



Clinical Practice Guideline: Orthostatic Vital Signs Full Version

[Formerly known as Emergency Nursing Resource (ENR)]

What orthostatic vital sign procedure is needed to detect significant fluid volume alteration in adult and pediatric patients?

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Background/Significance

Orthostatic, or postural, vital signs are used to evaluate the body's response to position changes when volume loss is suspected. Under normal conditions blood pooling in the lower extremities during position change is directed back to the upper body through the vasoconstriction of blood vessels (Winslow, Lane, & Woods, 1995). However, conditions leading to hypovolemia and autonomic failure may result in a sudden drop in blood pressure known as orthostatic hypotension (OH) and result in impaired perfusion to the upper body. The American Autonomic Society and the American Academy of Neurology define OH as a 20 mmHg or greater decrease in systolic blood pressure (SBP) and a 10 mmHg or greater decrease in diastolic blood pressure (DBP) within three minutes of standing (American Academy of Neurology, 1996). This drop in blood pressure may be associated with symptoms such as lightheadedness, dizziness, blurred vision, weakness, fatigue, cognitive impairment, nausea, palpitations, tremulousness, headache, neck ache and syncope (American Academy Neurology, 1996; Cooke et al., 2009; Koziol-McLain, Lowenstein, & Fuller, 1991; Naschitz, & Rosner, 2007; Sarasin et al., 2002).

An increase in heart rate is often noted when there is a change in posture. This compensatory change occurs in response to the sudden drop in blood pressure (Naschitz & Rosner, 2007; Winslow, Lane, & Woods, 1995; Smith, Porth, & Erickson, 1994). While heart rate is not included in the official definition for OH per the American Academy of Neurology, changes in heart rate aid the differential diagnosis for OH. For instance, a drop in blood pressure accompanied by a rise in heart rate indicates volume depletion, while no change in heart rate may point to a neurogenic cause (Naschitz, & Rosner, 2007). Knopp, Claypool, and Leonardi (1980) found that in adults a heart rate increase of 30 beats per minute or more is considered indicative of volume loss.

The most common reason for performing orthostatic vital signs in the emergency department (ED) is to evaluate fluid volume status. However, research has shown orthostatic vitals are not reliably sensitive to volume losses less than 1000-mL in adult patients (Barraf, & Schriger, 1992; Knopp, Claypool, & Leonardi, 1980). Studies have also revealed wide variations in response to the orthostatic challenge among normal adult individuals (Koziol-McLain, Lowenstein, & Fuller, 1991; Levitt, Lopez, Lieberman, & Sutton, 1992).

To add to the confusion, the procedure for measurement of orthostatic vital signs is not standardized as evidenced by a review of the literature reflecting significant variations in practice. The duration of position change differs between research studies as do the position changes (lying to standing, lying to sitting to standing). There is even some debate as to which findings are the most important indicators of OH and what the cut-points are for vital signs changes.

Methodology

This CPG was created based on a thorough review and critical analysis of the literature following ENA's [Guidelines for the Development of the Clinical Practice Guidelines](#). The following databases were searched for relevant literature: Medline (PubMed), CINAHL, Cochrane, BioMed Central-Open Access, Google Scholar, and National Guideline Clearinghouse. Various terms appear in the literature relating to vital sign changes with position changes. These terms are: tilt test (which may involve passive versus active position change), postural vital signs, and orthostatic vital signs.

Searches were conducted using the key words and subject headings: blood pressure, hypotension, orthostatics, orthostatic hypotension, orthostatic vital signs, orthostatic, and vital signs. The search term

of “hypovolemic” was added to identify orthostatic vital sign research related to volume status rather than pharmacological treatment. Initial searches were limited to English language from January 1990 to March 2011. This timeframe was later expanded to include orthostatic research dating back to the 1940s to retrieve the seminal orthostatic vital sign studies. In addition, the reference lists in the selected articles were scanned for pertinent research findings. Research articles from ED settings, non- ED settings, position statements and guidelines from other sources were also reviewed.

