**OBJECTIVE** To review the literature on use of the Trendelenburg position as a position for resuscitation of patients who are hypotensive.

**METHODS** PubMed online, cited bibliographies, critical care textbooks, and Advanced Cardiac Life Support guidelines were searched for information on the position used for resuscitation. Because of the heterogeneity of the data, only pertinent articles and chapters were summarized.

**RESULTS** Eight peer-reviewed publications on the position used for resuscitation were found. Pertinent information from 2 critical care textbooks and from the Advanced Cardiac Life Support guidelines was included in the review. Literature on the position was scarce, lacked strength, and seemed to be guided by “expert opinion.”

**CONCLUSION** The general “slant” of the available data seems to indicate that the Trendelenburg position is probably not a good position for resuscitation of patients who are hypotensive. Further clinical studies are needed to determine the optimal position for resuscitation. (American Journal of Critical Care. 2005;14:364-368)

Shock is a relatively common life-threatening condition in out-of-hospital and in-hospital acute care settings such as emergency departments, operating rooms, and intensive care units. Optimal positioning of patients during the resuscitation period, either to maximize effort and outcome or to minimize further injury, seems like a basic consideration to bear in mind and is probably clinically relevant.

The Trendelenburg position was originally used to improve surgical exposure of the pelvic organs. It is credited to German surgeon Friedrich Trendelenburg (1844-1924). After World War I, use of the Trendelenburg position became common practice in managing patients with shock. The position was later used to prevent air embolism during central venous cannulation and to enhance the effects of spinal anesthesia.

In the Trendelenburg position, the patient is supine and the head is tilted down, allowing the patient’s feet and legs to remain above the level of the heart. Health-care workers have continued to use this position on the assumption that it will divert blood from the lower extremities into the central circulation. The diversion of blood augments cardiac filling, central blood volume, and cardiac stroke volume, thus providing rapid and temporary management of shock.

An alternative position for resuscitation is the modified Trendelenburg position, or passive leg elevation. In this position, the patient is supine and the lower extremities are lifted up above the cardiac level (the degree of elevation remains unclear). Supposedly, in this position, blood is displaced from the veins in the lower extremities into the central body compartment. In consequence, right and left ventricular preloads, stroke volume, and cardiac output are increased.

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**Data to support the use of the Trendelenburg position during shock are limited and do not reveal beneficial or sustained changes in systolic blood pressure or cardiac output.**

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With the increasing emphasis on evidence-based practice, we reviewed the published literature to summarize recent views and clinical studies on the use of the Trendelenburg position for resuscitation of patients who have hypotension or shock.

Methods
We searched PubMed for the years 1966 through 2004. We limited the search to articles in the English language, on humans and used the following search criteria: (shock OR hypotension) AND Trendelenburg position, and (shock OR hypotension) AND resuscitation position.

Articles pertinent to the issue of resuscitation in shock, hypotension, or both were extracted. The bibliographies in these articles were used to find other publications.

We adapted the standard classification for the levels of evidence and the strength of evidence for recommendations for treatment from published guidelines (Table 1).

The available literature, supplemented by related chapters from recent critical care textbooks and the American Heart Association’s guidelines for cardiopulmonary resuscitation, is summarized.

Results
The first PubMed search yielded 31 articles; the second yielded 29 articles. Most were related to anesthesiology or surgical techniques or to the endocrine responses to changes induced by body posture.

The 8 peer-reviewed publications found were grade C (supported by level III to level V evidence). No grade A or grade B clinical evidence was found.

Summaries of Peer-Reviewed Publications
In a prospective study of 10 normotensive patients 24 to 38 years old, red blood cells tagged with technetium 99m were used to quantify the volume of blood distribution from the supine position (baseline) to a 15° Trendelenburg position. The duration of use of the Trendelenburg position was undisclosed. The median total blood volume was 5462 mL: 46.0% (2512 mL) of the volume was distributed to the upper compartments, 35.4% (1933 mL) to the abdomen, and 18.6% (1016 mL) to the lower compartments of the body. Use of the Trendelenburg position resulted in an overall median increase in blood volume of 1.8% (98 mL) in the upper compartment and a decrease of 3.2% (175 mL) in the lower compartments. Because of the minimal amount of volume distributed centrally, no significant hemodynamic or clinical effect in normotensive, normovolemic patients placed in the Trendelenburg position was indicated in this study (level IV).

Reuter et al prospectively studied 12 hypovolemic patients undergoing mechanical ventilation immediately after cardiac surgery. Transpulmonary dilution of an indicator and echocardiography were used to assess intrathoracic blood volume and cardiac performance before, during, and after patients were placed in the 30° Trendelenburg position for 15 minutes. All measurements were obtained in triplicate and means were calculated. Use of the Trendelenburg position caused only a slight increase in preload volume, despite marked increases in cardiac filling pressure, without significantly improving cardiac performance (mean arterial pressure and cardiac index). A deterioration in cardiac performance occurred when patients were moved from the Trendelenburg position to the supine position (level III).

