ALABAMA
Emergency Medical Services and Trauma

Update from the Office of EMS
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BiPAP for Prehospital Providers

Over the years, continuous positive airway pressure (CPAP) has become an accepted and routinely used prehospital emergency treatment for acute respiratory failure. Evidence shows noninvasive ventilatory management can reduce intubation rates and improve patient recovery, and with the arrival of CPAP several years ago, many alterations and advances have improved this therapy, resulting in better patient outcomes. Among these advances has been bilevel positive airway pressure, or BiPAP.

BiPAP, more commonly observed in hospital emergency departments and intensive care units, has also made its way to the prehospital setting. Many prehospital providers seem to have a natural curiosity about this lifesaving intervention. This article will discuss the pulmonary mechanism of BiPAP, how it differs from CPAP and technical aspects providers can utilize in their practice where BiPAP is offered.

Pulmonary Mechanics

As the name implies, bilevel positive airway pressure offers two different levels of noninvasive pressure that correspond to the respiratory cycle. These levels are called the inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP). These are also known as the inspiratory baseline and the expiratory baseline pressures. When a patient receives BiPAP, the noninvasive ventilator functions to provide a preset expiratory pressure during the expiratory phase and a preset inspiratory pressure during the inspiratory phase of the respiratory cycle.

This mechanism creates an astonishingly powerful method of reducing the patient's work of breathing and increasing the functional residual capacity (FRC) of the lungs (FRC is the volume of air left in the lungs at the end of exhalation). It is important to note there are two separate physiological processes working in the lungs: ventilation and oxygenation. Ventilation specifically deals with the removal of carbon dioxide from the lungs. The effectiveness of ventilation is measured by arterial carbon dioxide levels, or PaCO ; in the prehospital environment this is often correlated with end-tidal carbon dioxide, or EtCO.

From a mechanical ventilation standpoint, ventilation is monitored and even controlled by adjusting values such as tidal volume, minute ventilation and respiratory rate. Oxygenation specifically deals with the ability of the lungs to deliver oxygen to the pulmonary capillaries. Oxygenation is measured most accurately by obtaining the partial pressure of arterial oxygen, or PaO ; this is most commonly related to the patient's SpO value in the prehospital environment. In mechanical ventilation the PaO and/or SpO is improved by increasing the positive end expiratory pressure (PEEP, which coincidentally is directly proportional to the FRC in the lungs) and the fraction of inspired oxygen (FiO2, 21%–100%).

The removal of carbon dioxide in BiPAP is done through the use of pressure support. Pressure support is a value determined by the difference between IPAP and EPAP. Pressure support is primarily used for ventilation, meaning it's inversely proportional to arterial carbon dioxide levels. As pressure support increases, PaCO should decrease; when pressure support decreases, PaCO should increase. The pressure support is directly proportional to tidal volume: As pressure support increases, tidal volume should increase, and vice versa.

Patients who present in the latter stages of acute respiratory failure often present with arterial blood gases reflective of uncompensated respiratory acidosis, usually as a result of decreased tidal

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volumes and minute ventilation due to muscle fatigue and/or abnormal ventilatory rates. BiPAP may benefit these patients by accelerating their recovery from respiratory failure. The ventilating pressure support augments the patient's compromised respiratory effort by alleviating muscle demand for ventilation. Thus, the addition of pressure support utilizing IPAP effectively and safely ventilates the patient, much in the same way bag-valve mask ventilation works, a service CPAP does not perform.

BiPAP offers another pulmonary mechanism that CPAP already offers: positive end expiratory pressure. CPAP provides a constant airway pressure in the lungs during both inspiration and expiration. This constant baseline provides the lungs with PEEP, which increases the pulmonary reserve, or functional residual capacity. BiPAP does this through expiratory positive airway pressure. During the expiratory phase, the noninvasive ventilator lowers airway pressure to a preset EPAP, which is synonymous with the PEEP. This maintains small-airway patency, prevents atelectasis and increases FRC, drastically improving oxygenation. While CPAP works to improve only oxygenation (hypoxemic respiratory failure), the use of BiPAP improves not only oxygenation but also ventilation with the use of pressure support.

