Prior Authorization Review Panel  
MCO Policy Submission

A separate copy of this form must accompany each policy submitted for review. Policies submitted without this form will not be considered for review.

<table>
<thead>
<tr>
<th>Plan: Aetna Better Health</th>
<th>Submission Date: 11/01/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy Number: 0793</td>
<td>Effective Date:</td>
</tr>
<tr>
<td>Policy Name: Esophageal Doppler Monitoring</td>
<td>Revision Date:</td>
</tr>
</tbody>
</table>

Type of Submission – Check all that apply:

- [ ] New Policy
- [ ] Revised Policy*
- [x] Annual Review – No Revisions
- [ ] Statewide PDL

*All revisions to the policy must be highlighted using track changes throughout the document.

Please provide any clarifying information for the policy below:

CPB 0793 Esophageal Doppler Monitoring

Clinical content was never revised. No additional non-clinical updates were made by Corporate since the last PARP submission.

Name of Authorized Individual (Please type or print):  
Dr. Bernard Lewin, M.D.

Signature of Authorized Individual:  
[Signature]

Proprietary
Revised July 22, 2019
Esophageal Doppler Monitoring

**Policy**

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.*

Aetna considers esophageal Doppler monitoring (EDM) medically necessary for monitoring of cardiac output in either of the following 2 groups:

- Persons with a need for intra-operative fluid optimization; or
- Ventilated persons in the intensive care unit.

Aetna considers EDM experimental and investigational for all other indications because its effectiveness for indications other than the ones listed above has not been established.

See also

- CPB 0472 - Thoracic Electrical Bioimpedance for Cardiac Output Monitoring
- CPB 0714 - Re-breathing of Inert Gas for Measurement of Cardiac Output

**Background**

The clinical assessment of cardiovascular performance is often unreliable in critically ill patients; therefore hemodynamic monitoring is of great significance in the caring of the critically ill. Patterns of hemodynamic variables such as oxygenation, ventilation, arterial pressure, cardiac output (CO), stroke volume, and intra-vascular volume often suggest cardiogenic, hypo-
volemic, obstructive, or distributive (septic) etiologies to cardiovascular insufficiency. In particular, CO is a principal determinant of perfusion in many critically ill patients. A number of technologies have been developed to provide clinicians with indexes of cardiovascular function to assist in therapeutic decision-making and monitoring of response to therapy. Pulmonary artery catheterization (PAC) is considered to be the gold standard for continuous monitoring of CO. Indeed, the PAC has largely shaped the practice of modern critical care. Yet, the information provided by the PAC is largely misunderstood, and its effectiveness is never proven. Other approaches/devices have been introduced and gaining attention. In this regard, continuous esophageal Doppler monitoring (EDM) has emerged as an alternative to PAC (Marik, 1999).

Esophageal Doppler monitoring measures blood flow velocity in the descending thoracic aorta using a flexible trans-esophageal Doppler ultrasound probe about the size of a naso-gastric tube. Cardiac output and stroke volume (SV) are estimated using a nomogram-based estimate of aortic cross-sectional area (derived from the patient's age, height, and weight). By means of EDM, intra-vascular volume status or pre-load of the left ventricle can be optimized by titrating intravenous fluid boluses (usually 250 ml of colloidal fluid) to a flow chart based in large part on the Frank-Starling principle. Because the EDM probe is much smaller than an ordinary trans-esophageal echocardiographic probe, it is less invasive and has a very good safety record. Specifically, there have been no case reports of esophageal perforation and only reports of minor complications such as mucosal trauma and endo-bronchial placement, which is readily identified and re-positioned (Phan et al, 2008).