Miyabe and Namiki studied 90 women 24 to 56 years old who were undergoing major elective gynecological surgery with spinal anesthesia. The patients were examined in the 10° Trendelenburg position for treatment of hypotension during spinal block when the systolic blood pressure decreased more than 10%. Forty of the patients in the study met this requirement and were monitored for 10 minutes after being placed in the Trendelenburg position. The authors also compared prophylactic use of the Trendelenburg position immediately after injection of anesthetic (20 patients); the other group (26 patients) remained in the horizontal position. A small and limited increase in arterial blood pressure occurred only in patients with a decrease in systemic blood pressure greater than 30% from the control (horizontal group). The results indicated that prophylactic use of the Trendelenburg position has no effect on maintaining blood pressure (level III).

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Strength of recommendation</th>
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<tbody>
<tr>
<td>I</td>
<td>Grade A Supported by level I evidence</td>
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<tr>
<td>II</td>
<td>Grade B Supported by level II evidence</td>
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<tr>
<td>III</td>
<td>Grade C Supported by levels III through level V evidence</td>
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<td>IV</td>
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*Reprinted with permission from Broderick et al.

Table 1 Levels of evidence and strength of recommendation for treatment of patients with acute ischemic stroke

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Sibbald et al\textsuperscript{15} examined the hemodynamic responses of 61 normotensive and 15 hypotensive critically ill patients placed in the 15° to 20° Trendelenburg position. Each measurement was done in triplicate, and the invasive equipment was rezeroed at each position. The mean (SD) arterial pressure increased from 87.1 (17.7) mm Hg to 88.3 (18.7) mm Hg, with no significant change in the pulmonary artery opening pressure. On the basis of their results, the authors\textsuperscript{15} concluded that the Trendelenburg position does not induce consistent hemodynamically beneficial effects in critically ill patients (level III).

In another study,\textsuperscript{16} 8 hypovolemic patients were placed in the Trendelenburg position, and several oxygenation variables were measured. Patients with low pulmonary artery opening pressure had an increase in mean arterial pressure, with no significant effect on the oxygenation variables. The researchers\textsuperscript{16} concluded that the increase in mean arterial pressure was due to an increase in systemic vascular resistance and not to an increase in cardiac output (level IV).

The hemodynamic effects of a 15-minute period in the Trendelenburg position were studied in 22 elderly (mean age 68.4 years), nonhypotensive (mean arterial pressure, mean 98 mm Hg) postoperative patients to assess the safety of the Trendelenburg position.\textsuperscript{17} Heart rate, mean arterial pressure, central venous pressure, pulmonary artery opening pressure, cardiac output, arterial oxygen and carbon dioxide tensions, mixed venous oxygenation, and oxygen saturation were noted at 5-, 10-, and 15-minute intervals. No new arrhythmias or electrocardiographic changes were observed, but increases occurred in mean arterial pressure, cardiac index, central venous pressure, pulmonary artery opening pressure, and left and right ventricular stroke work index. When the patients were repositioned supine, however, all values returned to baseline except for the cardiac output and the left ventricular stroke work index, which remained elevated. The researchers\textsuperscript{17} concluded that the Trendelenburg position does not have deleterious effects on cardiac and pulmonary function. Furthermore, use of the Trendelenburg position may improve cardiac function by increasing cardiac output, mean arterial pressure, and central venous pressure. The authors\textsuperscript{17} encourage use of this position for only a minimal amount of time (15 minutes or less) during the placement of central catheters (level IV). This study was done on nonhypotensive patients to assess safety of the Trendelenburg position and not to study resuscitation of patients who were hypotensive.

Boulain et al\textsuperscript{5} prospectively studied 39 patients with a variety of medical and surgical conditions who were receiving mechanical ventilation in 2 separate university hospital intensive care units. The hypothesis was that the modified Trendelenburg position can induce changes in arterial blood pressure that can be used to predict the response to fluid loading. The authors' concluded that the response to fluid loading could be predicted noninvasively on the basis of a simple observation of changes in pulse pressure when patients with acute circulatory failure were put in the modified Trendelenburg position for more than 4 minutes. These findings suggest that placing a patient in the modified Trendelenburg position can effectively displace blood from the lower extremities into the central circulation to improve hemodynamics. This "test" is used to predict how a state of hypotension in a patient receiving mechanical ventilation will respond to fluid loading (level III).