Technical Aspects

There are different types of BiPAP modes. Some models provide a time-triggered mode, where the IPAP and EPAP cycles occur at a prescribed respiratory rate. This type of BiPAP is less frequently used because it is associated with patient-ventilator dyssynchrony and increased respiratory distress. The more commonly used mode of BiPAP is known as spontaneous timed. This mode allows the operator to set a minimal respiratory rate, usually around 8–12 bpm. The idea is that the patient continues to breathe spontaneously, and the IPAP and EPAP are triggered according to the patient's spontaneous effort; however, if the patient experiences a period of apnea or their respiratory rate drops below the rate set on the ventilator, the machine will switch to a prescribed respiratory rate until the patient begins to breathe spontaneously again.

This approach is not designed to actually ventilate the patient, but it is meant as a safety mechanism to allow for some positive pressure ventilation to occur should the patient begin deteriorating. Most models have built-in alarms that alert providers that the BiPAP has switched to a prescribed respiratory rate or if no spontaneous effort is noted from the patient. This is most helpful when BiPAP is used in patients who have central sleep apnea, a form of sleep apnea in which efforts to breathe do not occur (versus obstructive sleep apnea, where the airway is compromised by decreased muscle tone or from some other obstruction). The machine time cycled IPAP and EPAP are meant to prompt the patient to begin spontaneously breathing again.

In the emergency setting, noninvasive ventilation (NIV) is often used for two distinct types of respiratory disorders: restrictive lung disease and obstructive airway disease. Most of the time this is due to acute cardiogenic pulmonary edema, asthma or chronic obstructive pulmonary disease. Other conditions that benefit from the use of NIV are acute hypoxemia, acute respiratory distress syndrome and palliative care. Settings for NIV are most often determined based upon presentation and titrated to effect. Most clinicians start at an IPAP of 10 cm H O and an EPAP of 5 cm H O, leaving a pressure support of 5 cm H O. Sources recommend titrating the pressure support to meet appropriate tidal volumes of 6 ml/kg of ideal body weight. If the presenting tidal volume is lower than predicted, it is important for the clinician to increase the pressure support to assure adequate ventilation. Other sources seriously recommend not exceeding an IPAP of 20 25 cm H O due to the risk of gastric distention.

It is helpful to distinguish which respiratory process is compromised, oxygenation or ventilation. If the patient is oxygenating well with respiratory distress, increased levels of PEEP may not be necessary,

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allowing the clinician to leave EPAP at a normal level of 5 cm H O. However, in some cases, such as acute pulmonary edema, increased levels of PEEP may be necessary to maintain alveoli patency and reduce fluid infiltration to improve oxygenation. EPAP levels of 5, 8 or 10 cm H O may be necessary in the presence of hypoxia. It is theorized that consistently high levels of intrathoracic pressure due to PEEP decrease preload on the heart, reducing the circulating volume of blood and fluid through the lungs, reducing pulmonary edema and decreasing hydrostatic pressures in the pulmonary vasculature.

Most prehospital providers are comfortable with determining the liter flow required for oxygen devices such as a nasal cannula or nonrebreather; however, when using a noninvasive ventilator for BiPAP, oxygen is most often determined by the fraction of inspired oxygen, or FiO. FiO is the percentage of oxygen inspired, room air being 21% and a nonrebreather with 15 lpm of oxygen at 100% FiO (theoretically). When initiating BiPAP it is also important to determine the amount of oxygen the patient needs. The use of CPAP (PEEP) or EPAP (in the case of BiPAP) often eliminates the need for high levels of FiO ; some clinicians with experience using BiPAP often find the mechanism of expiratory pressure allows clinicians to supply lower levels of oxygen, sometimes between 30%–50% (which is roughly equivalent to using a nasal cannula for oxygenation), and maintain SpO levels.

Oxygen toxicity has become a hot topic in prehospital literature; make all attempts to avoid excessive oxygen administration. In mechanical ventilation, the amount of PEEP used often corresponds with the level of FiO required. For example, when using high levels of PEEP, a lower amount of oxygen is needed to maintain oxygenation, and vice versa for circumstances using low levels of PEEP. The same concept holds true for noninvasive BiPAP. Clinicians may titrate EPAP according to the amount of FiO required to maintain SpO or PaO . Most sources recommend maximum EPAP levels between 10–15 cm H O, and of course FiO can be adjusted to maintain appropriate SpO. Patients requiring high levels of both EPAP and FiO may have decompensated to the point where intubation and invasive mechanical ventilation are required.