Rodriguez and Berumen (2000) examined if physicians' estimates of CO, or cardiac index, are accurate compared with CO/cardiac index measured by esophageal Doppler. These investigators also estimated the physician time necessary for Emergency Department (ED) CO/cardiac index measurement. They prospectively evaluated a convenience sample of critically ill, adult ED patients. Based on all available clinical information, residents and emergency medicine attending physicians estimated patients' cardiac index as being high, normal, or low. A blinded investigator measured CO/cardiac index using an esophageal Doppler probe. Times to achieve optimal Doppler signal were recorded. Agreement between physician cardiac index estimates and measured cardiac index values was assessed using the weighted kappa statistic. A total of 33 patients were evaluated. There was no agreement beyond chance between physicians' estimates of cardiac index and measured cardiac index. The mean time for optimal Doppler signal was 5.7 +/- 4.3 mins. Physicians' estimates of cardiac index were inaccurate compared with measured cardiac index. The authors concluded that esophageal Doppler measurement of CO/cardiac index appears to be practical from a physician time standpoint.
Dark and Singer (2004) determined the validity of the EDM and echo-esophageal Doppler (Echo-ED) in measuring CO in the critically ill. A total of 11 validation papers for EDM (21 studies) involving 314 patients and 2,400 paired measurements were reviewed. The pooled median bias for PAC-thermo-dilution (PAC-TD) versus EDM was 0.19 L/min (range of -0.69 to 2.00 L/min) for CO (16 studies), and 0.6 % (range of 0 to 2.3 %) for changes in CO (5 studies). The pooled median percentage of clinical agreement (PCA) for PAC-TD versus EDM was 52 % (inter-quartile range [IQR] of 42 to 69 %) for CO and 86 % (IQR of 55 to 93 %) for changes in CO. These differences in PCA were significant (p = 0.03 Mann-Whitney) for bolus PAC-TD as the clinical "gold standard". The authors found an insufficient number of studies (2 papers) to assess the validity of Echo-ED. They concluded that the EDM has high validity (no bias and high clinical agreement with PAC-TD) for monitoring changes in CO.

Bein and associates (2004) compared esophageal Doppler, pulse contour analysis, and real-time PAC-TD for CO. Patients scheduled for elective coronary artery bypass grafting were included in this study; CO measurements were analyzed using a Bland-Altman plot. Bias between CO and pulse contour cardiac output (PCCO), and Doppler-derived cardiac output (UCCO) was (mean +/- 1 SD) -0.71 +/- 1 L/min versus -0.15 +/- 1.09 L/min, and between UCCO and PCCO was 0.58 +/- 1.06 L/min. Bias was not significantly different among methods, nor were comparative values before and after cardiopulmonary bypass (p > 0.05). The authors concluded that agreement between the CO method and both less-invasive measurements was clinically acceptable. There were no adverse events associated with the use of either device.

Another use of EDM is to guide intra-operative fluid resuscitation in elderly patients undergoing major surgery (e.g., abdominal surgery, repair of proximal femoral fractures). These patients are usually managed with only minimal intra-operative monitoring. In a prospective, randomized open study, Mythen and Webb (1995) tested the hypothesis that peri-operative plasma volume expansion would preserve gut mucosal perfusion during elective cardiac surgery. A total of 60 American Society of Anesthesiology grade III patients with a pre-operative left ventricular ejection fraction of 50 % or greater undergoing elective cardiac surgery. Patients were allocated randomly to a control or protocol group. The control group was treated according to standard practices. After induction of general anesthesia, the protocol group received, in addition, 200-ml boluses of a 6 % hydroxyethyl starch solution to obtain a maximum SV. This procedure was repeated every 15 mins until the end of surgery, except when the patient underwent cardiopulmonary bypass. Cardiac SV was estimated by an esophageal Doppler system, and gastric mucosal perfusion was measured by tonometric assessment of gastric intra-mucosal pH in all patients. Patients were followed-up post-operatively until discharge from the hospital or death. The incidence of gut mucosal hypo-perfusion (gastric intra-mucosal pH less than 7.32) at the end of surgery was reduced in the protocol group (7 % versus 56 %) (p < 0.001), as were the number of patients in whom major complications developed (0 versus 6) (p = 0.01), mean
number of days spent in the hospital (6.4 [range of 5 to 9] versus 10.1 [range of 5 to 48]) (p = 0.011), and mean number of days spent in the intensive care unit (ICU) (1 [range of 1 to 1] versus 1.7 [range of 1 to 11] days) (p = 0.023). The authors concluded that peri-operative plasma volume expansion with colloid during cardiac surgery, guided by esophageal Doppler measurement of cardiac SV, reduced the incidence of gut mucosal hypo-perfusion. This group of patients also had an improved outcome when compared with controls.

