

Helicopter Emergency Medical Services in Oklahoma

An overview of current status and future directions

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EXECUTIVE SUMMARY

In 2011, the Oklahoma State Department of Health (OSDH) commissioned the University of Oklahoma Department of Emergency Medicine (OUDEM) to prepare an assessment of helicopter Emergency Medical Services (EMS) in Oklahoma. OSDH felt that the subject was sufficiently important to warrant an in-depth analysis of the *status quo*, in order to enable considerations as to how the system may be improved.

OUDEM embarked upon the project in the spring of 2011, and completed the initial draft of this report in November 2011. With assistance from OSDH, review and discussion of the draft report culminated in the preparation of this final monograph, submitted in April 2012.

The initial ten pages of the report comprise the Executive Summary. The summary is intended to highlight important findings and recommendations of the authors. Supporting information (including references) for all topics addressed in the Executive Summary is found in the report's body. The Executive Summary commences with outlining of EMS issues, and concludes with an overview of the report authors' ideas as to how the state may consider moving forward to address issues and improve care, outcomes, and efficiency.

Introduction to EMS

EMS remains controversial, but the debate's fervor diminishes after a balanced review of the available evidence. The preponderance of available data suggests quite strongly that, for at least some types of patients, EMS improves mortality and nonmortality outcomes. The question is not, "Does EMS improve outcome?" Rather, it is "For whom does EMS have a realistic chance of improving outcome, and how can we identify those cases at the time of transport decision making?"

Historically, the integration of EMS resources into prehospital and interhospital systems of care, has focused on the injured patient. Lessons learned in Korea and Vietnam were translated to the civilian setting and EMS became an integral part of many trauma systems. EMS remains a valuable, if sometimes questionably deployed, asset for trauma care. Moreover, the emergence of regionalization of care for other time-critical populations – most notably cardiac and stroke – has translated into increasing use of EMS for non-trauma transports. EMS is thus used, with varying levels of supporting evidence, for a wide variety of patient types. Indeed, for many EMS programs trauma patients now comprise a minority of flights.

EMS and outcomes improvement

While it is true that an objective review of available data suggests judicious EMS deployment is associated with outcomes improvement, the literature is less clear on the mechanisms for EMS' positive impact. The initial theory that EMS improved trauma survival based upon time factors was quickly realized to be difficult to test. This is partially because EMS trauma patients are transported a far greater distance than those who come by ground. Unadjusted analysis usually demonstrates longer prehospital times for the air transported cohort.

Another contributor to the time conundrum, is that EMS crews can provide such advanced care as to blur the cutoff of the "golden hour." EMS capabilities often resemble those of the Emergency Department (ED) more than they resemble those of referring ground EMS providers. Thus, some trauma surgeons specializing in researching prehospital and stabilization times have averred that the critical initial resuscitation time frame clock "stops" with arrival of EMS units (since those units can provide advanced interventions).

Whatever the truth is with regard to time savings and trauma care, it is quite clear that time savings are the critical variable driving EMS decisions for some nontrauma diagnoses. The literature addressing ST-elevation myocardial infarction (STEMI) and ischemic stroke care outlines very precise timeline goals. First, there are endpoints addressing whether or not patients arrive at definitive care fast enough to receive time-windowed therapies. Additionally, there are data suggesting incremental benefits for degrees of time savings for those patients who do meet the therapeutic deadlines.

The time issue can be summarized as follows: Time is sometimes, but not always, a factor in the puta-

tive outcomes impact achieved with air transport. In some cases the time benefit is manifest in allowing patients to receive therapy that cannot be administered outside certain time windows. In other cases time benefit is simply a matter of expeditiously getting the sickest patients to the centers best suited to care for them.

If time is not always responsible for HEMS' outcomes benefit, what other variables come into play? The first, already mentioned with respect to trauma and golden-hour interventions, is crew expertise. While obviously not always the case, it is quite frequently true that HEMS crews have considerably more experience and expertise with critically ill and injured patients than providers available at referring agencies. This elevation in medical care can be the case regardless of whether the mission type is a scene run or interfacility transport.

Another possible avenue by which HEMS can contribute to overall system effectiveness relates to capability for direct transport to specialized centers. "Scene runs" can represent an important tool in a care system's armamentarium, to transport patients with trauma or nontrauma (e.g. STEMI) directly from an out-of-hospital setting to tertiary care. In essence, HEMS can extend the reach of regionalized systems for trauma, cardiac, stroke, neonatal, obstetric, pediatric, and other patient populations.

Risks and benefits of HEMS transport

As reviewed in detail in the body of this report, there are clear indications that properly deployed HEMS can improve outcome in a breadth of patient types. Whether moving the critically injured patient to the experienced trauma team or assuring the high-risk obstetric patient can be transferred for delivery at a hospital with appropriate fetal-maternal care, HEMS offers potential benefits. Against those benefits, what are the risks?

Risks inherent to HEMS transport can be broadly separated into "medical" and "aviation" risks. Incremental medical risks (over ground transport) have been demonstrated to be essentially nil. Issues that were raised in HEMS' early years (e.g. inability to hear breath sounds, concerns over vibration-induced hemorrhage in post-lysis cases) have been disproved or found surmountable. The available evidence does not suggest that HEMS poses any medical risks to patients, that are significantly greater than the risks of ground transport.

Aviation risk is a different matter. Unfortunately, the real fact that helicopter flight is associated with non-zero risk, has been obscured in emotion-driven observations that ignore both the evidence surrounding HEMS risk, and the lack of (comparator) evidence addressing risk of alternative means of transport. The report addresses some risk issues, but the authors refer interested readers to those with broadly recognized expertise and experience in this arena. Perhaps the best summary statement is that the overall risk of HEMS transport has remained relatively stable, and relatively low, for many years. Increasing numbers of HEMS accidents generally reflect burgeoning of the number of HEMS transports, rather than an increasing accident rate. That said, safety remains the self-identified Job One of the HEMS industry.

Triage and utilization review

Selection of patients for whom HEMS is appropriate, has been and remains the bugaboo of air medical transport. Every prehospital and hospital provider has stories about patients for whom helicopters were used but who "obviously didn't need it." There can be little doubt that HEMS is often used for patients who, in retrospect, didn't need it. Where the difficulty lies, is in defining criteria that allow prospective assignation of transport mode, in such fashion that HEMS is neither over- nor underutilized.

The first barrier in triage is encountered with trauma patients. There is regrettable but currently unavoidable lack of precision in available instruments designed to ascertain which patients require high-level trauma care. Professional societies such as the American College of Surgeons acknowledge that, in order to keep undertriage at desirable levels of 5-10%, overtriage rates can approach and even exceed 50%.

The relevance of trauma triage imprecision to the HEMS triage debate is both direct and clear. If we can't minimize overtriage to trauma centers, how can we minimize trauma overtriage to HEMS? The short answer is, we can't. No one suggests that the 50% overtriage rate that's accepted for trauma center triage, should be accepted for air transport triage. However, those who criticize *ex post facto*, individual decisions for air transport, should do so with an eye to avoid nonconstructive Monday-morning quarterbacking. There are clear-

ly some cases in which HEMS is used, when there is no reasonable chance that helicopter deployment will help either the patient or the system. The review process' focus on triage adequacy should address elimination of those clear-cut cases, in which overtriage clearly represents overutilization.

Nationally generated and disseminated guidelines exist, upon which regional HEMS triage criteria should be adapted. Constitution of those guidelines in a given region is just the first step. Next steps include monitoring of overall regional compliance with established HEMS use criteria, and assessment for heterogeneity within a region's providers in their compliance with agreed-upon guidelines. Finally, feedback to the consumers of (*i.e.* triagers to) HEMS is necessary in order to close the loop and contribute to ongoing system improvement.

Triage and utilization review for nontrauma can be simpler, if the transport is being effected to get patients into time-windowed therapy. HEMS use that allows a patient to receive a therapy that could otherwise not be given, is far more likely to be appropriate than, for example, transport of a post-lysis STEMI patient with no ongoing pain or other indication for urgent cardiac catheterization. While the approaches may be different than those for trauma, the take-home message is that triage guidelines and utilization review are just as important for nontrauma, as they are for transport of the injured.

A final aspect of triage worthy of mention here, is the use of fixed-wing (airplane) transport. Oklahoma is sufficiently large in area, that such transport is occasionally useful and sometimes the only realistic option. Fixed-wing craft can help bridge transport gaps created by distance, weather, or simple unavailability of rotor-wing (helicopter) assets.

Cost-effectiveness

Outcomes impact and triage efficiency contribute to the larger policy-related question as to HEMS' cost-effectiveness. The big-picture analysis of HEMS from a healthcare economics perspective, includes both "effectiveness" in lives, and other types of HEMS-related benefit (*e.g.* savings of ground EMS resources in a given area, by prevention of their having to execute a multi-hour ground transport). It's not easy to generate a model that encompasses all of the variables, but some excellent work has been executed in this arena. Evidence from many countries (mostly in Europe) rates HEMS' cost-benefit favorability at nearly 6:1; cost-utility in quality-adjusted life-years appears to be roughly \$30,000-\$50,000 (well within acceptable levels in Europe and in the U.S.).

The preceding estimates are not necessarily exportable to Oklahoma, but they do provide justification for ongoing HEMS use. Existing data also provide a guide for future studies of HEMS economics in our state. Fortunately, trauma systems data from Oklahoma (from a 2011 study) produces a 2.4 estimate for *W* (the number of lives saved per 100 scene trauma runs) that is squarely in the range of that predicted by the balance of the literature. The consistency of the Oklahoma data with those of the rest of the world, indicates it's likely appropriate to extrapolate some other areas' cost-effectiveness approaches to our state.