Prehospital Clinical Applications

A common complaint of 9-1-1 callers is respiratory distress or difficulty breathing. Since this has a high occurrence, it's important for prehospital providers to know when BiPAP is appropriate for those experiencing it. First and foremost, BiPAP is not indicated for patients who are unable to maintain their airway, are hemodynamically unstable, have an altered level of consciousness or are apneic or require immediate intubation. Complications or adverse effects of BiPAP include gastric distention, hypotension, anxiety and (less likely) pneumothorax.

COPD is an obstructive disorder characterized by increased airway resistance and decreased expiratory flow rates. This makes it difficult for COPD patients to fully exhale their tidal volume. Although most people associate it with smoking and emphysema, COPD is actually an umbrella term that includes other respiratory conditions, such as asthma and chronic bronchitis. During an exacerbation of this disease, increased airway resistance leads to air trapping and a retained volume of air in the distal airways and alveoli. As the exacerbation worsens, trapped gases decrease the volume of air the patient can inspire.

The solution to this is to open the airways and maintain their patency. This can be done with medications such as bronchodilators, steroids and smooth muscle relaxers. However, BiPAP offers the ability to "stint" airways by providing PEEP. This maintains the patency of lower airways and allows the patient to exhale with much more ease. The addition of pressure support decreases muscle fatigue by augmenting the amount of work the patient performs to breathe. Patients in acute respiratory failure, a common occurrence with COPD, benefit from the pressure support because it decreases arterial carbon dioxide by increasing the patient's tidal volume with the increased positive

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pressure during the inspiratory phase of the respiratory cycle.

Patients with congestive heart failure and/or pulmonary edema benefit greatly from BiPAP. Not only does BiPAP decrease muscle fatigue, increase tidal volume and maintain alveolar/distal airway patency, but therapeutically BiPAP benefits "wet" lungs by decreasing central venous return. This decreases the amount of circulating blood volume that goes through the pulmonary vasculature, which in turn decreases hydrostatic vessel pressure and prevents fluid from crossing the capillary membrane in the alveoli and flooding the interstitial spaces. The decreased venous return is caused by the PEEP or, in the case of BiPAP, the EPAP. The increased expiratory pressure increases intrathoracic pressures, putting stress on the venous return system, decreasing central venous pressures. This increased EPAP increases the functional residual capacity of the lungs, leading to an increase in arterial oxygen and/or SpO. Note also that pulmonary edema does not have to be a result of CHF for BiPAP to be effective. Other causes of noncardiogenic pulmonary edema, such as acute respiratory distress syndrome (ARDS), sepsis/systemic inflammatory response syndrome and renal failure (with fluid overload) with respiratory distress, warrant noninvasive ventilation if immediate intubation is not required.

When differentiating the appropriate use of CPAP versus BiPAP, it is important to consider whether the patient is suffering from type 1 or type 2 respiratory failure. In type 1 (hypoxemic) respiratory failure, the patient suffers from hypoxemia alone, usually defined as a PaO less than 50 mmHg. In type 2 (ventilatory/hypercapnic) respiratory failure, the patient suffers from hypercapnia, usually defined as a PaCO greater than 50 mmHg, which can be accompanied by type 1. CPAP itself is an effective first-line agent for type 1 patients, as it is effective for increasing FRC by applying PEEP. Type 2 patients are recommended to be placed on BiPAP as an effective means of improving gas exchange and normalizing arterial blood gases. When considering changes in practice and purchasing equipment, it may be prudent to utilize devices that can provide BiPAP since BiPAP utilizes EPAP, which essentially is PEEP. This may be why BiPAP does not display a clinical benefit in outcomes over CPAP in cases of acute cardiogenic pulmonary edema that may initially present as type 1 respiratory failure.

