patients should be treated according to their clinical needs at the time with due consideration of all relevant factors.

The contentious issue of colloid versus crystalloid solution in fluid resuscitation will continue to be debated. As the body of available research increases it is vital therefore for nurses to keep abreast of all developments so that they can be safe practitioners and ensure optimal care for their patients.

<table>
<thead>
<tr>
<th>CRYSALLOIDS</th>
<th>COLLOIDS</th>
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<tbody>
<tr>
<td>Half-life of 30-60 minutes</td>
<td>Half-life of several hours to days</td>
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<tr>
<td>Three times the lost volume needed for replacement</td>
<td>Replaces fluid volume for volume</td>
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<tr>
<td>Significant financial benefit</td>
<td>Expensive</td>
</tr>
<tr>
<td>Excessive use can cause peripheral and pulmonary oedema</td>
<td>Excessive use can precipitate cardiac failure</td>
</tr>
<tr>
<td>Molecules small enough to freely cross capillary walls so less fluid remains in intravascular space</td>
<td>Molecules larger and remain in intravascular space longer</td>
</tr>
<tr>
<td>Non-allergenic</td>
<td>Risk of anaphylactic reactions</td>
</tr>
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</table>

- Plasma protein fraction; Dextran.

There has been criticism of research, however, because tests involved a single colloid type only but the conclusions drawn were applied to the whole classification of colloids (Krau, 1998). Those who support the use of colloids argue that because in hypovolaemia the intravascular space is the site of injury, fluid resuscitation should be aimed at the optimal restoration of the intravascular space (Bradley, 2001).

Advantages and disadvantages

Colloids are better than crystalloids at expanding the circulatory volume, because their larger molecules are retained more easily in the intravascular space (Kwan et al, 2003) and increase osmotic pressure (Bradley, 2001). However, excessive use of colloids can precipitate cardiac failure, and pulmonary and peripheral oedema (O’Neill, 2001). Although the pulmonary oedema caused by excessive use of colloids is delayed in comparison with that caused by colloids, it is more sustained (Bradley, 2001). Schierhout and Roberts (1998) also found that fluid resuscitation using colloids can cause pulmonary oedema as well as anaphylactic shock and they can lead to a small increase in the rate of death.

Gelatins can cause anaphylactic reactions and there is concern regarding the possible transmission of bovine spongiform encephalopathy (Bradley, 2001).

In addition, colloids are required for fluid challenges, as 200ml of colloid solution will re-expand intravascular volume by 200ml (Webb, 1999).

Comparisons

The selection of the type of fluid to use depends on the primary origin of the exact kind of fluid loss, the condition of the patient and the preference of the prescribing clinician (Krau, 1998).

It is generally agreed that colloid solutions act more

REFERENCES


Moretti, E. et al. (2003) Intra-operative colloid administration reduces postoperative nausea and vomiting and improves postoperative outcomes compared with crystalloid administration. Anaesthesia and Analgesia; 96: 2, 611-617.