HEMS services, aircraft, and care in Oklahoma

There are four HEMS services based within Oklahoma. The number of helicopters continues to evolve, but as of this report's generation there were 19 rotor-wing assets based in-state. All are private-enterprise competitors, technically against all others, although MediFlight and Tulsa Life Flight are part of one single larger business, and EagleMed and Air Evac are part of another single larger company. Other aircraft do respond from Texas, Arkansas, Missouri, or Kansas, but the vast majority of HEMS flights in Oklahoma originate and terminate within the state boundaries.

The aircraft comprising the Oklahoma-based fleets are all single-engine helicopters that only fly Visual Flight Rules (VFR). There are some differences between aircraft, in terms of space and speed. Since all of the aircraft are relatively small (compared to larger twin-engine helicopters traditionally used by U.S. HEMS providers), and since crews are remarkable in their ability to adapt to ergonomic challenges, the impact of space issues seems likely to be marginal in most cases.

Speed is clearly important, especially given the need to move patients long distances within therapeutic windows. However, the differences in speed among Oklahoma's helicopters are of limited magnitude (15-30

knots) and are likely to often be marginally relevant. A particular helicopter's "by the book" speed capabilities are often outweighed by other aviation factors such as wind and transport routing (e.g. due to weather).

The bottom line based upon assessment of the aircraft servicing our state, is that as a general rule there is little reason to use one Oklahoma HEMS service over another, based solely on aircraft type. There are clearly exceptions to this rule, but those exceptions are often obvious in case-by-case analysis (e.g. need for equipment that is only available on a certain aircraft).

Comparison of crews on Oklahoma's helicopters is not as straightforward as assessment of aviation assets. Most of the Oklahoma HEMS aircraft are certified by the national accrediting body (CAMTS); such accreditation assures some level of consistency in crew education, training, and proficiency. Information on the years' experience, number of transports executed, or other characteristics of Oklahoma HEMS crews is not available. There is much opinion, but very little fact, addressing whether a particular Oklahoma HEMS service should be used based upon crew qualifications. As with the aircraft issue, there are occasional exceptions – most notably, the use of specialized pediatric transport crews for the OKC-based helicopter providing pediatric transports.

Since the practices and protocols of the HEMS crews are not known to this report's authors, it is not clear to what extent the crews' clinical capabilities differ. The HEMS crews usually have nonphysician staffing, with crews' possessing the expanded scope of practice that is typical for nonphysician HEMS crews in the U.S. With few exceptions – the capability to carry packed red blood cells (PRBCs) to trauma scenes is one – there appears to be no major difference between the on-paper qualifications of the crews.

The PRBC transfusion issue is one that, in the report's authors, requires attention. The ability to provide PRBCs for scene runs is reported to be marketed by MediFlight and Tulsa Life Flight, as an advantage of their services. The sense of this report's authors, is that there *are* sufficient data supporting the potential utility of PRBC availability for scene administration as long as attention is paid to safety and clinical evidence (e.g. avoidance of use of "old" PRBCs). What matters, though, are not the opinions of this report's authors but rather the preferences of the state's receiving trauma surgeons. If the specialists in our state believe that field PRBC administration is desirable, then the goal should be for such care to be provided by *all* HEMS services. Conversely, if the receiving trauma specialists are not of the opinion that prehospital PRBC therapy impacts outcome, the state should include these opinions in education of prehospital providers.

The crux of the PRBC issue, is that the state should take steps to minimize parameters that confound the imperative to call the closest helicopter. Prehospital providers are faced with an incredibly difficult job, in trauma triage; asking these providers to enter PRBC transfusion capability into the equation renders a difficult job nearly impossible. Consider a trauma scene with a hypotensive patient, and consider the variables that prehospital personnel may need to think about. EagleMed (no PRBCs on board) is 20 minutes away. MediFlight (with PRBCs) is 25 minutes away. Is the PRBC capability worth a loss of 5 minutes' response time? What if the difference is 15 minutes? 20 minutes? Is the bleeding site controllable or uncontrollable? How profound is the hypotension? How well will this patient respond to crystalloids? To us, asking the on-the-spot prehospital providers to consider all of these variables is unrealistic. We suspect – and have interview evidence suggesting – that EMS providers have pre-existing "protocols" (i.e. "always call MediFlight because they have blood") and those protocols are executed regardless of particular situational circumstances.

Payment for HEMS services

The cost issue lies at the root of most criticism of HEMS. A HEMS flight can reasonably be presumed to cost about \$20,000 as a rough approximation. Some stories known to the report's authors, are alarming. A \$16,000 bill for an 8-mile flight between two hospitals in the same city makes little sense regardless of the clinical circumstances. Similarly questionable is the expense of HEMS in a case in which an EMSA ambulance crew hands off a trauma-scene patient to a helicopter, only to subsequently have the *same ambulance* answer the call to the receiving trauma center's landing zone, to receive the patient for the ground-leg transport to the receiving center. Travels around the state during the production of this report produced many other stories (e.g. multiple helicopters arriving at a 1-patient trauma scene) that were attention-getting.

The preceding paragraph paints a bleak picture, and one that begs for follow-up, but that picture is incomplete and possibly one-sided. Other information should be considered before judgments can be rendered.

First, the state has decided to have HEMS provided by the free market; there is no state-sponsored HEMS agency. It is problematic to expect corporate entities to do more than aim to optimize profits within the context of legal and regulatory compliance. Second, it is risky for HEMS to not respond when called. Refusing a transport based on inherently sketchy information is problematic; it doesn't take but one incorrect refusal to have a high-profile patient outcome disaster on one's hands. Furthermore, we suspect that HEMS services' triaging away of inappropriate calls will usually not direct patients to ground transport – another phone call to a second HEMS service is more likely. Third, when we spoke with prehospital and hospital providers as to their perception of utilization review and feedback regarding inappropriate HEMS, the responses indicated there was widespread belief that little such feedback comes from HEMS services, hospitals, or the state.

There is an additional payment issue for HEMS in Oklahoma, that comes into play in many regions of the U.S. The “membership” approach to HEMS entails a person's paying about \$50 annually, that translates into no costs to the patient if they undergo air transport by either EagleMed or Air Evac. If the \$50 is paid, but the person undergoes transport by MediFlight or Tulsa Life Flight, they are stuck with an out-of-pocket bill that can easily reach \$10,000 or (far) more. These dollar amounts are significant and they absolutely impact HEMS triage if the interviews we conducted as part of this report's preparation are any indication. Prehospital and hospital personnel stated (for example) that it's hard to call MediFlight if EagleMed is 20 minutes' further away, but \$10,000 cheaper to the patient.

Just as it's unrealistic to expect prehospital personnel to execute the time calculus related to triage and PRBC capability, it's Russian roulette to ask triagers to adjudicate how much time can be safely traded away, to save their patients (often their neighbors) an enormous out-of-pocket expense. The refrain we heard in many parts of Oklahoma was, “you'd better be a member.” In fact, the \$50 annual fee to cover HEMS expenses is quite in line with the literature on the public's willingness to pay for air transport. Unfortunately, it's far too easy to hypothesize realistic problem cases in which someone pays a too-steep price for failing to be a “member” of a HEMS service. Much attention has been paid the membership model, and it seems likely that the state can benefit from further consideration as to how such models are best applied in Oklahoma.

Performance of HEMS in Oklahoma

Oklahoma HEMS performance is generally favorable when compared against national benchmarks. The paucity of benchmarks limits conclusions that can be drawn, but response (launch) and on-scene times are close to U.S. norms. In terms of trauma, the fact that injury acuity is higher for scene than for interfacility transports suggests scene triage is reasonably well-done (interfacility lessons for Oklahoma HEMS remain to be studied).

For some diagnostic groups, limited data are available regarding operations and logistics benefits of HEMS. For cardiac patients in the eastern part of the state, as an example, there are data indicating that HEMS deployment to get heart patients directly to cath labs is critically useful in the extension of centers' “reach” for primary percutaneous coronary intervention (PCI). The contributions of HEMS to PCI-related outcomes improvement are relatively easily tracked, given the survival-related time savings benchmarks. There is a 10% survival advantage for each 30-minute time frame, or 6.3 lives saved per 1000 patients for every 15 minutes' time savings within a window of roughly 45 minutes through 200+ minutes.

For other critical diagnoses (*e.g.* stroke) and for most clinical indicators, there are insufficient information to definitively assess performance of HEMS services in Oklahoma. Statewide intubation performance parameters and success rates, for example, are not able to be easily calculated with currently available data.

The preliminary snapshots of performance data in Oklahoma suggest the numbers, once obtained, will be useful for education. There are hints at inter-region differences in some important endpoints (*e.g.* on-scene times). Usually, heterogeneity in performance and operations data represent areas for educational focus and potential improvement. The capabilities and willingness of OSDH to foster data collection and analysis in the realm of performance and operations, will be a strong contributor to the success of such studies.

Introduction to Recommendations

The most important parts of this report are found in the descriptive sections. The project's main goals comprised the objective recording of both facts and perceptions, and the outlining of areas that may be problematic. The authors' impressions of areas of potential action and improvement were sought by OSDH, so the report does include specific recommendations for further steps towards optimizing HEMS in our state.

It is important to acknowledge, that the recommendations in this report (and in this Executive Summary) are not presented in any particular order of importance or emphasis. Recommendations that follow are grouped within categories, and no one category is of prime importance. Finally, the recommendations that follow are understood to span the spectrum of cost and feasibility. Some of the recommendations could probably be easily and quickly executed, with minimal resource expenditure or angst. Other moves proposed in this report would require many years, lengthy collaborative effort, and surmounting of significant barriers, before any results would be likely to be seen.