In a prospective, randomized study, Gan and colleagues (2002) evaluated the effect of goal-directed intra-operative fluid administration on length of post-operative hospital stay. A total of 100 patients who were to undergo major elective surgery with an anticipated blood loss greater than 500 ml were randomly assigned to a control group (n = 50) that received standard intra-operative care or to a protocol group (n = 50) that, in addition, received intra-operative plasma volume expansion guided by the esophageal Doppler monitor to maintain maximal SV. Length of post-operative hospital stay and post-operative surgical morbidity were assessed. Groups were similar with respect to demographics, surgical procedures, and baseline hemodynamic variables. The protocol group had a significantly higher SV and CO at the end of surgery compared with the control group. Patients in the protocol group had a shorter duration of hospital stay compared with the control group: 5 +/- 3 versus 7 +/- 3 days (mean +/- SD), with a median of 6 versus 7 days, respectively (p = 0.03). These patients also tolerated oral intake of solid food earlier than the control group: 3 +/- 0.5 versus 4.7 +/- 0.5 days (mean +/- SD), with a median of 3 versus 5 days, respectively (p = 0.01). The authors concluded that goal-directed intra-operative fluid administration results in earlier return to bowel function, lower incidence of post-operative nausea and vomiting, and decrease in length of post-operative hospital stay.

In a prospective, randomized controlled trial, Venn and associates (2002) compared conventional intra-operative fluid management with two differing methods of invasive haemodynamic monitoring to optimize intra-operative fluid therapy, in patients undergoing proximal femoral fracture repair under general anesthesia. A total of 90 patients were randomized to three groups -- conventional intra-operative fluid management (group CON, n = 29), and two groups receiving additional repeated colloid fluid challenges guided by central venous pressure (group CVP, n = 31) or esophageal Doppler ultrasonography (group DOP, n = 30). Primary outcome measures were time to medical fitness to discharge, hospital stay and post-operative morbidity. The fluid challenge resulted in significantly greater peri-operative changes in CVP between group CVP and group CON (mean 5 (95 % confidence interval [CI]: 3 to 7) mm Hg) (p < 0.0001). Important peri-operative changes were also shown in group DOP with increases of 49.4 ms (19.7 to 79.1 ms) in the corrected flow time, 13.5 ml (7.4 to 19.6 ml) in SV, and 0.9 (0.49 to 1.39) L/min in CO. As a result, fewer patients in group CVP and group DOP experienced severe intra-operative hypotension (group CON 28 % (8/29), group CVP 9 % (3/31), group DOP 7 % (2/30), p = 0.048 (chi-squared, 2 degrees of freedom (df). No differences were
seen between the 3 groups when major morbidity and mortality were combined, $p = 0.24$ (chi-squared, 2 df). Post-operative recovery for survivors, as defined by time to be deemed medically fit for discharge, was significantly faster, in comparison with group CON, in both the group CVP (10 versus 14 (95 % CI: 8 to 12 versus 12 to 17) days, $p = 0.008$ (t-test)), and group DOP (8 versus 14 (95 % CI: 6 to 12 versus 12 to 17) days, $p = 0.023$ (t-test)). There were no significant differences between groups, for survivors, with respect to acute orthopedic hospital and total hospital stay. The authors concluded that invasive intra-operative hemodynamic monitoring with fluid challenges during repair of femoral fracture under general anesthetic shortens time to being medically fit for discharge.

Conway et al (2002) examined the impact of Doppler-guided fluid optimization on hemodynamic parameters, peri-operative morbidity and hospital stay in patients undergoing major bowel surgery. A total of 57 patients were randomly assigned to Doppler (D) or control (C) groups. All patients received intra-operative fluid therapy at the discretion of the non-investigating anesthetist. In addition, group D were given fluid challenges (3 ml/kg) guided by esophageal Doppler. Group D received significantly more intra-operative colloid than group C (mean of 28 (SD 16) versus 19.4 (SD 14.7) ml/kg, $p = 0.02$). Cardiac output increased significantly for group D while that of controls remained unchanged. The mean difference between the groups in final CO was 0.87 L/min (95 % CI: 0.31 to 1.43 L/min, $p = 0.003$). Five control patients needed post-operative critical care admission. The authors concluded that fluid titration using esophageal Doppler during bowel surgery can improve hemodynamic parameters and may reduce critical care admissions post-operatively.