Conclusion

It is proven to prevent and delay endotracheal intubation in patients experiencing acute respiratory failure. Paramedics interested in providing advanced emergency and critical care in the field will find BiPAP a tool that can be applied in situations where emergency CPAP may have been used. With the proper training, didactic opportunity and clinical practice, prehospital providers can and should be comfortable applying this therapy with the potential to reduce the burdens of endotracheal intubation and respiratory arrest in patients experiencing pulmonary disease exacerbations.

References available upon request.

Jamie Gray, BS, AAS, NRP
Deputy Director

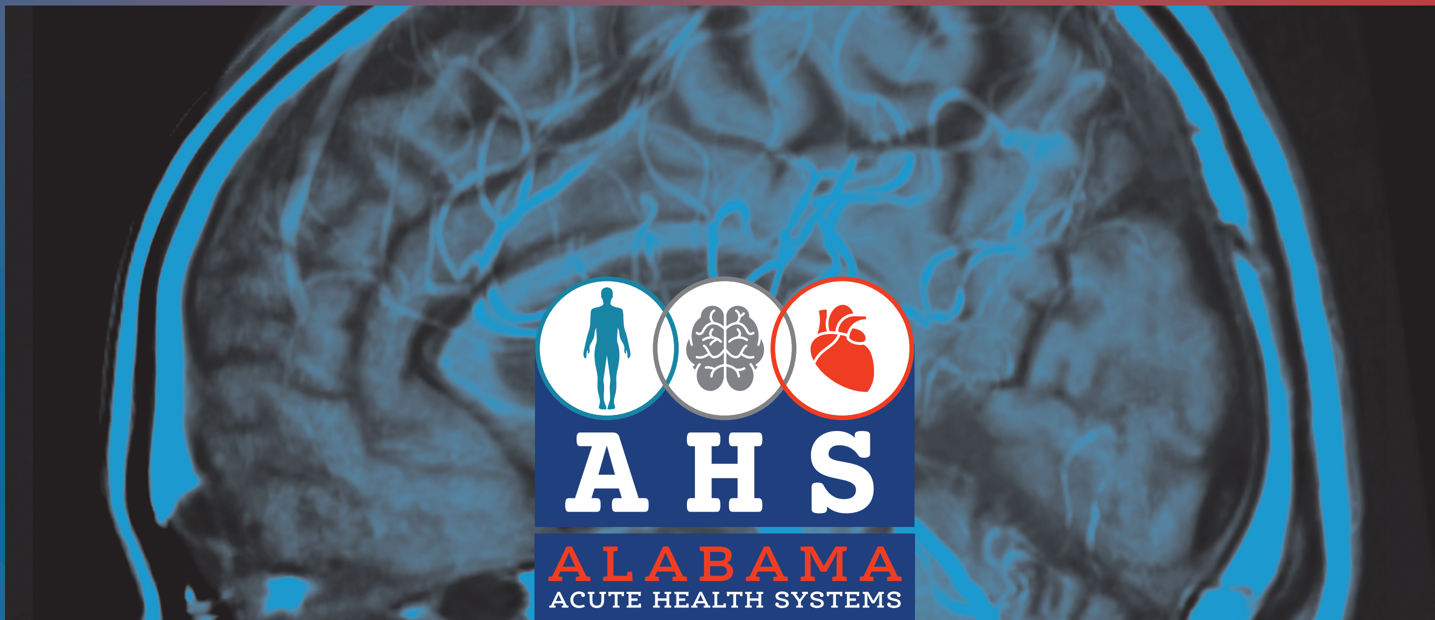
Compliance Issues

Name	Rule/Protocol	Complaint	Action Taken
John R. Blankenship EMSP-Paramedic 1100534	420-2-1-.21	Documentation	Suspension
Heather Bolling EMSP-AEMT 1100451	420-2-1-.29	ALS Equipment in Personal Vehicle	Suspension
Kyle D. Brock EMSP-Paramedic 1400799	420-2-1-.29	Medication Error	Remedial Training
Jody Lane Brown EMSP-Paramedic 0300415	420-2-1-.29	Academic Dishonesty	Suspension
Joshua R. Feller EMSP-Paramedic 1700012	420-2-1-.21	Documentation	Suspension
Abigail L. Harris EMSP-EMT 1800778	420-2-1-.21	Documentation	Remedial Training
Norman Patrick Morrison EMSP-Paramedic 0801229	420-2-1-.29	Criminal Charge	Suspension
Nolan G. Watt EMSP-Paramedic 1000293	420-2-1-.29	Failed to Follow Physician's Orders	Suspension
EMSP-EMT	420-2-1-.30	Impairment	Suspension
EMSP-EMT	420-2-1-.30	Impairment	Suspension
EMSP-Advanced EMT	420-2-1-.30	Impairment	Suspension
EMSP-Intermediate	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension
EMSP-Paramedic	420-2-1-.30	Impairment	Suspension

Provider Service Inspections

These inspections were completed January-June 2020.