Recommendations regarding triage and utilization review

Recommendations begin with the processes of triage and utilization review. The state (including its appropriate specialists who serve as information resources) needs to clarify the precise goals for identification of HEMS-appropriate patients. For instance, what is the level of acceptable overtriage for trauma transport? Can the national-level HEMS trauma use guidelines being now developed, be easily adapted to Oklahoma? Should HEMS be used to get patients to primary PCI if the time to cath lab (from initial presentation) is projected to be between 90 and 120 minutes? Does the state recognize the potential benefits associated with intervening on anterior circulation strokes within 180 minutes? What about posterior circulation strokes? What if symptoms are stuttering? These are examples of clinical questions for which there are experts within Oklahoma to provide guidance. There is clearly national-level literature and evidence as well, but in the final analysis the state should directly address the preferences of those actually providing treatment here. The goal should be to generate consensus where possible, as to which circumstances will be reasonable for HEMS use.

The process of improving triage should include careful consideration of which cases should be coming from scenes, via HEMS, directly to specialized centers. Ground transport to hospitals that provide little definitive care before calling for secondary transport (often by air) incurs high costs in both dollars and time. Given the particulars of Oklahoma's clinical and logistics situation, guidelines for direct-from-scene transport should be given significant consideration.

Once the indications for HEMS are clearly defined for Oklahoma, the next need is a rigorous and all-inclusive utilization review process. Every HEMS flight should be subject to some level of review. This should be led by the state, rather than by individual HEMS services or hospitals; of course the transport services and hospitals should participate. Without utilization review and feedback to those calling HEMS – appropriately and inappropriately – the utility of HEMS use guidelines is greatly diminished and perhaps even eliminated.

Utilization review should be rendered as straightforward as possible. This includes putting into place a requirement for prospective (at the time of transport) and specific documentation of medical and nonmedical reasons (*e.g.* maintenance of ground EMS coverage) for HEMS use. Furthermore, the process of utilization review should include assessment of all cases for which ground EMS wished to activate HEMS – even those for whom HEMS was not able to respond or for whom HEMS was never even called (*e.g.* due to obviously inclement weather). Such a complete dataset would eliminate selection bias from consideration of triage appropriateness, and the information gained would facilitate high-quality scientific analysis of HEMS triage decision making.

Utilization review without feedback, is incomplete utilization review. Since it's not fair to expect either HEMS services or receiving hospitals to always execute this feedback, the state should take the lead in informing HEMS triagers as to the "correctness" of their decisions. As an objective party, the state could take the lead on informing HEMS callers whether their consideration of the need for air transport was indeed consistent with state guidelines. Only if the consumers of HEMS are contacted with utilization review, can there be improvement in the precision of triage to HEMS.

Recommendations regarding dispatch

Perhaps surprisingly, interviews around our state consistently identified dispatch (rather than overutilization) as the major perceived HEMS problem in Oklahoma. To be sure, overtriage and (lack of) utilization review were also problematic in the eyes of many, but those problems are largely rooted in dispatch.

Currently, dispatch occurs in high-tech centers that are located out-of-state. Centralized communications centers for the corporations that operate HEMS services in Oklahoma also provide dispatch for same-company assets in other states. These centers' dispatch equipment and capabilities, complemented by communications and mapping/asset-tracking capabilities, are quite advanced. With respect to results achieved in Oklahoma, though, it is our opinion that there is room for overall system improvement.

The current centers' out-of-state locations do not mean they shouldn't be executing actual dispatch of aircraft. Reproduction of the HEMS companies' out-of-state dispatch and communications centers to a location in Oklahoma would be prohibitively expensive, not to mention wasteful and unnecessary. There is, however, an intermediate possibility, one that is open to discussion according to Air Methods and Air Evac officials: an initial call to an Oklahoma dispatch and communications center that is then responsible for calling the HEMS companies' out-of-state dispatchers to activate air medical response. There are many reasons to support this change.

One disadvantage of the current system, is that dispatchers are inherently less familiar than within-state personnel, about Oklahoma-specific assets and capabilities. This limitation applies to both non-HEMS resources and other-company HEMS resources. Dispatchers from Air Methods' Omaha site know to amazing detail, the locations and capabilities of MediFlight and Tulsa Life Flight assets; they know next to nothing about assets of EagleMed or Air Evac. The same can be said about Air Evac's Missouri-based dispatchers. This situation is no one's fault, but it is a predictable result of having multiple competing companies provide HEMS services.

Oklahoma's HEMS dispatch problems are illustrated by scenarios that can border on the absurd. Multiple side-by-side telephones (for different HEMS services), simultaneous conversations with two or even three companies, and mental juggling of logistics are a part of the daily lives of many who are trying to get a medical helicopter in Oklahoma. A confounding issue is the HEMS companies' broadly perceived unreliability in terms of estimated times of arrival (ETAs). Data shortcomings preclude clear documentation of this problem. However, based upon the overwhelming refrain from prehospital and hospital callers of HEMS in Oklahoma, there is either a major problem with ETA reliability, or a major problem with wholesale delusion on the part of dozens of complainants with whom we spoke. It seems clear that at least some parts of Oklahoma have a HEMS ETA issue.

What the state needs, and needs very badly, is Oklahoma-centralized asset tracking and dispatch. A central communications center, administered by the state, should work with the HEMS companies providing care in Oklahoma to effect asset tracking and facilitate dispatch of the most appropriate aircraft (or ground vehicle). Relevant information from HEMS companies' state-of-the-art communications centers would be provided to this Oklahoma-sponsored triage and dispatch center, and the Oklahoma center would use the information to assist callers seeking transport, in identification of the right asset. That asset would then be dispatched, through the companies' normal dispatch procedure, after a call from the Oklahoma communications center.

Adding a step in the dispatch process is almost never a good idea, and the initial impression of a state-level dispatch coming between providers and HEMS companies seems like an extra step. However, the state-based communications center is arguably not adding a step at all, but rather removing the (multiple) steps of calling various HEMS operations to see who's available and how long they'll take to get to a hospital or scene. Thus, the "addition" of the state-level dispatch is actually a streamlining step.

In addition to dispatching vehicles, state-level dispatch needs to be able to provide decision support and consultation. Immediate access to physician specialists with appropriate training can help a state dispatch center determine, for those inevitable cases where protocols do not provide clear guidance, whether air transport is even necessary. The first call from a prehospital provider or hospital personnel for a patient in potential need of HEMS, would go to the state center. Prehospital providers and hospitals would retain the ability to specify which HEMS service they wished. If another HEMS service asset were closer, the dispatch center will offer the alternative transport option. For those who refuse the closer HEMS asset without clear reason (e.g. need for

equipment uniquely available with one service), the dispatch physician will become involved.

In no way does a state-operated dispatch center translate into state-mandated receiving center selection. For those cases in which referring providers indicate a specific preference for receiving center (*e.g.* based upon patient preference or previous care), that center will be the default receiving center. If consultation with protocols incorporating clinical and logistics parameters triggers questions about the wisdom of the initially designated center, the dispatch center physician will provide assistance. For example, a patient with previous cardiac catheterization at Hospital A would likely go back to Hospital A for recurrence of cardiac issues even if Hospital A were moderately further away than an alternative center. If, however, a patient with no cardiac history or interventions had an acute STEMI and wished to go to Hospital A despite Hospital B having a significantly closer cath lab, the dispatch center physician would become involved and assist with decision making.

For those cases in which there is no clear patient or provider preference for receiving center, and in which transport time differences to competing receiving centers are not clinically important, the Oklahoma dispatch center would maintain a roster system to guide selection of receiving centers in various areas. The operation of such a roster system for “undesigned” patients has been demonstrated in the literature as being both efficient and consistent with (appropriate levels of) interhospital competition.

Part of the advantage of centralized state-level dispatch, is that there can be policing of the accuracy of both HEMS services and receiving centers, where such policing is indicated. If a HEMS service responds to the dispatch center with an ETA of 15 minutes, and that HEMS unit does not arrive on-scene for 30 minutes, sanctions will be applied. (While outside this report’s scope, similar sanctions can be applied to a receiving center that indicates, for example, cath lab availability, only to have patients incur long pre-PCI delays upon arrival.) Obviously sanctions must be discussed in great detail before implementation, but the potential for quality assurance and continuous process improvement can only be realized if there are some “teeth” in the system.

The state has already made significant inroads into the idea of centralized dispatch, with the TReC. The TReC is a great start, but in the opinion of this report’s authors TReC is underutilized and under-resourced in terms of data availability and accuracy (*e.g.* regarding exact locations of HEMS assets). Efforts to generate a state-level dispatch center should, in our opinion, include discussions about growth of current laudable efforts (*e.g.* TReC and EMResource), rather than wholesale reinvention of the wheel.

Recommendations regarding logistics

Dispatch decision making needs to be informed by certain types of information, some of which data are not currently known with precision. The logistics of air transport must be fully characterized, with accounting for (and minimization of) “hidden” times. The state should study the process of HEMS transport from a time-based perspective, to identify areas for process delay and potential improvement. For example, many hospitals reporting “on-site” helipads in Oklahoma, actually require an extra ground transport leg from the “on-site” pad to the receiving clinical area. Such extra legs are disadvantageous from both clinical and logistics perspectives. Indeed, professional organizations such as the National Association of EMS Physicians have opined that the need for a ground transport leg can completely negate any benefit to HEMS transport.

Analysis of geography should include determination as to where HEMS assets are ideally needed, where they are currently located, and whether any changes are warranted. The state may need to make decisions as to whether certain areas of the state that are less profitable for HEMS, still deserve more air coverage than they currently have. The financial implications of these decisions are recognized, but the topic of HEMS coverage in some parts of western Oklahoma deserves at least some level of attention. Dispatch center information could assist with this process. Only through a systematic review of *real* dispatch and response times, complemented by an assessment of over- and undertriaged cases, can an accurate picture of our state’s needs be drawn.

Inherent in the centralized dispatch idea, is centralized asset tracking. The companies operating air medical assets in Oklahoma have indicated they are comfortable with an Oklahoma state communication centers’ downloading GPS-based asset information in real-time, so those data are available to assist in the decision making process.