Articles that met the following criteria were chosen to formulate the CPG: research studies, meta-analyses, systematic reviews and existing guidelines relevant to the topic of orthostatic vital signs and hypovolemia. Other types of reference articles and textbooks were also reviewed and used to provide additional information. The CPG authors used [standardized worksheets](#), including the Evidence-Appraisal Table Template, Critique Worksheet and AGREE Work Sheet, to prepare tables of evidence ranking each article in terms of the level of evidence, quality of evidence, and relevance and applicability to practice. Clinical findings and levels of recommendations regarding patient management were then made by the Clinical Practice Guidelines Development Committee according to ENA’s classification of levels of recommendation for practice: Level A - High, Level B - Moderate, Level C –Weak, or Not recommended for practice (See Table 1).

Table 1. Levels of Recommendation for Practice

<p>Level A recommendations: High</p> <ul style="list-style-type: none"> • Reflects a high degree of clinical certainty • Based on availability of high quality level I, II and/or III evidence available using Melnyk & Fineout-Overholt grading system (Melnyk & Fineout-Overholt, 2005) • Based on consistent and good quality evidence; has relevance and applicability to emergency nursing practice • Is beneficial
<p>Level B recommendations: Moderate</p> <ul style="list-style-type: none"> • Reflects moderate clinical certainty • Based on availability of Level III and/or Level IV and V evidence using Melnyk & Fineout-Overholt grading system (Melnyk & Fineout-Overholt, 2005) • There are some minor or inconsistencies in quality evidence; has relevance and applicability to emergency nursing practice • Is likely to be beneficial
<p>Level C recommendations: Weak</p> <ul style="list-style-type: none"> • Level V, VI and/or VII evidence available using Melnyk & Fineout-Overholt grading system (Melnyk & Fineout-Overholt, 2005) - Based on consensus, usual practice, evidence, case series for studies of treatment or screening, anecdotal evidence and/or opinion • There is limited or low quality patient-oriented evidence; has relevance and applicability to emergency nursing practice • Has limited or unknown effectiveness
<p>Not recommended for practice</p> <ul style="list-style-type: none"> • No objective evidence or only anecdotal evidence available; or the supportive evidence is from poorly controlled or uncontrolled studies • Other indications for not recommending evidence for practice may include: <ul style="list-style-type: none"> ○ Conflicting evidence ○ Harmfulness has been demonstrated ○ Cost or burden necessary for intervention exceeds anticipated benefit ○ Does not have relevance or applicability to emergency nursing practice • There are certain circumstances in which the recommendations stemming from a body of evidence should not be rated as highly as the individual studies on which they are based. For example: <ul style="list-style-type: none"> ○ Heterogeneity of results ○ Uncertainty about effect magnitude and consequences, ○ Strength of prior beliefs ○ Publication bias

Evidence Table and Other Resources

The articles reviewed to formulate the CPG are described in the [Evidence Table](#). Other articles relevant to temperature measurement were reviewed and identified as additional resources ([Other Resources Table](#)).

Summary of Literature Review

Summary of Definitions

The definition of orthostatic vital signs warrants further research despite its common use in clinical practice, textbooks, guidelines and research studies. A review of definitions from the literature indicates that the assessment parameter labeled as orthostatic vital signs can be summarized by its: physiological variables, measurement method, and purpose. The physiological variables include blood pressure, heart rate, and stroke index (Durukan et al., 2009; Fuchs & Jaffe, 1987; Horam & Roscelli, 1992; Koziol-McLain et al., 1991; Levitt et al., 1992; Witting & Gallagher, 2003), as well as symptoms of dizziness or lightheadedness (Lance et al., 2009; Sarasin et al., 2002). Stated purposes of orthostatic vital signs assessment include identification of hypovolemia (both dehydration and blood loss) and treatment efficacy of pharmacological agents for neurological conditions. Assessment for hypovolemia is the purpose of orthostatic vital signs for this review. The most common variables measured to assess orthostatic vital signs in potentially hypovolemic patients include blood pressure and heart rate, measured with the patient in different positions (supine, sitting, standing). Equipment used to obtain orthostatic vital signs, as well as the feasibility of obtaining orthostatic vital signs in the clinical setting will be described. For the purposes of this document, orthostatic vital signs are defined as a change in blood pressure, heart rate, or onset of symptoms after a change in position in individuals (adult, child, and adolescent) with a decrease in intravascular volume (Durukan et al., 2009; Fuchs & Jaffe, 1987; Horam & Roscelli, 1992; Koziol-McLain et al., 1991; Levitt et al., 1992; Witting & Gallagher, 2003).