Wakeling et al (2005) noted that occult hypo-volemia is a key factor in the etiology of post-operative morbidity and may not be detected by routine heart rate and arterial pressure measurements. Intra-operative gut hypo-perfusion during major surgery is associated with increased morbidity and post-operative hospital stay. These investigators evaluated if using intra-operative esophageal Doppler-guided fluid management to minimize hypo-volemia would reduce post-operative hospital stay and the time before return of gut function after colorectal surgery. In a single-center, blinded, prospective controlled trial, these researchers randomized 128 consecutive consenting patients undergoing colorectal resection to esophageal Doppler-guided or CVP-based (conventional) intra-operative fluid management. The intervention group patients followed a dynamic esophageal Doppler-guided fluid protocol whereas control patients were managed using routine cardiovascular monitoring aiming for a CVP between 12 and 15 mm Hg. The median post-operative stay in the Doppler-guided fluid group was 10 versus 11.5 days in the control group ($p < 0.05$). The median time to resuming full diet in the Doppler-guided fluid group was 6 versus 7 for controls ($p < 0.001$). Doppler patients achieved significantly higher CO, SV, and oxygen delivery. A total of 29 (45.3 %) control patients suffered gastro-intestinal morbidity compared with 9 (14.1 %) in the Doppler-guided fluid group ($p < 0.001$); overall
morbidity was also significantly higher in the control group \( (p = 0.05) \). The authors concluded that intra-operative esophageal Doppler-guided fluid management was associated with a 1.5-day median reduction in post-operative hospital stay. Patients recovered gut function significantly faster and suffered significantly less gastro-intestinal and overall morbidity.

In a prospective, double-blind randomized controlled trial, Noblett et al (2006) assessed the effect of Doppler-optimized fluid management on outcome after elective colorectal resection. A total of 108 patients undergoing elective colorectal resection were included in this study. An esophageal Doppler probe was placed in all patients. The control group received peri-operative fluid at the discretion of the anesthetist, whereas the intervention group received additional colloid boluses based on Doppler assessment. Primary outcome was length of post-operative hospital stay. Secondary outcomes were morbidity, return of gastro-intestinal function and cytokine markers of the systemic inflammatory response. Standard pre-operative and post-operative management was used in all patients. Demographic and surgical details were similar in the two groups. Aortic flow time, SV, CO and cardiac index during the intra-operative period were higher in the intervention group \( (p < 0.05) \). The intervention group had a reduced post-operative hospital stay (7 versus 9 days in the control group; \( p = 0.005 \)), fewer intermediate or major post-operative complications (2 versus 15 \%; \( p = 0.043 \)) and tolerated diet earlier (2 versus 4 days; \( p = 0.029 \)). There was a reduced rise in peri-operative level of the cytokine interleukin 6 in the intervention group \( (p = 0.039) \). The authors concluded that a protocol-based fluid optimization program using intra-operative EDM leads to a shorter hospital stay and decreased morbidity in patients undergoing elective colorectal resection.