Recommendations regarding system performance monitoring and improvement

Once a decision has been made to utilize HEMS, a longitudinal transport timeline commences. Much attention is appropriately paid to the strengths and weaknesses of HEMS response. Referring facility contributions to the timeline receive far less attention. State-promulgated trauma guidelines admonish against performance of unnecessary testing, but there is little loop-closure to see if those guidelines are being followed (there are a few ongoing studies in the state, assessing this issue). Referring facilities' areas of potential improvement are not limited to elimination of delay-inducing testing. For a variety of reasons, turnaround times at various referring facilities can minimize or even completely offset any time advantages associated with HEMS.

The HEMS services themselves seem to be shouldering much of the burden of educating referring EMS and hospital providers as to patient stabilization for transport. Certainly, the HEMS personnel are most familiar with what they need in terms of patient stabilization, so any efforts to centralize patient stabilization education must include the HEMS services actually providing transport. Where the HEMS services may be able to use some help, is in the feedback arena. Whether one likes it or not, economics and competition often prevent meaningful process improvement from coming from the HEMS services. An air transport service that provides feedback that is negative – no matter how appropriate – places itself at risk for not being called the next time. The state should be more than willing to provide appropriate, constructive criticisms to those who need help with either HEMS utilization or “packaging” of patients, for transport.

System improvement should optimally include development of a scorecard that follows a dashboard of quality and performance items. These items, which would be agreed upon by the participating HEMS services in the state, would allow ongoing monitoring of a breadth of issues that have been previously addressed in this Executive Summary. For example, triage guideline compliance, turnaround times at scenes or hospital facilities, and ETA accuracy should be followed. Operational improvement efforts would be guided by the data obtained. The degree to which the data should be “public” would need to be discussed and agreed upon by the HEMS services. At first blush, one would presume that no HEMS service should be concerned about keeping its performance “secret.” However, the authors' years of EMS experiences provide basis for some degree of caution, due to risks of misinterpretation or misuse of data telling only a partial story. Not least of the many issues, is that in any region, those with the most qualification to interpret HEMS-related data are also those with some degree of conflict of interest.

Though barriers exist, the ongoing monitoring of referring agency and HEMS service performance is sufficiently important to warrant efforts at overcoming obstacles. It seems highly likely that a cooperative and balanced approach can be agreed upon, once the stakeholders are assembled and given voice.

Cost-benefit and cost-effectiveness

Population-based financial analyses have been executed for HEMS, but most of these studies have been outside of the U.S. in areas with different healthcare economics. With the implementation of some of the previously recommended steps, Oklahoma would be in a prime position to seek external resources (funds) to support truly useful cost studies.

One reason that Oklahoma is well-situated for costs analyses, is its large area. By dint of its size, our state encounters some of the most critical challenges that guide determination of true costs and benefits of HEMS. Loss of advanced life support (ground) EMS coverage for lengthy transports from rural areas, is one problem leading to potential HEMS overuse. Other problems include HEMS unavailability due to geographically sparse coverage and/or weather.

Population-based studies of cost-effectiveness could help address HEMS' role in Oklahoma health care from a variety of diagnostic and logistic perspectives. Some example areas of inquiry have been suggested by hospital administrators. For urban hospitals, how many patients (and dollars) are lost to out-of-state ground transport of patients for whom HEMS transport to cities was unavailable? For rural hospitals, how much money is saved by their not having to pay major dollars to specialists to take call, since they rely on HEMS and regionalization of care to get their patients to the city? These are just a few questions that deserve attention.

Interactions with HEMS companies

On occasion, Oklahoma healthcare providers and even policymakers levy criticisms of the private companies that provide air medical transport in our state. Such criticism, when based upon reasonable foundation, is a normal, expected, and even healthy part of private enterprise. Any provider of a service that's making a profit, must be ready to handle questions regarding aspects of that service. By the same token, any consumer can hardly be surprised when a for-profit entity acts in a fashion to (legally) maximize profit.

By avoiding the multimillion-dollar resource investment that would be required for state-provided HEMS services (*e.g.* as in Maryland), Oklahoma sacrifices capability for 100% command and control over air medical transport. HEMS companies can be expected to make business decisions that are not best-case scenario for statewide healthcare access (*e.g.* using slower aircraft or moving nonprofit able helicopters from areas that are then left uncovered).

Fortunately, there is a large area of overlap between what is best for the state, and what is best for HEMS companies' business. Inappropriate transports and HEMS overutilization may reap short-term profits, but these practices spell long-term trouble for the air medical transport industry and companies indicate they understand this. Other areas of focus are even less controversial. Optimal crew qualifications and evidence-based clinical care guidelines are in everyone's best interests. Asset tracking and accuracy in response times are also areas in which there is obvious benefit.

We believe OSDH should convene a meeting to bring together state-level representatives and representatives from air transport companies providing services in Oklahoma. The agenda could be open, but would be expected to stem from the general outline of this report. HEMS services should be afforded, and would likely greatly appreciate, the opportunity to respond to this report's criticisms and suggestions. The main purpose of the meeting, would not be to assign blame or direct criticism, but rather to work on improving system-wide performance and healthcare outcomes for Oklahomans.

Specific issues in this report that could be discussed with HEMS companies include baseline requirements for proper execution of HEMS transport, as well as incentives for outstanding performance. Most bases providing transport in Oklahoma are CAMTS-certified; discussions as to whether this should be required (and what should be the surrogate if CAMTS is not required) would be a worthy subject. Performance incentives should address areas that are outlined in this report as showing room for improvement (*e.g.* estimated arrival times). There are plenty of subjects, for which there should be little debate as to importance. Conversations about tracking, assessing, and reporting these data would likely move fairly quickly and with few major barriers.

Other conversations may be more difficult, but are still warranted. Marketing of air medical transport is an area of potential disagreement. This report's authors have major concerns over the appearance of inducement to call a particular service (*i.e.* not the closest appropriate helicopter). Discussions surrounding marketing may be initially nonproductive, but OSDH should at least get a handle on what it is that particular services are marketing (*e.g.* better aircraft, more experienced crews, more advanced protocols) as a reason to do anything other than call the closest capable HEMS unit. The state, in discussions with HEMS services, needs to determine whether the goal for non-specialty transports is to truly call the closest aircraft, or whether there are other parameters that should be considered.

Marketing conversations will inevitably lead to financial discussions. Is it fair to ask those calling helicopters, to decide how much longer they are willing to wait for Membership Service X, rather than Nonmembership Service Y, in order to save their patient a \$10,000 balance-bill? Is the subscription model the right model for Oklahoma? Is there some alternative, in which HEMS services – who are, after all, the ones “at risk” financially – make reasonable profit while not confounding triage and finance? The HEMS services themselves will have opinions on this, and those opinions must be listened to and considered.

Oklahoma has developed a system in which private companies provide HEMS services. Thus, working with those private services, and fostering ongoing conversation and collaboration, is the most viable path to a statewide system in which our citizens have access to optimal healthcare. This report's authors believe that the first step down that path is to institute regular and open dialogue with the appropriate stakeholders.

SECTION I: INTRODUCTION AND REPORT INFORMATION

Main abbreviations used throughout this report

AAMS	Association of Air Medical Services
ALS	Advanced Life Support
AMI	Acute myocardial infarction
AMPA	Air Medical Physicians Association
AMT	Air medical transport
BLS	Basic Life Support
CAMTS	Commission on Accreditation of Medical Transport Systems
CDC	Centers for Disease Control
CI	(95%) Confidence interval
CVA	Cerebrovascular accident (stroke)
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EMTB	EMT-Basic
EMTP	EMT-Paramedic
ETI	Endotracheal intubation
FAA	Federal Aviation Administration
FW	Fixed-wing (airplane)
GCS	Glasgow Coma Score
HEMS	Helicopter Emergency Medical Services
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
ISS	Injury Severity Score
MCI	Mass casualty incident
NAEMSP	National Association of EMS Physicians
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
OSDH	Oklahoma State Department of Health
OUDEM	University of Oklahoma Department of Emergency Medicine
PCI	Percutaneous coronary intervention (cath lab treatment)
RW	Rotor-wing (helicopter)
SBP	Systolic blood pressure
SD	Standard deviation
STEMI	ST-elevation AMI
TS	Trauma Score
VFR	Visual Flight Rules

Introduction and acknowledgments

The growing air medical transport (AMT) sector represents a highly visible concentration of resources. A 2007 publication estimated that in the U.S., 753 helicopters (and 150 dedicated fixed-wing aircraft) were in EMS service, providing about 3% of all ambulance transports.¹ By 2011, the Association of Air Medical Services (AAMS) placed the number of rotor-wing (RW, or helicopter) transport vehicles at about 900.

Individual helicopter EMS (HEMS) programs' mission profiles and crew configurations vary widely. AMT programs have varying mission breakdowns, as well as differing aircraft and crew configurations, but a typical U.S. HEMS program operates with a pair of nonphysician medical crew and performs 54% interfacility transports ("secondary missions"), 33% scene runs ("primary missions"), and 13% "other" missions (e.g. neonatal).²

Some additional resources are recommended to cover information that space requirements preclude from inclusion in this report. An annotated bibliography of English-language peer-reviewed AMT outcomes studies published since 1980 is found at www.cctcore.org. The National Association of EMS Physicians (NAEMSP, www.naemsp.org) website offers free access to position papers on flight crew and medical director training as well as HEMS dispatch.^{3,4}

This report does not attempt to be comprehensive in treatment of all subjects conceivably related to AMT. Rather, the authors have attempted to provide a detailed analysis of the most important issues, while devoting at least some attention to nearly all of the questions relevant to Oklahoma AMT.