Body Positioning and Timing

Supine

The period of rest prior to the supine measurement is variously identified as one minute (Barraf, & Schriger, 1992), two minutes (Knopp, Claypool, & Leonardi, 1980; Levitt et al., 1992), three minutes (Cooke et al., 2009; Koziol-McLain et al., 1991), or five minutes (Atkins, Hanusa, Sefcik, & Kapoor, 1991; Cohen et al., 2006; Kennedy & Crawford, 1984; Sarasin et al., 2002).

Harkel and colleagues (1990) discovered that the period of rest did impact the changes in blood pressure and heart rate with more pronounced changes identified following a longer period of rest. They measured vital signs following one minute, five minutes and 20 minutes of rest and found that “the augmentation of the BP and HR response is small when the period of rest is increased from five to 20 minutes, it seems adequate to perform this test after at least five minutes of supine rest” (Harkel, Lieshout, Lieshout, & Wieling, 1990, p. 152). However, Lance et al. (2009) found that 10 minutes of rest was required for accurate measurement of orthostatic vital signs. It should be noted that both studies

by Harkel et al. and Lance et al. were conducted on small samples of 10 and 34 (respectively) of young, healthy, normotensive subjects. In addition, different methods of recording vital signs were used by the researchers: Harkel et al. used the Ohmeda 2300 Finapres continuous, non-invasive finger blood pressure device, and heart rate was measured via electrocardiogram; Lance et al. used the Johnson and Johnson Critikon DINAMAP model 1846 SX to measure blood pressure and heart rate in the upper arm.

The American Heart Association recommends blood pressure measurements to be made in the upper arm with 5 minutes of rest time prior to the first blood pressure measurement (Pickering et al., 2005). Furthermore, the subject should refrain from talking and the legs should be “uncrossed, and the back and arm supported” (Pickering et al., 2005, p.104). Crossing the legs elevates the SBP while an unsupported back raises the diastolic blood pressure (Pickering et al., 2005). Failure to support the arm will also impact blood pressure readings: readings taken above the level of the heart are artificially low while those taken below heart level are artificially high (Pickering et al., 2005).

Sitting

The definition of OH provided by the American Autonomic Society and the American Academy of Neurology only considers blood pressure changes from the supine to the standing, not the sitting, position. Measuring vitals in the sitting position can actually lessen the orthostatic effect of standing (Kennedy & Crawford, 1984; McGee, Abernethy, & Simel, 1999). Cooke and colleagues (2009) found that, in adults on a syncope unit (n=730), the sit-stand test had low diagnostic accuracy. In a review of the literature, Winslow, Lane, and Woods (1995) report less dramatic changes in SBP when the sitting position is included but this finding was not statistically significant. However, it may be unsafe to move from the lying position directly to standing, especially in patients with large volume losses (Koziol-McLain et al., 1991). Kennedy and Crawford (1984) recommended measuring vitals in the sitting position first and, if no change occurs, measuring in the standing position to avoid falls in orthostatic individuals.

Standing

Empirical evidence reveals inconsistencies in the process of measuring vital signs after standing. OH can be detected within two minutes of standing in most cases (Atkins et al., 1991; Lance et al., 2000). Cohen and colleagues (2006) found that 83.5% of OH could be detected within three minutes of standing. Knopp and colleagues (1980) determined that measurements taken one minute after standing demonstrated the greatest change in pulse rate between no blood loss and 1000 ml blood loss. However, the detection of OH is enhanced by the measurement of vital signs at multiple points per position (Atkins et al., 1991). This is especially true in cases where OH is delayed.