Abbeville Fire Rescue
Allgood Volunteer Fire and Rescue
Anniston EMS, Inc.
ASAP EMS-Sumter County
Blount EMS, Inc.
Care Ambulance-Chilton County
Childersburg Ambulance Service
Clanton Fire Department
Clay County Rescue Squad
Cleburne County EMS
Cottonwood Ambulance and Rescue Squad
Dale EMS & Rescue Squad, Inc.
Daleville Police Volunteer Rescue
East Alabama EMS, LLC
Echo EMS
Emergency Medical Transport, LLC
Fairview Volunteer Fire & Rescue
Floyd EMS-Cherokee County
Forestdale Fire District
GEMS Ambulance
Greene County EMS
Greenville Fire Department
Haleburg Rescue Squad
Hartselle Fire Rescue
Haynes Ambulance-Montgomery County
Haynes Ambulance of Troy, LLC
Haynes Lifeflight-Pike County
Headland Fire Rescue
Helena Fire Department
Indian Ford Fire District
Jacksonville Fire District
Jemison Fire and Rescue
Lifeline EMS
Lincoln Fire & Rescue
Livingston Fire & Rescue
Locust Fork Fire and Rescue
Mobile Fire Rescue Department
Monroeville Fire/Rescue Department
Mountain Brook Fire Department
Nectar Fire Department
North Chilton Volunteer Fire Department
Northstar Paramedic Services-Talladega County
Oneonta Fire and Rescue Service
Opelika Fire Rescue
Oxford EMS, Inc.
Oxford Fire Department
Ozark EMS
Ozark Fire Department
Pickens County Ambulance Service
Piedmont Rescue Squad
Pine Mountain Volunteer Fire and
EMS District, Inc.
Pintlala Volunteer Fire Department
ProgressiveHealth, LLC
Rosa Volunteer Fire & Rescue
RPS-Chilton County
Securitas Services, Inc.
Smiths Station Fire & Rescue
Snead Fire and Rescue
Southern Ambulance Transport
Survival Flight, Inc.-Henry county
Sylacauga Ambulance Service
Thorsby Fire Department
Troy Fire Department
West Blount Fire District
Winterboro Volunteer Fire & Rescue



Acute Health Systems

Stroke System

The thrombolytic checklist is a useful tool for systematically gathering pertinent information when dealing with stroke patients. Often our patients are unable to speak or give an accurate history when they arrive at the ED. A completed checklist can assist hospital staff in their assessment by providing them with, not only a historian's contact number, but other valid information. This could potentially prevent loss of valuable time in patient care and outcome. The thrombolytic checklist can be found in our protocols and on our website.

American Stroke Association Articles

Knocking down fears, myths, and misinformation about calling 911 in the pandemic

5 reasons hospitals are safe for heart, stroke emergencies—even in the pandemic

Culture of Excellence

Allgood Volunteer Fire and Rescue

Blount EMS

Cleburne County EMS

Haynes Lifeflight-Pike County

Helena Fire Department

Lincoln Fire and Rescue

Livingston Fire & Rescue

Mobile Fire Rescue Department

Mountain Brook Fire Department

Nectar Fire Department

Oneonta Fire and Rescue

Ozark EMS

Pine Mountain Volunteer Fire and EMS District

Snead Fire and Rescue

Survival Flight, Inc.-Henry County

Troy Fire Department

How can CARES help?

Each year in the United States, more than 350,000 cardiac arrests occur outside of a hospital setting. Cardiac arrest is the abrupt loss of heart function in a person who may or may not have been diagnosed with heart disease. Considering heart disease is the leading cause of death in Alabama, it is important to study the factors of cardiac arrest.