The authors wish to be quick to point out gracious provision of assistance from OSDH personnel. These include, but are not limited to, Tim Cathey on medical issues, Lee Martin on trauma/systems issues, Grace Pelley on trauma reimbursement fund, Kenneth Stewart on data, and Dale Adkerson on making contacts with EMS providers. Strategic advice and program-specific information was obtained from others at OSDH, including Tom Welin, Bill Henrion, Patrice Greenawalt, Brandon Bowen, and Vonnie Meritt. Without the assistance of these individuals (and others at OSDH) this report could never have been attempted, much less completed.

Aimee Stilwell-Hass generated virtually all of the report's maps, on ArcGIS. Alisa Davenport was instrumental in coordinating interviews and assisting with printing of the final report. Of course, any errors in this report are the sole responsibility of the authors.

Others who deserve acknowledgment number far too many to be named here. The authors would like to express overarching thanks to the scores of individuals in prehospital medicine, hospital care, and healthcare administration, who gave selflessly of their time in order to better inform us about the issues relevant to air transport in Oklahoma. We believe this collaborative spirit will inevitably result in improvements for our state.

This report represents the views of the authors, and the authors alone. The report does not purport to speak for the State of Oklahoma, or the Oklahoma State Department of Public Health.



Evidence strongly supports trauma outcomes improvement with judiciously deployed HEMS.

Author brief biographies and relevant disclosures

Stephen H. Thomas MD MPH

Thomas trained in Emergency Medicine between 1990 and 1993, at University Medical Center of Eastern Carolina in Greenville, NC. He subsequently completed an Air Medical Fellowship in NC before moving to Boston to join the Emergency Medicine faculty at Harvard Medical School and Massachusetts General Hospital. Upon arriving in Boston, he joined Boston MedFlight where he served roles in medical directorship, crew training, and research. During his 16-year tenure at Harvard he rose to the rank of Associate Professor of Surgery. He attended the Harvard School of Public Health where he obtained a Master's in Public Health with a concentration in Quantitative Methods (biostatistics).

In 2009, Thomas moved to Oklahoma, accepting the post of Professor and Chair at OU's School of Community Medicine in Tulsa. It is in the role as Chairman of the state university's Department of Emergency Medicine, that he was asked by OSDH to prepare this report. His work on this report is an extension of previous and ongoing efforts in optimizing helicopter EMS and trauma triage. He has chaired the National Association of EMS Physicians (NAEMSP) Air Medical Committee, and was the 2007 Distinguished Physician of the Air Medical Physician Association (AMPA). He co-authored the NAEMSP Guidelines for Air Medical Response that have been endorsed by numerous stakeholder associations (*e.g.* AMPA, American College of Emergency Physicians). He served on the Centers for Disease Control (CDC) expert panel that generated the updated (2009) trauma triage guidelines, and he continues to work on the CDC panel as it addresses the challenge of "getting the right patient to the right destination, in the right time frame." He also serves on CDC and National Highway Traffic Safety Administration (NHTSA) expert panels focused specifically on helicopter EMS adult and pediatric trauma triage.

During his career, Thomas has received grants from biotech and pharmaceutical companies that dealt directly or indirectly with use of drugs and/or devices in the air medical setting, but which pose no potential conflicts with this report. A full listing of those grants is available upon request. Additionally, he has received grants from, and serves on, air medical transport-associated organizations. He currently is the Principal Investigator on two grants from such organizations. One is a multinational/multicenter grant from the Foundation for Air Medical Research and Education (FARE), that seeks to ascertain whether early HEMS provision (at the trauma scene) of antibiotics improves morbidity in patients with open fractures. The other is a grant from AMPA that assesses the potential role for HEMS in system-based care for patients with acute myocardial infarction.

Thomas serves as a member of two Boards of Directors with potential relevance to this report. The first is MedEvac Foundation International (formerly FARE), a multinational organization aimed at fundraising, education, safety, and research initiatives dealing with critical care transport (HEMS, fixed-wing, and ground). The second board is for the Ohio State University-based Center for Medical Transport Research, which focuses on research in the HEMS and ground critical care transport arenas.

Thomas, Jeff Goodloe and John Nalagan (another OUDEM faculty member) all participate in provision of training and medical oversight for ground and air EMS services in Oklahoma. The OU Department of Emergency Medicine, including Thomas, provides compensated medical oversight for helicopters with the following for-profit services executing transports in Oklahoma: Air Evac, MediFlight, and Tulsa Life Flight.

Jeffrey M. Goodloe MD NREMT-P FACEP

Goodloe serves as the Medical Director for all Medical Control Board affiliated agencies in metropolitan Oklahoma City and Tulsa. He began his multifaceted EMS career in Waco, Texas in 1988. During his undergraduate years at Baylor University, he worked as an EMT-Basic, an EMT-Intermediate, and as a paramedic for Baylor University EMS and American Medical Transport, the 911 system ambulance service for Waco and surrounding

cities within McLennan County, TX. After graduating *cum laude* with a BS in Biology, he matriculated in 1991 at The University of Texas Medical School at San Antonio. Throughout his medical school years, he worked as a paramedic in the San Antonio metro area as well as in Pasadena, Texas. During his last two years of medical school, he was appointed an instructor of EMS personnel (civilian and military), nurses, fellow medical students, and physicians at The University of Texas Health Science Center in San Antonio as well as its counterpart medical institution in Houston.

Goodloe completed residency in Emergency Medicine at Indiana University/Methodist Hospital of Indiana in 1998. During residency, he worked as a helicopter physician at Methodist Hospital's LifeLine and as a motorsports physician at the Indianapolis Motor Speedway. Additionally, he served as the Associate EMS Medical Director for Hendricks County EMS, a consortium of fire-based EMS services. Upon residency graduation, he helped create the EMS fellowship training program at The University of Texas Southwestern Medical Center at Dallas, serving as its inaugural fellow and as an attending faculty physician in Parkland Memorial Hospital's Emergency Department. Prior to being recruited to the OU School of Community Medicine's Department of Emergency Medicine in August of 2007, he served 8 years as the EMS Medical Director for the Plano, Texas Fire Department which provided both first response and ambulance transport. He led a team of Plano EMS professionals in developing medical helicopter activation criteria that simultaneously promoted optimal patient outcomes and clinically responsible HEMS usage patterns. These criteria were subsequently adopted by EMS agency leaders across Texas for use within their systems, and they still serve as a benchmarks in Texas and beyond.

Goodloe is an Associate Professor and Director of the EMS Division in the OU Department of Emergency Medicine. A board-certified Emergency Medicine specialist, he is a Fellow of the American College of Emergency Physicians. He maintains an active clinical and academic practice at Tulsa's Hillcrest Medical Center (the base hospital of the OU Department of Emergency Medicine). He has maintained paramedic certification since 1990, and is a frequently requested lecturer in EMS education events nationally and internationally. He has particular knowledge in designing in-house EMS educational programs.

Goodloe is the only physician in the U.S. who is currently credentialed as an on-site reviewer for the Commission on Accreditation of Ambulance Services and as an organization and course reviewer for the Continuing Education Coordinating Board for EMS. These organizations promulgate "gold standard" accreditation criteria for EMS agencies and EMS continuing education, respectively.

Goodloe's EMS-related clinical interests include cardiac arrest, airway management and confirmation of airway placement, continuous positive airway pressure (CPAP), post-exposure prophylaxis, and optimizing timeliness of care for acute coronary syndromes and multisystems trauma.

Goodloe has no potential conflicts involving any grants or other research support. He owns no stock in, nor has any financial relationship with, any ground or air transport provider.

Annette O. Arthur PharmD

Arthur obtained her Pharmacy BS degree in 1992 from the University of Oklahoma. She practiced as a pharmacist in the home infusion industry for 9 years before working as an IV pharmacist in Tulsa hospitals. In January 2009, she returned to OU to obtain a Doctor of Pharmacy degree, which she finished in December 2010.

Since joining the OU Department of Emergency Medicine, Arthur has served as the Research Director. She has primary responsibility for teaching and mentoring the EM residents and medical students working in the department, in research methods and related writing techniques. She's been an organizer, planner, and co-author of many studies and successful grant applications, including some addressing prehospital care and helicopter utilization.

Arthur is a co-investigator with Stephen Thomas on grants from FARE and AMPA (see description under Thomas). She has no potential conflicts involving any grants or other research support. She owns no stock in, nor has any financial relationship with, any ground or air transport provider.

Process of data-gathering and interview material use for this report

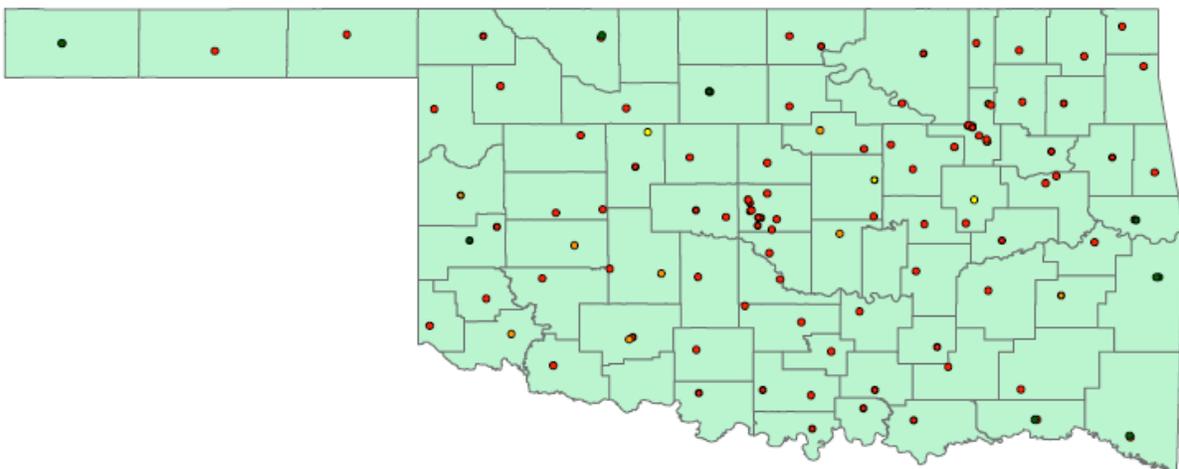
The process for soliciting and assembling this report’s information included formal and informal methods. Letters were sent to every Oklahoma acute-care hospital, and announcements were made at regional and state EMS gatherings. Messages conveyed this report’s aims, and included requests for any individual (or institution) wishing to share information relevant to AMT in Oklahoma, to contact any of the report’s authors.