In a randomized controlled trial (RCT), Chytra et al (2007) evaluated the effect of early optimization of intra-vascular volume using esophageal Doppler on blood lactate levels and organ dysfunction development in comparison with standard hemodynamic management in multiple-trauma patients. Multiple-trauma patients with blood loss of more than 2,000 ml admitted to the ICU were randomly assigned to the protocol group with EDM and to the control group. Fluid resuscitation in the Doppler group was guided for the first 12 hours of ICU stay according to the protocol based on data obtained by esophageal Doppler, whereas control patients were managed conventionally. Blood lactate levels and organ dysfunction during ICU stay were evaluated. A total of 80 patients were randomly assigned to Doppler and 82 patients to control treatment. The Doppler group received more intravenous colloid during the first 12 hours of ICU stay \( (1,667 +/- 426 \text{ ml versus } 682 +/- 322 \text{ ml}; p < 0.0001) \), and blood lactate levels in the Doppler group were lower after 12 and 24 hours of treatment than in the control group \( (2.92 +/- 0.54 \text{ mmol/L versus } 3.23 +/- 0.54 \text{ mmol/L} \ [p = 0.0003] \text{ and } 1.99 +/- 0.44 \text{ mmol/L versus } 2.37 +/- 0.58 \text{ mmol/L} \ [p < 0.0001], \text{ respectively}) \). No difference in organ dysfunction between the groups was found. Fewer patients in the Doppler group developed infectious complications \( (15 \text{ [18.8 \%] versus } 28 \text{ [34.1 \%]; relative risk } = 0.5491; 95 \% CI: 0.3180 \text{ to } 0.9482; p = 0.032) \). In the
Doppler group, stay in the ICU was reduced from a median of 8.5 days (IQR 6 to 16) to 7 days (IQR 6 to 11) \( (p = 0.031) \), and hospital stay was decreased from a median of 17.5 days (IQR 11 to 29) to 14 days (IQR 8.25 to 21) \( (p = 0.045) \). No significant difference in ICU and hospital mortalities between the groups was found. The authors concluded that optimization of intra-vascular volume using esophageal Doppler in multiple-trauma patients is associated with a decrease of blood lactate levels, a lower incidence of infectious complications, and a reduced duration of ICU and hospital stays.

Abbas and Hill (2008) conducted a systematic review of the literature for the use of EDM for fluid replacement in major abdominal surgery. Medline and Embase were searched using the standard methodology of the Cochrane collaboration for trials that compared EDM with conventional clinical parameters for fluid replacement in patients undergoing major elective abdominal surgery. Data from RCTs were entered and analyzed in Meta-view in Rev-Man 4.2 (Nordic, Denmark). The authors included 5 studies that recruited 420 patients undergoing major abdominal surgery who were randomly allocated to receive either intravenous fluid treatment guided by monitoring ventricular filling using EDM or fluid administration according to conventional parameters. Pooled analysis showed a reduced hospital stay in the intervention group. Overall, there were fewer complications and ICU admissions, and less requirement for inotropes in the intervention group. Return of normal gastro-intestinal function was also significantly faster in the intervention group. The authors concluded that esophageal Doppler use for monitoring and optimization of flow-related hemodynamic variables improves short-term outcome in patients undergoing major abdominal surgery. Furthermore, in a meta-analysis and review on fluid optimization with the EDM, Phan et al (2008) concluded that using an esophageal Doppler monitor can lead to an increase in use of peri-operative colloid fluid and a reduction in (i) length of hospital stay, (ii) time to resume full oral diet or bowel function, and (iii) complications after major surgery.

de Waal et al (2009) noted that the primary goal of hemodynamic therapy is the prevention of inadequate tissue perfusion and inadequate oxygenation. Advanced cardiovascular monitoring is a pre-requisite to optimize hemodynamic treatment in critically ill patients prone to cardio-circulatory failure. The most ideal CO monitor should be reliable, continuous, non-invasive, operator-independent and cost-effective and should have a fast response time. Moreover, simultaneous measurement of cardiac pre-load enables the diagnosis of hypo-olemia and hyper-olemia. Over recent years, a number of significant studies in the field of CO monitoring have been published. The available CO monitoring techniques can be divided into invasive techniques, minimally invasive techniques, and non-invasive techniques. Minor invasive arterial thermo-dilution is the standard for the estimation of CO. Less invasive and continuous
techniques such as pulse contour CO and arterial waveform analysis are preferable. The accuracy of non-calibrated pulse contour analysis is still a matter of discussion, although recent studies demonstrate acceptable accuracy compared with a standard technique. Doppler techniques are minimally invasive and offer a reasonable trend monitoring of CO. Non-invasive continuous techniques such as bio-impedance and bio-reactance require further investigation.