Delayed OH occurs within 10 to 30 minutes of standing (Streeten, & Anderson, 1992) classical OH occurs within three minutes (Moya, Sutton, Ammirati, Blanc, Brignole, Dahm, & Wieling, 2009; Streeten & Anderson, 1992). Delayed OH may occur more frequently in the elderly, with vasoactive and diuretic drug use, and co-morbidities (Moya et al., 2009). In mildly symptomatic individuals who have normal orthostatic vital signs within two minutes of standing, it is recommended that additional vital signs be taken to rule out delayed OH.

Sensitivity to Fluid Volume Loss

Researchers have shown that orthostatic vitals are not reliably sensitive to volume losses less than 1000 ml in adult patients (Barraf & Schriger, 1992; Knopp, Claypool, & Leonardi, 1980). Barraf and Schriger (1991) determined that pulse rate was the most sensitive vital sign in detecting a 450 ml blood loss (9% sensitivity for a pulse rate increase of 20 or higher). Knopp et al. (1980) had similar findings comparing two groups: Group 1 with a 450 ml blood loss and Group 2 with a 1000 ml blood loss in 500 ml increments. Pulse change (supine to standing) at one minute had the greatest change between no blood loss and 1000 ml blood loss. Blood pressure change did not distinguish patients with no blood loss; patients with 500 ml blood loss; or patients with 1000 ml blood loss (Knopp et al., 1980).

Levitt et al. (1992) evaluated the degree of volume loss and orthostatic vital sign changes in ED patients. They found wide variation in orthostatic vital sign changes for healthy and ill individuals and poor correlation of vital signs and level of dehydration (Levitt et al., 1992). Heart rate ($p=0.0165$) and age ($p=0.0047$) had a small correlation ($r^2=0.098$) with level of dehydration. While SBP did not demonstrate a statistically significant association with the degree of dehydration ($r^2= 0.032$, $p=0.56$), SBP was the only vital sign to distinguish between patients with blood loss and healthy volunteers. Patients with blood loss had a mean SBP change of -10.7 mmHg (± 13.7 mmHg, $p=0.001$).

Orthostatic Vital Signs

Blood Pressure

Blood pressure and heart rate were the most frequent physiological variables measured during orthostatic vital sign assessment. Generally, orthostatic hypotension in an adult can be described as a drop in blood pressure and an increase in heart rate associated with position change. Several studies reported blood pressure changes following position changes. In a convenience sample of 814 adult ED patients suspected to be hypovolemic, Cohen and colleagues (2006) found that, of those with diagnosed OH, 83.5% could be detected at one and three minutes after standing. Similarly, a decline in SBP of 20 mmHg or more in 31% of the patients ($n = 69$) and decline in diastolic blood pressure of 10 mmHg or more in 14% of the patients ($n = 31$) within 10 minutes of standing were reported by Atkins et al., 1991.

As discussed in section on *Body Position and Timing: Supine* (page 3), it is important that the patient rest prior to the first blood pressure measurement. Physical activity immediately preceding orthostatic vital signs can influence the results. Generally, 5-10 minutes is thought to be a sufficient period of time. The important thing to remember is that patients should not have their orthostatic vital signs measured immediately after physical exertion.

In a contrasting population, different blood pressure changes were found in a convenience sample of 100 normovolemic adolescent patients, ages 12 to 19 years, in a study by Horam and Roscelli (1992). The mean SBP change ranged from a 17 mmHg decrease to a 19 mmHg increase, and diastolic blood pressure change ranged from a 7 mmHg decrease to a 24 mmHg increase. In other words, systolic and diastolic blood pressure tended to increase rather than decrease upon position changes in many adolescents. These findings suggest the physiological response to position changes yields a different blood pressure response in adolescents compared to hypovolemic adults. Compensatory mechanisms

that may influence the blood pressure response in adolescents include: baroreceptor activity, arteriolar vasoconstriction, capillary hydrostatic forces, renin aldosterone stimulation and antidiuretic hormone release (Horam & Roscelli, 1992). Given the wide variability of orthostatic vital signs in the adolescent population, further research is warranted.