In addition to relatively formal report notification and information solicitation, networking and word-of-mouth approaches were used in an effort to identify stakeholders or others with interest in the report’s subject. Clinicians in key specialties (*e.g.* emergency medicine, trauma, cardiology, neurology, neonatology) were contacted. Nonmedical prehospital personnel (*e.g.* sheriffs, Oklahoma Highway Patrol troopers) were also approached – in fact this group provided some very useful information. Productive conversations included those with groups from a given hospital or network; it was not uncommon for one of the study authors to meet simultaneously with a hospital CEO and that CEO’s leadership team of clinical and nonclinical administrators.

Some of the information exchange was conducted over email, but most of the report’s information-gathering proceeded via either telephone or in-person meetings (about two-dozen phone calls and an equal number of in-person meetings around the state). Because the report’s senior author had minimal time in Oklahoma, and because it was deemed important to get a “close-up” look at the varying medical and logistics situations in our state, in-person interviews were set up around the state. These interviews ranged across Oklahoma in all directions, from Boise City to Idabel, from Miami to Lawton, from Sayre to Sallisaw, and from Blackwell to Ardmore. A map indicating the sites from which information for this report came, is shown below.

One of the most important components incorporated into data-gathering from interviews, was the promise of confidentiality. For even those individuals with no problem being quoted directly, all comments, opinions, and statements have been anonymized. (In part, this is because identifying some information providers would likely render it easier to identify those remaining persons, who wished to remain anonymous.)

The interview process was characterized by high likelihood of honesty, but it must be clearly acknowledged that the information-gathering was inherently subjective; conjecture and opinion are necessarily included amongst the many quotes from our sources. Quotes from a few “squeaky wheels” can easily be overemphasized, if readers are not careful to maintain perspective. With that *caveat*, the authors found invaluable the inclusion of direct quotes and observations from Oklahomans involved in our healthcare system, in our attempts to paint a true picture of AMT in our state. In general, all “strongly worded” quotes and opinions are included in this report; ***inclusion of quotes does not imply agreement with, or endorsement by, the report’s authors.***



Each dot on the map, represents a contact producing information used in this report. Orange dots represent phone contact; yellow dots, email contact; other dots represent in-person site visits.

Organization and presentation of this report

This report’s length, while allowing for maximal inclusion of information felt to be worthy of presenting, brings with it issues of “readability.” The authors understand there may be portions of the report that do not represent “news” to OSDH. Furthermore, we are cognizant of the risks – when a report exceeds 100 pages’ length – of having important key points buried. In order to improve the report’s “readability” and make it user-friendly, we have subdivided the monograph into multiple sections. Those sections are grouped, in an order that follows the general aims of the report:

- 1) *Provide information about the state of the art for AMT in general*
- 2) *Outline the current AMT picture for Oklahoma*
- 3) *Offer suggestions as to follow-up steps, action items, potential system changes, etc.*



Hospitals in Hugo (left) and Boise City (right) are representative of the various places visited as part of preparation of this report. Unless otherwise noted, all photos are from the authors’ collections.

In following the three general goals as just outlined, the report first tackles the subject of air medical transport. While all of this information has relevance to aspects of the air medical transport picture in Oklahoma, most state-specific and region-specific information is presented after the “general overview” discussion.

The second major portion of the report is that which addresses the air medical transport *status quo* in Oklahoma. This section attempts to cast the local Oklahoma picture, into the background provided by the previous discussion on general AMT principles and issues. The section includes information on AMT assets, as well as other healthcare and systems assets (e.g. trauma centers, stroke centers, cardiac centers). Information on current systems performance is provided, and cast against a background of national “norms” (quotation marks used, to reflect the paucity of true norms or benchmarks for most of these data).

The third and final portion of the report presents the conclusions and recommendations generated by the authors as the result of our work on this project. This final “synthesis and opinion” section represents an attempt on the part of the authors, to point the way towards ongoing systems improvement.

Many data used in this report were publicly available. Other information was provided by individuals (e.g. Kenneth Stewart, Vonnie Meritt) at OSDH. Where data analysis was performed, STATA 12MP was used.

With some exceptions (e.g. Vonnie Meritt’s provision of the OSDH stroke center map and cardiac imagery from Tim Cathey), all maps in this report were prepared by OUDEM Research Associate Aimee Stilwell-Hass (using the software program ArcGIS). The “flying radius” maps use a 130 mph average flying time, to generate 30-, 60-, and 90-minute flying zones (in helicopters). These zones’ size is intended as a coarse marker, since actual flying times and radii will differ depending on myriad factors such as routing, weather, and aircraft type.

SECTION II: GENERAL OVERVIEW OF AMT



Systems of care must include planning and capabilities for multiple transport modes.

Integration of air medical services into field response

Most of the time, the discussion of “scene response” (or primary HEMS transport) denotes use of HEMS for injured patients. There is occasional utility in HEMS deployment for non-trauma situations such as acute myocardial infarction (AMI) or stroke (CVA).^{5,6} However, the preponderance of applicable use and evidence for primary air medical response deals with trauma.

Evidence supporting incorporation of air medical assets into system scene response

In 2007, a Canadian government review of all HEMS scene trauma studies since 2000, concluded: “Overall, patients transported by helicopter showed a benefit in terms of survival, time interval to reach the healthcare facility, time interval to definite treatment, better results, or a benefit in general.”⁷ This finding was endorsed in a recent review of the worldwide HEMS scene response literature.⁸

Since the landmark 1983 *JAMA* paper from Baxt and Moody,⁹ which suggested roughly 50% mortality improvement with HEMS, the preponderance of evidence has identified lesser, but fairly consistent, outcomes benefit, with a 20-30% survival improvement range.¹⁰⁻¹⁴ As outlined elsewhere,¹⁰⁻¹⁴ evidence supporting HEMS use varies in methodology and quality, but the overall evidence supports a benefit from proper HEMS use.

HEMS use for nontrauma is supported by a lesser body of evidence. However, with the increasing emphasis on time-criticality of medical conditions such as stroke or ST-elevation AMI (STEMI), it appears likely that there is some role for HEMS nontrauma scene response in a rural state such as Oklahoma. Previous literature has demonstrated, for instance, that activation of HEMS from the scene saves valuable time in both cardiac¹⁵ and CVA⁶ situations.

Introduction to possible mechanisms by which HEMS scene response may improve outcome

Analysis of over 250,000 scene trauma transports from the National Trauma Data Bank (NTDB)¹⁶ recently found that HEMS (as compared to ground EMS) reduced mortality by 22%. The methodology did not allow for focus on mechanism by which HEMS benefit was achieved. Of course, there are well-characterized speculative mechanisms for HEMS benefit, and the “truth” underlying AMT outcomes doubtless varies with the situation. Because the mechanisms for outcome improvement are relevant to the understanding of HEMS deployment and use in Oklahoma, some putative explanations for HEMS’ salutary benefits are outlined next.



(Left) Flight crew airway management improves trauma patient outcomes.

Potential HEMS scene response benefits: Earlier arrival of advanced care

Nationally, it is fashionable – although unwise – to dismiss the idea that HEMS benefit lies in speed. In some situations there is undoubtedly an important time advantage. Particularly in rural regions, the only readily available ground prehospital care may be BLS.² Data focusing on patients with severe trauma (*e.g.* head injury) suggests that HEMS crews’ early provisions of ALS-level airway and hemodynamic support (*i.e.* intravenous access and fluid management) are the mechanism for improved overall outcome and better neurological function.¹⁷ Better functional outcome in HEMS near-drowning patients has been theorized as explainable by deployment of HEMS to areas lacking ALS coverage (by ground EMS).¹⁸

Studies conducted from regions as disparate as California and the Netherlands clearly demonstrate HEMS mortality benefit, yet often find similar scene-to-trauma center times for ground and HEMS transports.^{19,20} These studies’ results provide support for the notion that there is benefit

in rapidly transporting highly qualified crew (occasionally physicians) to patients.

While much of the applicable evidence comes from sites around the U.S. and the world, some of the on-point data come from nearby states with similar “mostly-rural” geography. In Nebraska, for instance, the HEMS-associated one-third mortality reduction for severely injured patients has been ascribed to much higher rates of airway management (80% in HEMS, versus 10% in ground EMS) and even intravenous access placement (100% in HEMS, versus 50% in ground EMS).²¹ Assuring optimal prehospital care for all Oklahomans will mean acknowledgment that, for patients in some isolated areas, HEMS represents the best mechanism to get needed advanced therapy to the scene.



HEMS extends the reach of trauma systems of care in large states with sparsely populated areas – like Oklahoma and Maine (HEMS at the latter state’s only Level I trauma center is pictured above).

Potential HEMS scene response benefits: Streamlined prehospital times and direct transport to high-level care

For injured-patient cases far removed from the nearest trauma center, air medical scene response for direct transport of patients to the trauma center is often the best course.²² On the nontrauma front, suggestion of potentially growing indications for HEMS “scene” transports of non-injured patients is provided by an evolving literature. There are case series (*e.g.* for primary percutaneous intervention) and sporadic reports (*e.g.* scene transport to neurological centers for lytic therapy for ischemic stroke).^{5,23,24} In these cases – particularly in nontrauma – the speed of the helicopter in getting the patient to high-level hospital care, is the likeliest major contributor to outcomes improvement.