Funk et al (2009) noted that with advancing age and increased co-morbidities in patients, the need for monitoring devices during the peri-operative period that allow clinicians to track physiological variables, such as CO, fluid responsiveness and tissue perfusion, is increasing. Until recently, the only tool available to anesthesiologists to monitor CO was either via PAC or transesophageal echocardiography. These approaches have their limitations and potential for morbidity. Several new methods such as EDM, pulse contour analysis, indicator dilution, thoracic bioimpedance and partial non-rebreathing have recently been marketed, and have the ability to monitor CO non-invasively and, in some cases, evaluate the patients' ability to respond to fluid challenges. The authors stated that EDM has proven itself to be a reliable tool for monitoring goal-directed therapy. Further clinical trials, however, are needed to ascertain its utility in different patient populations, specifically those who are hemodynamically unstable requiring vasopressor support and those with dynamic changes in systemic vascular resistance.

A technology assessment on "Esophageal Doppler Ultrasound-Based Cardiac Output Monitoring for Real-Time Therapeutic Management of Hospitalized Patients" by the Agency for Healthcare Research and Quality (AHRQ, 2007) reviewed over 300 articles, including 7 independently conducted, randomized controlled trials. The technology assessment graded the quality of evidence for a given technology as being "strong", "moderate", "weak" or "inconclusive". Strong evidence is defined as evidence supporting the qualitative conclusion is convincing. It is highly unlikely that new evidence will lead to a change in this conclusion”. This report concluded that in patients undergoing surgical procedures with an expected substantial blood loss or fluid compartment shifts requiring fluid replacement, the clinical evidence for EDM was strong in respect of the following statements:

- Doppler-guided fluid replacement during surgery leads to a clinically significant reduction in major complications.
- Doppler-guided fluid replacement during surgery leads to a clinically significant reduction in the total number of complications.
- Doppler-monitored fluid replacement leads to a reduction in hospital stay.

Based on the AHRQ report as well as its internal review, the Centers for Medicare and Medicaid Services (2007) determined that it would provide coverage for EDM of CO for ventilated patients in the ICU and operative patients with a need for intra-operative fluid optimization.
A systematic review (Mowatts et al, 2009) evaluated the clinical effectiveness and cost-effectiveness of EDM compared with conventional clinical assessment and other methods of monitoring cardiovascular function in critically ill and high-risk surgical patients. Electronic databases and relevant websites from 1990 to May 2007 were searched. This review was based on a systematic review conducted by the AHRQ, supplemented by evidence from any additional studies identified. Comparator interventions for effectiveness were standard care, PAC, pulse contour analysis monitoring and lithium or thermo-dilution cardiac monitoring. Data were extracted on mortality, length of stay overall and in critical care, complications and quality of life. The economic assessment evaluated strategies involving EDM compared with standard care, PAC, pulse contour analysis monitoring and lithium or thermo-dilution cardiac monitoring. The AHRQ report contained 8 RCTs and was judged to be of high quality overall. Four comparisons were reported: (i) EDM plus CVP monitoring plus conventional assessment versus CVP monitoring plus conventional assessment during surgery; (ii) EDM plus conventional assessment versus CVP monitoring plus conventional assessment during surgery; (iii) EDM plus conventional assessment versus conventional assessment during surgery; and (iv) EDM plus CVP monitoring plus conventional assessment versus CVP monitoring plus conventional assessment post-operatively. Five studies compared EDM plus CVP monitoring plus conventional assessment with CVP monitoring plus conventional assessment during surgery. There were fewer deaths [Peto odds ratio (OR) 0.13, 95 % CI: 0.02 to 0.96], fewer major complications (Peto OR 0.12, 95 % CI: 0.04 to 0.31), fewer total complications (fixed-effects OR 0.43, 95 % CI: 0.26 to 0.71) and shorter length of stay (pooled estimate not presented, 95 % CI: -2.21 to -0.57) in the EDM group. The results of the meta-analysis of mortality should be treated with caution owing to the low number of events and low overall number of patients in the combined totals. Three studies compared EDM plus conventional assessment with conventional assessment during surgery. There was no evidence of a difference in mortality (fixed-effects OR 0.81, 95 % CI: 0.23 to 2.77). Length of hospital stay was shorter in all three studies in the EDM group. Two studies compared EDM plus CVP monitoring plus conventional assessment versus CVP monitoring plus conventional assessment in critically ill patients. The patient groups were quite different (cardiac surgery and major trauma) and neither study, nor a meta-analysis, showed a statistically significant difference in mortality (fixed-effects OR 0.84, 95 % CI: 0.41 to 1.70). Fewer patients in the EDM group experienced complications (OR 0.49, 95 % CI: 0.30 to 0.81) and both studies reported a statistically significant shorter median length of hospital stay in that group. No economic evaluations that met the inclusion criteria were identified from the existing literature so a series of balance sheets was constructed. The results showed that EDM strategies are likely to be cost-effective. The authors stated that more formal economic evaluation would allow better use of the available data. All identified studies were conducted in unconscious patients. Moreover, further research is needed to evaluate new EDM probes that may be tolerated by awake patients.
Absi et al (2010) examined some of the newer non-invasive techniques for monitoring CO in the pediatric population. These new techniques can be utilized in both a wide variety of patient sizes as well as the unique pathology of congenital cardiopathy; and may assist in optimizing therapy in the intensive care setting. Recently, it was reported that near-infrared spectroscopy positively correlates with venous O2 saturation. Esophageal Doppler is an accurate method only if used by experienced personnel. Both impedance cardiography and electrical cardiometry use thoracic electrical bioimpedance. However, the algorithm differs between the 2 methods. Cardiometry may be more accurate in patients with a low CO state. It has been reported that an analytical method using arterial pulse pressure recording (pressure recording analytical method) shows a high correlation with Doppler echocardiography. Finally, it has also been reported that partial CO2 re-breathing may be used to trend CO continuously, but not for providing absolute values. The authors concluded that although promising, studies validating the use of these methods in a variety of real clinical situations are needed before they will be widely used in pediatric practice. The currently available data suggest that pressure recording analytical method and electrical cardiometry will prove to be useful in the pediatric cardiac intensive care unit to monitor trends in CO.