Cardiac arrest can come on suddenly, or in the wake of other symptoms. Cardiac arrest is often fatal, if appropriate steps aren't taken immediately. It may be caused by almost any known heart condition. Also, most cardiac arrest survivors have some degree of brain injury and impaired consciousness. Some remain in a persistent vegetative state. Then factor in determining the survivor's prognosis and making the decision to treat or to withdraw care is complicated and based on many variables, many of which have not been thoroughly studied. This is really where CARES benefits the EMS system in a community.

CARES can provide metrics to better understand the cardiac arrest in a community. When an EMS system participates in CARES they will have access to their data and will be able to run reports on the factors behind the cardiac arrests. The reports they generate will tell them factors before a cardiac arrest happens such as age, ethnicity, pre-existing conditions, and location. The next step will give them factors during the cardiac arrest such as time of arrest to start of CPR or defibrillation, quality of resuscitation efforts, and if the patient sustained a return of spontaneous circulation (ROSC). Then the final piece of the cardiac arrest event is the patient outcomes such as the neurological outcome and where the patient was released, such as to home. The reports provide all of these factors in one report and can be customized to really see what is happing in the community.

CARES
Cardiac Arrest Registry
to Enhance Survival

In order to, improve an EMS system has to be actively monitoring and working to improve their response to cardiac arrest events. Armed with the knowledge that CARES provides to them will make it that much easier to know what, where, and how to improve their response to cardiac arrests in the future. The goal is to improve the patient outcomes and survivability from these events in Alabama.

If your service isn't participating and would like to know more you can contact Kent Wilson at kent.wilson@adph.state.al.us.

Alabama e-PCR Submission Requirements

Some e-PCR Points of Clarification:

1. It is a requirement to complete a patient care report on every response. This office is already monitoring submission rates and comparative data suggests that many agencies are not reporting all runs as required. Please submit all required runs to avoid noncompliance.

2. Each record must be submitted electronically within 72 hours or less. The goal is to eventually narrow that down to within 24 hours. The 24 hour reporting allows Public Health to monitor surveillance trends as required by the Federal emergency preparedness guidelines.

3. Our IT staff is always available to assist you with your e-PCR needs. If you need assistance, you may call Chris or Lori at 334-206-5383. You may get a voice recording depending on the call volume. They will eventually get back to you. If you do not hear from them within a reasonable time, you may wish to email them (emsis@adph.state.al.us).

4. Collecting and importing data is paramount only to reporting reliable data. Reliable data is accurate and contains no errors. When one looks for shortcuts and/or skips data entry in areas that has been discovered to have no validation rules, it dilutes the integrity of the data, not to mention falsifies a legal document. Please make sure you enter data accurately.

5. Alabama became a NEMSIS version 3.4 compliant state beginning January 1, 2018.

GENERAL INFORMATION

Do You Have Questions for OEMS Staff?

This is another reminder to those of you calling our office (334) 206-5383:

Complaints, Investigations, and Inspections: Call Jamie Gray

Licensure: Call Stephanie Smith, Kembley Thomas, or Vickie Turner

Individual Training or Testing: Call Chris Hutto

EMS for Children, Website, and Social Media: Call Katherine Dixon Hert

EMS Data/NEMSIS: Call Gary Varner

Requests for Information from Regional Offices

The Office of EMS would like to request that you comply with any request for information from your regional office. Some Directors are still having issues receiving information and data as requested by the State office. We would greatly appreciate your cooperation and compliance.

Reporting Requirements

A licensed EMSP shall perform his or her job duties and responsibilities in a manner that reflects the highest ethical and professional standards of conduct. Actions that are in violation of the standard of conduct will be considered misconduct and are subject to immediate disciplinary action, up to and including license revocation.

Please be reminded that, according to Rule 420-2-1-.28 (6h), All licensed provider services shall provide notification and written documentation within three working days to the OEMS regarding any protocol or rule violation, which includes but not limited to, items listed in 420-2-1-.29 (2).

Also, be reminded that, according to Rule 420-2-1-.30 (6), All licensed provider services shall provide notification and written documentation about any individual who meets the definition of an impaired EMSP.