Potential HEMS scene response benefits: Extension of advanced level of care throughout a region

There is a regional benefit to having HEMS. Air medical capabilities may allow an EMS system to provide for early ALS in isolated and/or difficult-to-reach areas which otherwise would be poorly covered. In pointing out that HEMS can cover roughly the geographic area of seven ground ALS ambulances, Hankins² has written that “This kind of coverage, in many areas of the country, provides advanced care where it is not otherwise available.” Others considering the U.S. trauma system as a whole, have agreed that at least in some areas of the U.S., the extension of trauma regional care provided by HEMS is critical.¹⁶ The alternative of expanding ground EMS to cover isolated areas is probably financially non-feasible, and also brings questionable medical care capabilities due to skills dilution in ground crew who infrequently encounter critical illness or injury.

Air medical services and interfacility transports

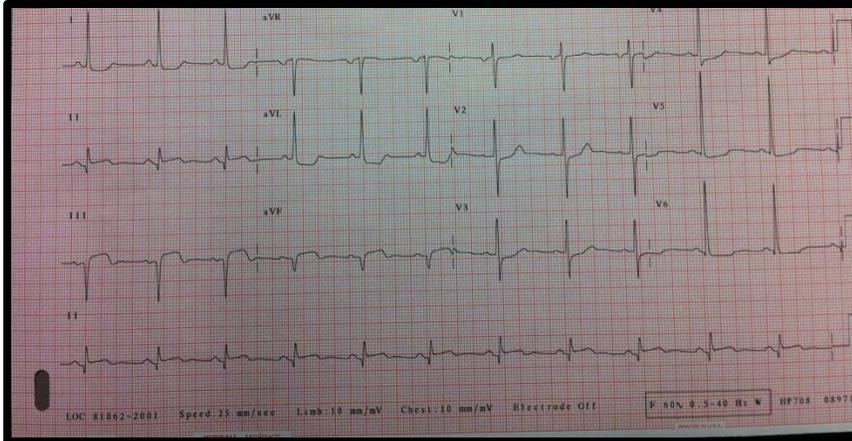
As compared to scene response, there are fewer data directly addressing outcomes benefits associated with interfacility AMT. Many of the same potential HEMS benefits to scene response, can apply in some interfacility transport situations.

Evidence supporting incorporation of air medical assets into system interfacility transport

There are data addressing interfacility HEMS trauma transport. Recently, Brown *et al* identified a significant benefit for secondary HEMS trauma transport when Injury Severity Score (ISS) exceeded 15.²⁵ A Canadian study, notable for its similarity in acuity between air and ground transport cohorts (ground patients were those in whom HEMS was requested but was unavailable), also found AMT significantly improved mortality.²⁶

On the nontrauma front, interfacility transport remains important. Reports outlining extension of percutaneous coronary intervention (PCI) to community hospitals include incorporation of HEMS into systems planning, as a necessary back-up in cases where urgent coronary artery bypass grafting is required.²⁷ It's increasingly well known that time savings can be helpful in the setting of acute ST-elevation myocardial infarction: each 30 minutes' additional ischemia time increases mortality by 8-10%.²⁸ Mortality benefit associated with time savings appears to be accrued across a breadth of door-to-balloon times (roughly between 45 and 225 minutes).²⁹

Similar to the situation with integration of HEMS into cardiac care systems, is the rapidly solidifying role for air transport in stroke care. NAEMSP recommends air transport of stroke patients if the closest fibrinolytic-capable facility is more than an hour away by ground.³⁰ The American Stroke Association Task Force on Development of Stroke Systems³¹ identified HEMS as an important part of stroke systems, with helicopters to be used to streamline times.



(Left) Air transport allows rapid movement of STEMI patients from outlying hospitals, to get them to a receiving center that can expedite provision of definitive treatment such as PCI. Time-critical treatments are not limited to STEMI; interfacility AMT can allow for rapid movement of a variety of patient types (e.g. CVA) to higher-level facilities where they can receive time-windowed therapy.

Possible mechanisms by which HEMS interfacility response may improve outcome

One mechanism for possible HEMS-mediated outcomes improvement in interfacility transport, is time savings. If air transport can get patients to definitive higher-level hospital care faster, outcomes are likely improved in a variety of situations (*e.g.* trauma patients needing operative intervention, cardiac patients needing urgent PCI). This is particularly true in Oklahoma, which despite its large size has a relatively sparse concentration of specialized care centers providing highest-level services such as for trauma, cardiac, and stroke patients.

Time savings for trauma interfacility transports have been cited in studies demonstrating HEMS mortality improvement.²⁵ Furthermore, loss of HEMS availability has been recognized as an important factor causing increased trauma mortality in patients presenting to non-Level I centers.³²

The criticality of HEMS in time savings in nontrauma, has been demonstrated in a study with broad implications. A logistics study from the University of Wisconsin³³ demonstrated the importance of time savings accrued by HEMS for interfacility transports of patients with time-critical cardiac or neurological conditions. In assessing average transport times from their 20-hospital network, the investigators found that for all hospitals, the *average* HEMS total transport time over the study period was at least as good as the *best* ground transport time. This finding occurred despite the fact that for many hospitals ground EMS was on-site at the time of transport request.

The Wisconsin group found clinically significant time savings for all institutions: patients at close-by hospitals accrued an average of 10 minutes' savings, while those from further-out hospitals' HEMS transport times were up to 45 minutes shorter than those achievable by ground. The bottom line for the Wisconsin study – very likely applicable in Oklahoma – is that one cannot assume that even suboptimal HEMS response times will result in transport being faster by ground.

In addition to the savings of overall time, HEMS may offer an additional time-related benefit that's applicable in interfacility transports. This benefit, is the minimization of "out-of-hospital time." Even the best intratransport care, is provided in an environment with limitations. Sometimes, having the patient out of the hospital setting for the shortest possible time – even if that means delaying transport until a helicopter can arrive – is in the patient's best interest. As an example, obstetrics transports often constitute situations in which out-of-hospital time intervals are best kept at a minimum. In this arena, air transport has long been used to enable ultimate delivery at high-level maternal-fetal centers, for patients who could not have been transported in the absence of an air medical option (due to prolonged ground transport times).³⁴

Just as HEMS may bring more experienced providers to scenes, isolated medical care facilities' providers may welcome the arrival of seasoned crews. HEMS providers may have more comfort with high-acuity patients than referring facility physicians.^{2,35} In some areas of rural Oklahoma, where referring providers may have limited expertise caring for the seriously ill and injured – some EDs even lack physician coverage – HEMS crews are more likely to contribute in the clinical arena.

Fixed-wing interfacility transport

While data are sparse, the available evidence suggests desirability of incorporation of FW aircraft into regionalized care. FW transport allows for long-distance transfer of complicated patients (*e.g.* those on extracorporeal membrane oxygenation^{36,37}) to centers of excellence. In rural areas, FW assets allow for air transports that would be otherwise nonfeasible.³⁸ The feasibility issues may be distance (most common), but could also be related to problems such as weather, that impact helicopter operations but still allow airplane use.



Fixed-wing air transport aircraft in Boise City to pick up a patient.

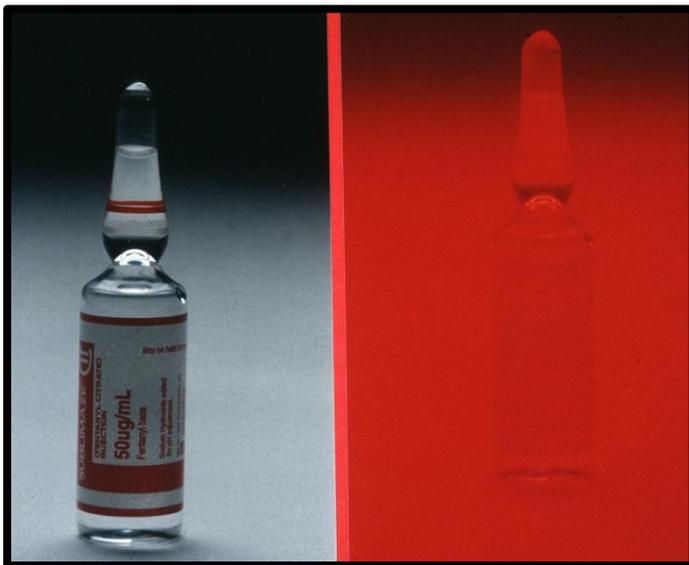
Patient safety in air transport

Even in nonmedical publications, patient safety has become a buzzword. While the focus of this report is in other areas, some overview of patient safety is provided. For the purposes of this discussion, patient safety is divided into “aviation” and “medical” components. Medical risk issues are discussed first; some aspects of aviation safety (e.g. helipads and landing zones) are discussed afterwards.

Patient safety from the medical perspective

Questioning of air transport’s “medical” (i.e. not crash-related) patient safety issues is fair, since in-cabin care poses challenges. Perhaps the most obvious example is that breath sounds can’t be reliably auscultated in helicopters.³⁹ Other real or theoretical concerns include vibrations and even lighting conditions in AMT.⁴⁰

In fact, patients’ medical safety is closely monitored and appropriately well-assured in the air transport environment. Large multicenter series of air medical intubation data reveal near-zero rates of unrecognized esophageal intubation.⁴¹ Concerns about vibrations, electrical interference, and other transport-mediated phenomena (e.g. catecholamine surge) have not been validated by studies assessing actual patient experiences.⁴²⁻⁴⁵



In some older helicopters, in which there was no in-cabin divider between the pilot and the air medical care compartment, night operations required use of red cabin lighting. Among the historical challenges handled by flight crews, was learning to provide care in an environment in which color-dependent tasks could be difficult. At left is a fentanyl vial in normal light; at right is the same vial (with its red lettering) as it appears in red light.