Maeso and colleagues (2011) examined the cost-effectiveness of EDM during colorectal resection. Meta-analyses of RCTs of EDM used in colorectal resection were conducted to help determine its cost-effectiveness. An analytical decision model was used to compare the cost-effectiveness of strategies involving conventional clinical assessment with or without the measurement of CVP, with or without EDM. Avoided mortality and avoided major complications were used as measures of clinical effectiveness. In the meta-analyses comparing conventional clinical assessment plus CVP monitoring with or without EDM, statistically significant differences in total and major complications favoring the use of Doppler were found. No differences were seen in mortality. The use of EDM was associated with lower costs, mainly due to fewer complications, shorter hospital stays and shorter surgery times. The authors concluded that although the information regarding the clinical effectiveness of EDM in colorectal resection is limited, strategies including this form of blood flow monitoring may be cost-effective. They stated that further comparisons of Doppler monitoring against other hemodynamic monitoring systems should be undertaken.

Chattopadhyay et al (2013) examined the effect of fluid optimization using EDM when compared to standard fluid management in women who undergo major gynecological cancer surgery and whether its use is associated with reduced post-operative morbidity. From January 2009 to December 2010, women undergoing laparotomy for pelvic masses or uterine cancer had either fluid optimization using intra-operative EDM or standard fluid replacement without using EDM. Cases were selected from 2 surgeons to control for variability in surgical practice. Demographic and surgical details were collected prospectively. Uni-variate and multi-variate analyses were
performed to quantify the association between the use of EDM with "early post-operative recovery" and "early fitness for discharge." A total of 198 women were operated by the 2 pre-specified surgeons; 79 women had fluid optimization with EDM, whereas 119 women had standard anesthetic care. The use of ODM was associated with earlier post-operative recovery (adjusted OR, 2.83; 95 % CI: 1.20 to 6.68; p = 0.02) and earlier fitness for discharge (adjusted OR, 2.81; 95 % CI: 1.01 to 7.78; p = 0.05). Women with advanced-stage disease in the "EDM" group resumed oral diet earlier than women in the "no EDM" group (median, 1 day versus 2 days; p = 0.02). These benefits with EDM did not extend to women with early-stage disease/benign/borderline tumors. No significant difference in post-operative complications was noted. The authors concluded that intra-operative fluid optimization with EDM in women with advanced gynecological cancer may be associated with improved post-operative recovery and early fitness for discharge. Moreover, they state that studies with adequate power are needed to investigate its role in reducing post-operative complications.