Ostrow\textsuperscript{18} surveyed 1000 critical care nurses about their use, sources of knowledge, and beliefs about the effectiveness of using the Trendelenburg position. The survey return rate was 49.4%. The respondents had used both the Trendelenburg position (99%) and the modified Trendelenburg position (80%) for the treatment of hypotension or during placement of a central catheter. Most of the survey respondents had been exposed to the Trendelenburg position through their nursing education or interactions in the workplace. Eighty percent were convinced that use of the Trendelenburg position was a beneficial adjunct in treatment of hypotension whereas others recognized adverse effects. Ostrow\textsuperscript{18} concluded that many nurses were using tradition-based therapy and outdated information without support from the current literature.

\textbf{Summaries of Recommendations in Textbooks}

Coursin et al\textsuperscript{1} briefly summarize indications for treatment and management of hypovolemic shock. Initially, an airway must be established, and then volume replacement and positioning are done. The recommended positioning of patients during resuscitation is not described, but the authors\textsuperscript{1} state that use of the Trendelenburg position can cause shifting of blood volume from the lower extremities to the central circulation and that this position does not offer consistent benefits. No references are provided.

Civetta et al\textsuperscript{3} discourage use of the Trendelenburg position for the initial treatment of hypotension because of the detrimental effects such as worsening gas exchange and cardiac function without significant redistribution of blood volume centrally. As a result, they suggest that a patient’s lower extremities be elevated above the level of the heart if positioning changes are necessary to treat the patient’s hypotension.\textsuperscript{7} This recommendation is supported by a single bibliographical entry.
The 2000 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care from the American Heart Association have the following 2 statements about the position of the patient during resuscitation: “For resuscitative efforts and evaluation to be effective, the victim must be supine and on a firm, flat surface.”

In the section titled “Key to be effective, the victim must be supine and on a firm, flat surface.”

In the section titled “Key Interventions to Prevent Arrest,” the document states, “If hypotension is present, elevate the legs until replacement of fluids and vasopressors restores the blood pressure.”

Discussion

All the publications we found varied in the angle and the duration of use of the Trendelenburg position. They also differed in the technologies used to measure the hemodynamic variables; the populations studied and the clinical scenarios in which the patients were studied also varied.

Overall, the following can be concluded:

1. The literature on the position(s) for resuscitation is scarce.
2. The available literature lacks strength.
3. The general “slant” is that the Trendelenburg position is probably not a useful position for resuscitation.
4. The modified Trendelenburg position can be used as a test to determine response to fluid loading in patients with hypotension who are receiving mechanical ventilation.

Further clinical studies are needed to define the optimal position for resuscitation.

Use of the Trendelenburg position may increase the hydrostatic (gravitational effect) venous and arterial pressures in the upper part of the body and the head with potentially harmful consequences. No evidence supporting this proposition has been documented or published, to the best of our knowledge.

Use of the Trendelenburg position in the treatment of shock has been common practice on the assumption that it can divert blood into the central circulation and improve the systemic hemodynamics. The literature on the hemodynamic effects of the effectiveness of the Trendelenburg position in treating hypovolemic shock is small and does not reveal beneficial or sustained changes in systolic blood pressure, preload, afterload, or cardiac output.

Conclusion

On the basis of the results from our literature search, we advise judicious use of the Trendelenburg position as an adjunct to resuscitation in patients with hypovolemic shock or hypotension until further evidence provides support for its routine use in this clinical setting (Table 2). Some data, although weak, suggest that this position is not useful, yet potentially not harmful, in any kind of hemodynamic shock. Use of the Trendelenburg position has a history of widespread, ritualistic acceptance and is probably a good example of a nursing intervention that is based on tradition rather than on scientific evidence.

A sustained, systematic effort, which must start at the level of early nursing and medical training and be part of continuing education, will be required to gradually dissipate “reflex or routine” use of the Trendelenburg position for resuscitation of patients who are hypotensive.

High-quality clinical studies must be conducted to determine the optimal position for resuscitation.

Commentary by Mary Jo Grap (see shaded box).

Table 2 Clinical uses of the Trendelenburg position

<table>
<thead>
<tr>
<th>The Trendelenburg position is useful for</th>
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<tr>
<td>Insertion or removal of central catheters</td>
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<td>Certain spinal anesthetic techniques</td>
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<table>
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<tr>
<th>The Trendelenburg position is probably not indicated or may have harmful effects in</th>
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<tr>
<td>Resuscitation of patients who are hypotensive</td>
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<tr>
<td>Patients in whom mechanical ventilation is difficult, or patients with decreased vital capacity</td>
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<td>Patients who have increased intracranial pressure</td>
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<td>Patients who have cerebral edema</td>
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<td>Patients who have increased intraocular pressure</td>
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<td>Patients with ischemia of the lower limbs</td>
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REFERENCES

Use of the Trendelenburg Position as the Resuscitation Position: To T or Not to T?
Natalie Bridges and Adrian A. Jarquin-Valdivia

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