

AGENCY SUCCESS STORY

The road to improved ventilation quality

Out-of-hospital sudden cardiac arrest

Approximately 350,000 people in the United States suffer out-of-hospital cardiac arrest (OHCA) annually. Less than 10% survive neurologically intact.¹ The quality of cardiopulmonary resuscitation (CPR) that patients receive has been shown to impact patient outcome.² Proper ventilation with a bag-valve-mask (BVM) is also a critical component of CPR.

High-quality CPR:

- Rate: 100 to 120 compressions/minute
- Depth: 2 to 2.4 inches
- Chest recoil: Allow the chest to fully expand between compressions
- Avoid excessive ventilation: rate <12 breaths per minute and minimal chest rise

The AHA and ERC recommend two ventilations for every thirty compressions (30:2) and a tidal volume of approximately 500 to 600 mL, or enough to create a visible chest rise.³

South Metropolitan Fire District

Location: Raymore, Missouri

Comprised of three fire stations, three ALS ambulances, and 3 ALS fire trucks, South Metro is a small agency that responds to approximately 5,000 calls annually.

Lawrence-Douglas County Fire Medical

Location: Lawrence, Kansas

Provides fire suppression services to the City of Lawrence and emergency medical services to all of Douglas County, Kansas. It responds to approximately 17,500 calls annually.



Manual ventilation—a vital CPR component

Historically, ventilating patients with a BVM has presented challenges. Studies show frequent hyperventilation, often up to three times the recommended rate.⁴ Hyperventilation worsens cardiac arrest outcomes, and excessive positive pressure ventilation can impair circulation and CPR effectiveness.⁴ Providers have been able to distinguish chest rises on anesthetized volunteers with mean tidal volumes of 181 mL, and ventilations were perceived as adequate when tidal volumes on average exceeded 384 mL,⁵ indicating that relying on chest rise and fall may lead to inadequate ventilation.⁶ Out-of-hospital providers delivering compressions during CPR have the benefit of real-time feedback to help improve their rate and depth. Historically, this technology hasn't been available to providers delivering ventilations. And when agencies use more than one size BVM, it can be challenging to rely on muscle memory to appropriately squeeze a self-inflating bag.

Improving outcomes

Leaders at two EMS agencies were searching for ways to overcome these ventilation quality challenges.

At Lawrence-Douglas County Fire Medical, EMS Division Chief Kevin Joles had tried several ways to improve ventilation quality. His efforts included moving to a standardized BVM size across the entire county and adopting a BVM that prevented excess ventilation. Even with these measures, Kevin wasn't satisfied with the service's ventilation quality and the equipment they used didn't offer metrics on rate or tidal volume.

At South Metropolitan Fire District on the southeast side of Kansas City, Missouri, Assistant Chief of EMS Joshua Collier was also looking at ventilation quality. After several years of reviewing cardiac arrest statistics, he realized that no two calls, paramedics, scenes, or patients were the same. He felt the key to improving care was to make it as consistent as possible. "What can we do as EMS providers to eliminate variables in the care we provide?" he wondered.

Both agencies decided to try the ZOLL® AccuVent® sensor, a disposable, pressure-based flow sensor that attaches to the end of a BVM. It can be used with or without an advanced airway, and it



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The use of real-time feedback was associated with an increased proportion of ventilations that were compliant with pre-defined targets during cardiac resuscitation. Further work is required to improve the use of real-time ventilation feedback, and to determine the impact of ventilations on patient outcomes.⁷

— Drennan et al., *Resuscitation*. 2024

provides breath-by-breath measurements of ventilation rate and volume. When connected to a ZOLL X Series® Advanced monitor, the Real BVM Help® dashboard displays breath-by-breath rate, ventilation volume, a countdown timer, and a ventilation quality indicator.

As recently as 2024, researchers in Canada demonstrated the value of real-time feedback during ventilation. In a before and after study, the use of real-time feedback was associated with an increased proportion of ventilations during cardiac arrest that were compliant with pre-defined targets.⁷

Training and implementation

The two agencies took different approaches to implementation. At South Metro, Josh gave the sensors to a few senior crews for input on how the technology worked in different clinical patient scenarios. After receiving positive feedback, he trained the crews and made ZOLL AccuVent sensors available to them.

Kevin took a slightly different approach at Lawrence Douglas. "I knew AccuVent was the best clinical opportunity we had to improve ventilations during CPR," he explains. Kevin trained crew members how and when to use the AccuVent sensor in combination with the Real BVM Help feedback displayed on the dashboard.