Lin and colleagues (2015) evaluated the effect of peri-operative goal-directed fluid therapy (GDFT) on clinical outcomes in elective colorectal resection. A total of 42 patients undergoing elective colorectal resection between March 2013 and December 2014 were recruited prospectively; GDFT was administrated based on corrected left ventricular ejection time and stroke volume using EDM. These patients were compared with a historical cohort of 58 patients managed without GDFT from January 2012 to February 2013. The primary end-point was post-operative hospital stay and complication rate. There was no significant difference in the overall fluid volumes administered intra-operatively between 2 groups [(2,657 ± 1,037) ml versus (2,846 ± 1,444) ml, p > 0.05], but patients in GDFT group received higher volume of colloid fluids [(935 ± 556) ml versus (688 ± 414) ml, p < 0.05]. After a period of concordance at the start of operation, corrected left ventricular ejection time, stroke volume and cardiac index increased in GDFT group compared with control group (all p < 0.05). No significant differences were found in post-operative hospital stay [(11.27 ± 6.42) days versus (12.04 ± 7.18) days, p > 0.05] and total complication rate (26.5 % versus 25.9 %, p > 0.05) between 2 groups, but GDFT group had earlier post-operative flatus [(3.52 ± 0.84) days versus (4.48 ± 0.71) days, p < 0.05] and faster tolerated diet [(5.92 ± 1.18) days versus (6.83 ± 0.95) days, p < 0.05]. The authors concluded that patients undergoing elective colorectal resection did not benefit from intra-operative GDFT. They stated that further studies should be performed to examine if GDFT can be routinely used during colorectal resection.

Ripolles-Melchor et al (2016) stated that numerous studies have compared peri-operative EDM-guided intravascular volume replacement strategies with conventional clinical volume replacement in surgical patients. The use of the EDM within hemodynamic algorithms is called “goal directed hemodynamic therapy” (GDHT). In a meta-analysis, these investigators examined the effects of EDM-guided GDHT in adult non-cardiac surgery on post-operative complications.
and mortality using PRISMA methodology. They performed a systematic search in Medline, PubMed, Embase, and the Cochrane Library (last update, March 2015). Randomized clinical trials in which peri-operative GDHT was compared to other fluid management were selected for analysis. The primary outcome was overall complications; secondary outcomes included mortality, number of patients with complications, cardiac, renal and infectious complications, and incidence of ileus. Studies were subjected to quantifiable analysis, pre-defined subgroup analysis (stratified by surgery, type of comparator and risk); pre-defined sensitivity analysis and trial sequential analysis (TSA). A total of 56 RCTs were initially identified, 15 fulfilling the inclusion criteria, including 1,368 patients. A significant reduction was observed in overall complications associated with GDHT compared to other fluid therapy (RR = 0.75; 95 % CI: 0.63 to 0.89; p = 0.0009) in colorectal, urological and high-risk surgery compared to conventional fluid therapy. No differences were found in secondary outcomes, neither in other subgroups. The impact on preventing the development of complications in patients using EDM is high, causing a relative risk reduction (RRR) of 50 % for a number needed to treat (NNT) = 6. The authors concluded that GDHT-guided by EDM decreased post-operative complications, especially in patients undergoing colorectal surgery and high-risk surgery. However, no differences versus restrictive fluid therapy and in intermediate-risk patients were found.

CPT Codes / HCPCS Codes / ICD-10 Codes

*Information in the [brackets] below has been added for clarification purposes.* Codes requiring a 7th character are represented by "+":

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>J95.850</td>
<td>Mechanical complication of respirator [ventilated persons in the intensive care unit]</td>
</tr>
<tr>
<td>Z99.11 - Z99.12</td>
<td>Dependence on respirator [ventilated persons in the intensive care unit]</td>
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The above policy is based on the following references:


AETNA BETTER HEALTH® OF PENNSYLVANIA

Amendment to
Aetna Clinical Policy Bulletin Number: 0793
Esophageal Doppler Monitoring

There are no amendments for Medicaid.

www.aetnabetterhealth.com/pennsylvania  annual 11/01/2019