Orthostatic vital signs were compared between normally-hydrated and volume-depleted children aged 4-15 in a 1987 study by Fuchs & Jaffe. Volume status was determined using an adaptation of the method discussed by Winters and Finberg (1982) which evaluates mucous membranes, eyes, skin color, urine output and urine specific gravity. Mean changes in systolic blood pressure were small and non-significant (-0.38 ± 8 mmHg) for both groups of children (Fuchs & Jaffe, 1987).

Heart Rate

Heart rate was the second most frequent variable used during orthostatic vital sign assessment. Five of the 12 research studies used heart rate as a measurement variable. Heart rate showed significant changes in two studies of healthy blood donors (Barraf & Schriger, 1992; Durukan, 2009). Barraf and colleagues conducted a study to determine the effect of age on orthostatic vital signs, whereas early detection of acute blood loss was the purpose of the study by Durukan et al. (2009). The heart rate variable by itself showed a sensitivity of 9% and a specificity of 98% with an increase in heart rate greater than 20 beats per minute in the Barraf et al. (1992) study. Also, an increase in heart rate greater than 20 beats per minute, plus a drop in diastolic blood pressure more than 10 mmHg, increased the sensitivity to 17% while maintaining a specificity of 98%. Levitt, Lopez, Liberman, and Sutton (1992) reported a weak, non-significant change in heart rate, in 202 dehydrated or acutely bleeding adults compared to 21 healthy individuals. Heart rate changes for the healthy individuals were 11.26 ± 11.3 bpm, whereas the ill adults had heart rate changes of 13.63 ± 10.3 bpm (Levitt, Lopez, Liberman, & Sutton, 1992).

The study by Fuchs and Jaffe (1987) investigated orthostatic vital sign changes in children. Like adults, children typically respond to a decrease in intravascular volume with an increase in heart rate. This study involved two groups of children between the ages of four and 15 years old who were seen in an ED. Group 1 consisted of 16 children meeting the dehydration criteria, compared to 21 children evaluated as normal. The mean orthostatic rise in heart rate was significantly different ($p=0.001$) between groups: 29.1 bpm (± 10.7) in the dehydrated group versus 13.1 bpm (± 8.5) in the normovolemic group. Further research of hypovolemic children is warranted to learn how the heart rate increase compares with the adult population.

Syncope Symptoms and Shock Index

In addition to blood pressure and heart rate, syncope symptoms and shock index (SI) are two other variables reported in the literature related to orthostatic hypotension. Adults, 16 years and older, presenting with complaints of syncope to an ED were studied to learn the relationship between syncope symptoms and orthostatic vital signs (Atkins, Hanusa, Seflik, & Kapoor, 1991). Syncope was defined as a “sudden, transient loss of consciousness associated with an inability to maintain postural tone that was not compatible with a seizure disorder, vertigo, dizziness, coma, shock, or other states of altered

consciousness” (Atkins, Hanusa, Seflik, & Kapoor, 1991, p. 180). A significant number, 31% (n=69/223) of patients with syncope as the chief complaint demonstrated a reduction in SBP of 20 mmHg or more upon standing (n=34, p=0.001; Atkins, Hanusa, Seflik, & Kapoor, 1991). Syncopal patients with and without OH were reported to be similar in age, medications, baseline blood pressure, and timing of blood pressure changes (one, two, three, five and 10 minutes after standing).

Similar findings regarding syncopal symptoms were reported in a study by Gehrking, Hines, Benurd-Larson, Orson-Gehrking, and Low (2005). Episodes referred to as presyncope, were reported in 67% of the patients (n = 24) after a 70 degree head up tilt (Gehrking, 2005). Presyncope was defined by the patient’s indication of feeling faint or the observer’s visual judgment of the patient. The study measured vital signs at one, two, three, and five minute intervals. The presyncopal symptoms occurred after the three minute but before the five minute interval.