Aha! moments

Training at South Metro was straightforward. "I thought it would be met with some resistance, particularly by some of the more senior EMTs," Josh recalls. Crews embraced the sensor and were enthusiastic. "The guys all picked it up quickly and they liked the feedback on the monitor," he explains.

"There's a commonly held view among EMTs that ventilating with a BVM is simply a matter of squeezing the self-inflating bag once every 6 seconds to maintain appropriate tidal volume. But when you get to a scene, the anxiety starts, your blood pressure rises, and you lose track of time. Your ventilations aren't as good as you think they are."

At Lawrence-Douglas County Fire Medical, crew members required hard evidence before embracing the sensor. "We implemented AccuVent, but it wasn't immediately adopted," Kevin recalls. He speculates that his team members thought their ventilation quality was adequate. But Kevin believed that without measurement, that was simply their opinion.

To demonstrate the power of this technology, he held a Real BVM Help challenge. Crew members

delivered ventilations with the AccuVent sensor in place without seeing the feedback on the Real BVM Help dashboard. Then they delivered ventilations with the support of the Real BVM Help feedback. "That was the aha moment for many of my team members," Kevin explains.

"There are so many different sized BVMs that it's challenging to know exactly where to put your fingers to squeeze exactly the same every time. The AccuVent sensor and Real BVM Help feedback give us the opportunity to not worry about BVM size. We can measure exactly what volume and rate we're delivering," he explains. The challenge opened their eyes to the benefits. "Over time they became accustomed to using it."

Beyond ventilation quality improvements

While RescueNet® CaseReview isn't needed to use the AccuVent sensor, in this instance both agencies were already utilizing it for training and quality improvement. Reviewing ventilation and CPR summaries together has strengthened quality improvement efforts, expanded crew members' understanding of how to improve ventilation delivery, and even helped identify opportunities to improve care across the continuum.

At South Metro, the clinical data from RescueNet CaseReview helped illustrate performance during a sudden cardiac arrest call received during shift change. A newly trained EMT on the job for only two weeks was tasked with patient ventilation. When Josh reviewed the event details, he saw that this crew member with only two weeks' experience was able to use real-time feedback to maintain an average tidal volume of 480 ml and provide ventilations within the target range of 10 breaths/minute for 87% of the call. "He did a great for someone on the job for only two weeks. His rate and rhythm were right on the money," says Josh.



During long scene times and prolonged transports, multiple crew members rotate in to deliver manual ventilations. As noted in this ventilation summary, AccuVent and Real BVM

Help technology help address the cognitive load EMTs carry as well as physical differences amongst providers, keeping all team members' ventilations within target rate and volume.

Perhaps one of the more profound benefits of implementing AccuVent and Real BVM Help feedback has been the ability to improve care across the continuum using quantifiable ventilation rate and tidal volume data. South Metro now uses ventilation summaries to identify best practices and to pinpoint what's happening when volume and rate fall out of range, such as times when patients are moved or transferred. This data helps them work constructively with care partners across the continuum.

Moving forward

Without changing protocol or mandating the use of the AccuVent sensor, South Metro has achieved a near 100% use rate when appropriate, such as during cardiac arrest from an overdose or other respiratory emergency.

At Lawrence-Douglas, crew members grew accustomed to using the AccuVent sensor and Real BVM Help to maintain ventilation rate and tidal volume within AHA Guidelines. They no longer rely on muscle memory when ventilating a patient. Reviewing ventilation rate and tidal volume has become a regular component of their QA review. "It's an added value to the crew to be able to see how their ventilation rate and volume compares to the Guidelines," explains Kevin. "Crew members want to know that they're not giving too much, not breathing too fast."

¹Cardiac Arrest Registry to Enhance Survival (CARES) website, <https://mycares.net/sitemap/aboutcares.jsp>. Accessed 27 Jan 2025.

²Meaney PA, et al. *Circulation*. 2013 Jul;23:128(4):417–35. doi: 10.1161/CIR.0b013e31829d8654.

³Panchal AR, et al. *Circulation*. 2020;142(16_suppl_2):S366–468.

⁴Aufderheide TP, et al. *Crit Care Med* 2004;32:9(Suppl.):S345–S351.

⁵Baskett et al. *Resuscitation*. 1996 Jun;31(3):231–4. doi:10.1016/0300-9572(96)00994-x.

⁶van Eijk JA, et al. *Resuscitation*. 2024;203:110366.

⁷Drennan IR, et al. *Resuscitation*. 2024 Nov;204:110381. doi:10.1016/j.resuscitation.2024.110381.

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