Durukan and colleagues (2009) added SI (heart rate divided by SBP) along with blood pressure and heart rate to detect hemodynamic changes after acute blood loss. The researchers reported significant changes in SBP and SI. Five minutes after blood donation, while remaining in a semi-supine position, SBP (108 ± 12 mmHg), and SI (0.76 ± 0.15) were significantly different ($p = 0.0001$) from pre-donation (SBP 120 ± 20 mmHg; SI 0.66 ± 0.15). While they only tested vital signs while participants remained in a semi-supine position, change in shock-index with position change might be investigated as an indicator of volume status in future research. The time to calculate SI could be a limitation in an emergency setting unless a calculator is readily available.

Equipment

Blood pressure equipment varied by type and manufacturer throughout the selected research studies. The studies were conducted from 1980 to 2009 using manual and automatic equipment. The automatic equipment used the oscillometric method to measure blood pressure. Manual equipment consisted of auscultation and human manipulation of pressure values (Atkins, 1991; Barrak, 1992; Durukan, 2009). The study reports did not indicate the manufacturer of the manual equipment. When auscultation was used, whether diastolic was noted at phase four or five Korotkoff sound was not consistently reported.

Automatic (Fuchs & Jaffe, 1987) or semi-automatic (Cooke, 2009) equipment measured blood pressure in four studies. Dinamap® Model 1846P, Critikon, Inc. Tampa, Florida was used in three studies (Fuchs & Jaffe, 1987; Koziol-McLain, 1991; Witting, 2003), whereas one study used Accucor 1A (Sidery, 2009). One study by Lance (1993) used a combination of manual and automatic blood pressure equipment. Two studies did not report the type of blood pressure equipment, rather referred to “standardized method” for obtaining blood pressure and heart rate (Sarasin, et al., 2002).

Patient Safety

Patient safety is a responsibility of the healthcare provider during the measurement of orthostatic vital signs. During position change, from supine to standing, complex homeostatic mechanisms such as increased heart rate and vascular resistance typically compensate for the effects of gravity on the circulation to maintain cerebral blood flow (Atkins, Hanusa, Sefcik, & Kapoor, 1991; Beddoe, 2010). In general, the literature suggests the compensatory mechanisms may be impaired in the hypovolemic

person predisposing them to weakness, dizziness, syncope, and the increased risk of falls. Contraindications for measuring orthostatic vital signs include: supine hypotension, shock, severe altered mental status and injuries to the spine, pelvis, or lower extremities (Beddoe, 2010).

Conclusion

This review highlights the variations in empirical evidence on several aspects of obtaining and interpreting orthostatic vital signs. While further research is warranted, recommendations about measuring and interpreting orthostatic vital signs follow.

Description of Decision Options/Interventions and the Level of Recommendation

1. Adults (age 17 years and older)*
 - i. The individual should rest in a flat, supine position 5-10 minutes prior to the first blood pressure measurement. Level B - Moderate
 - ii. Blood pressure measurements should be taken at one and three minutes after standing. Level B - Moderate
 - iii. Position change from supine to standing has better diagnostic accuracy in volume depleted adults compared to position changes from supine to sitting and then to standing. Level B -Moderate
 - iv. Orthostatic vital signs alone lack the sensitivity to reliably detect volume losses less than 1,000 ml. Level B - Moderate.
 - v. Symptoms such as dizziness and syncope, in combination with orthostatic vital signs, are more sensitive indicators of volume loss that vital sign changes alone. Therefore, symptoms and vital signs should be documented as the orthostatic variables. Level B - Moderate
 - vi. When measuring orthostatic vital signs, one or more of the following findings may indicate intravascular volume loss in adult patients (Level B - moderate):
 - a. Decrease in systolic blood pressure of 20 mmHg or more
 - b. Decrease in diastolic blood pressure of 10 mmHg or more
 - c. Increase in heart rate of 20 or greater beats per minute (Durukan et al., 2009).
2. Pediatric and Adolescent (less than 17 years)
 - i. There is *insufficient evidence* in the literature to make recommendations regarding orthostatic vital signs in the pediatric or adolescent population with fluid volume alterations.

* The correct procedure for measuring blood pressure while the patient is seated or standing is to measure the blood pressure in the upper arm while supporting the patient's arm and back. The legs should be uncrossed.

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