The literature suggests that air transport, even of the most critically ill and tenuous patients, does not result in a decrement in patient safety parameters or physiology.⁴⁵ Furthermore, recent literature shows that AMT investigators are among those at the forefront of moving patient safety forward.⁴⁶

Like other forms of patient movement, air transport does pose particular “risks” to patient safety, ranging from altitude-related issues to equipment failure or inadvertent extubation.^{47,48} Fortunately, air transport personnel are well-acquainted with the salient issues. In the experience of this report’s authors, the primary problems with patient safety in air transport often deal with *non*-HEMS providers, who may fail to understand nuances of medical care in the air transport setting. Lack of familiarity with appropriate principles leads to both undertreatment (e.g. nonintubation of combative head-injured patients) and overtreatment (e.g. placement of a pre-flight chest tubes for tiny pneumothoraces in nonintubated patients).

As considered from the medical perspective, patient safety does not inherently suffer in patients undergoing AMT. Ongoing investigation, vigilance, and education will continue to be important, but properly trained healthcare providers and air medical crews definitely have capability to provide a care experience that optimizes patient safety. The most important component of the safety initiative, is aviation safety; this is considered next.

Patient safety from the aviation perspective – a brief overview

FW transport occasionally results in crashes; a patient and family member died in a Chicago FW crash the month of this report's completion (www.chicagotribune.com, accessed 29 Nov 2011). However, airplane incidents are relatively uncommon and most air transport safety concerns deal with RW operations. Recent decades' experience with multiple high-profile HEMS crashes have led to regulatory authorities' focusing of attention on HEMS safety. The industry has responded, naming safety as its top priority. No one can dispute the undoubted risk associated with any transport modality; air transport is no exception. An evaluation of safety issues in HEMS should involve a deliberate, evidence-based approach. The stakes are high: if HEMS is really "unsafe" at an unacceptable level, then operations should not proceed even if some patients' lives would be saved.



This photo, received in a mass emailing, depicts destruction of an unoccupied helicopter by the Joplin tornado. Other crashes have gained notoriety, and the past decade has brought increasing scrutiny on HEMS safety.

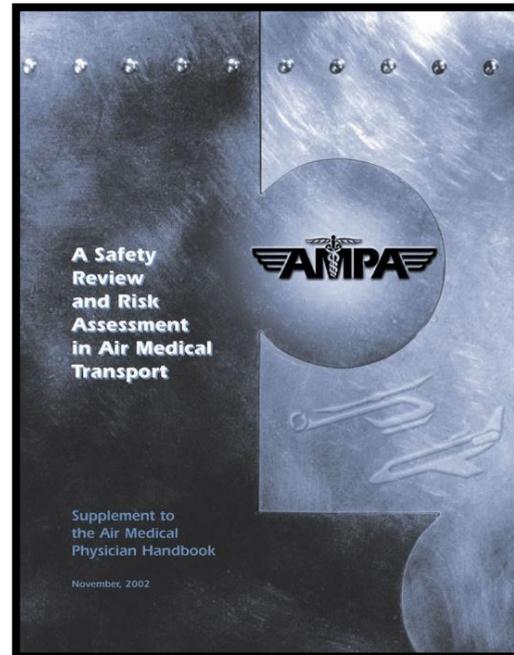
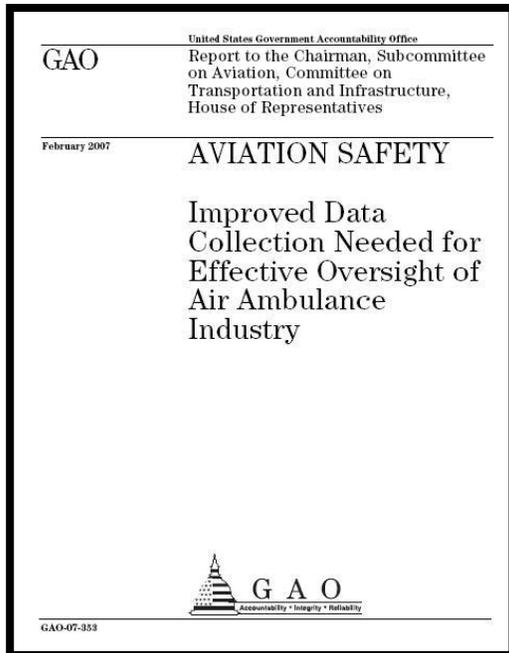
One of the foremost U.S. authorities on HEMS safety is Dr. Ira Blumen of the University of Chicago.⁴⁹ Discussions with Dr. Blumen pursuant to the preparation of this report, yielded the next-outlined points as highlights of the safety question. (Credit and appreciation are given to Dr. Blumen for providing these data, in personal communications to this report's authors in mid-2011.)

As of the latter part of 2010, the U.S. HEMS industry had averaged since 1988, over 13 crashes annually. A third of those crashes resulted in fatalities. Despite the alarming number of crashes and fatalities, the accident *rate* (in crashes per 100,000 flight hours) for dedicated HEMS aircraft has been relatively stable. This is because of the rise in number of HEMS flights (and HEMS programs). In fact, other than a spike in 2003, the rate of accidents declined from 2000 through 2007 to about 3 crashes/100,000 flight hours; the accident rate has remained about the same since 2007 (as of most recent data in 2010). The fatal accident rate (FAR) was consistently at about 2 per 100,000 flight hours, during the period 1998-2004. Although the FAR dropped to 0.5/100,000 flight hours over the next three years, the time period since 2007 has shown a return of the FAR to about 2 per 100,000 flight hours. Readers should judge for themselves, the take-home message of the above data. In our opinion, the data indicate a real risk, but not one that should be invoked to shut down HEMS.

The obvious next step in safety analysis is comparison of HEMS to the ground EMS alternative. Unfortunately, the most important number for comparison – the *ground* EMS accident rate per hour or per mile – is very difficult to ascertain. Prehospital safety experts have noted that "Unlike helicopter and fixed-wing EMS incidents, little is known about ambulance crashes."⁵⁰ What data there are, do not support a position that HEMS

should inevitably be considered the risky choice as compared to a risk-free ground transport alternative.

In the U.K., a 5-year analysis (1999-2004) found zero HEMS-crash fatalities as compared to 40 fatalities in ground EMS-related accidents.⁵¹ An Australian report⁵² overviewing a decade of HEMS transports (1992-2002) found that helicopter accidents resulted in one patient death per 50,164 missions. Similarly, a German series comprising six years (1999-2004) of HEMS transports, discovered a decreasing crash rate and zero patient deaths during the study period.⁵³ Definition of the safety-calculation denominator in *miles*, as compared to *hours*, has yielded a hypothesis – not necessarily endorsed by this report’s authors – that AMT is no more risky than ground transport (patient fatality rate of 0.4/million miles for HEMS versus 1.7/million miles for ground EMS).⁷



Federal attention to the issue of HEMS safety has resulted in better knowledge of AMT hazards and increasing efforts to mitigate HEMS risks. Experts such as Dr. Ira Blumen have advanced the state of the art with respect to understanding and improving medical helicopter safety.

Information relative to transport safety appeared in a 2010 (non-peer-reviewed) article in the *Annals of Emergency Medicine* (News & Perspective section, Volume 56 Number 5, p. 18A). In that piece Nadine Levick MD MPH, the Chair of the EMS Transport Safety Subcommittee of the National Academies Transportation Research Board, highlighted risks involved with ground EMS. She estimated that each year, 9000 annual ground EMS crashes result in over 50 deaths and 3500 serious injuries, at an annual cost exceeding \$500 million. Another U.S. group had lower estimates of risk (6500+ ambulance crashes and 32+ deaths per year), but shared the opinion that a rational examination of HEMS safety risks and benefits must consider both air and ground accident risk.⁵⁰ The authors of this report are *not* suggesting that ground EMS is “unsafe.” Rather, we believe that efforts to study, understand, and maximize safety should be focused upon both air and ground EMS operations.

As earlier stated, safety comes first. If HEMS is inherently unsafe as currently practiced, then there should be a moratorium on helicopter operations in Oklahoma (and elsewhere). The authors of this report have concluded, based upon available evidence, that there is no reason to suspect safety is sufficiently problematic to warrant cessation of AMT. Two additional conclusions follow: 1) HEMS operators should continue emphasizing safety’s prime importance, and 2) missions that are not potentially justifiable – based upon information available at dispatch – in terms of benefit to patients or systems, have unfavorable risk:benefit and should not occur.

Safety issues and landing areas at referring and receiving ends of transport

Air transport safety is of critical importance, but aviation portions of the mechanics of safety, are complex. This report will mention some safety issues, but a detailed treatment of air transport safety lies outside our scope. For FW transports, unless there are aviation issues (*e.g.* need for a long runway for jets, need for precision approach in bad weather), the transporting airplane simply lands at the nearest airport. For HEMS, though, the advantage of flexible landing site brings with it the question of “where to land.” The selection of landing sites for scene missions will be addressed first. Next, there will be a discussion of HEMS landing sites at referring and receiving hospitals.

Different types of landing sites for scene missions

“Scene” flights comprise those missions, for trauma or nontrauma, in which the helicopter is dispatched to a patient who is not in a medical care facility. The decision as to where to direct the helicopter is one that is made considering safety (the most important variable), logistics, and the medical situation. While varying nomenclature is used, HEMS landing zones (LZs) for scene missions can generally be considered to occur at the incident site (*i.e.* no ground EMS transport) or at a site distant to the incident, to which ground EMS transports the patient. Sometimes, the latter situation entails helicopter landing at the helipad of a hospital that’s near the incident site; when the patient does not undergo evaluation at the initial hospital (at which the helipad is located) this is an example of a “modified scene call.” CMS (The Centers for Medicare and Medicaid Services) has promulgated the decision that such modified scene calls are *not* an EMTALA violation.⁵⁴



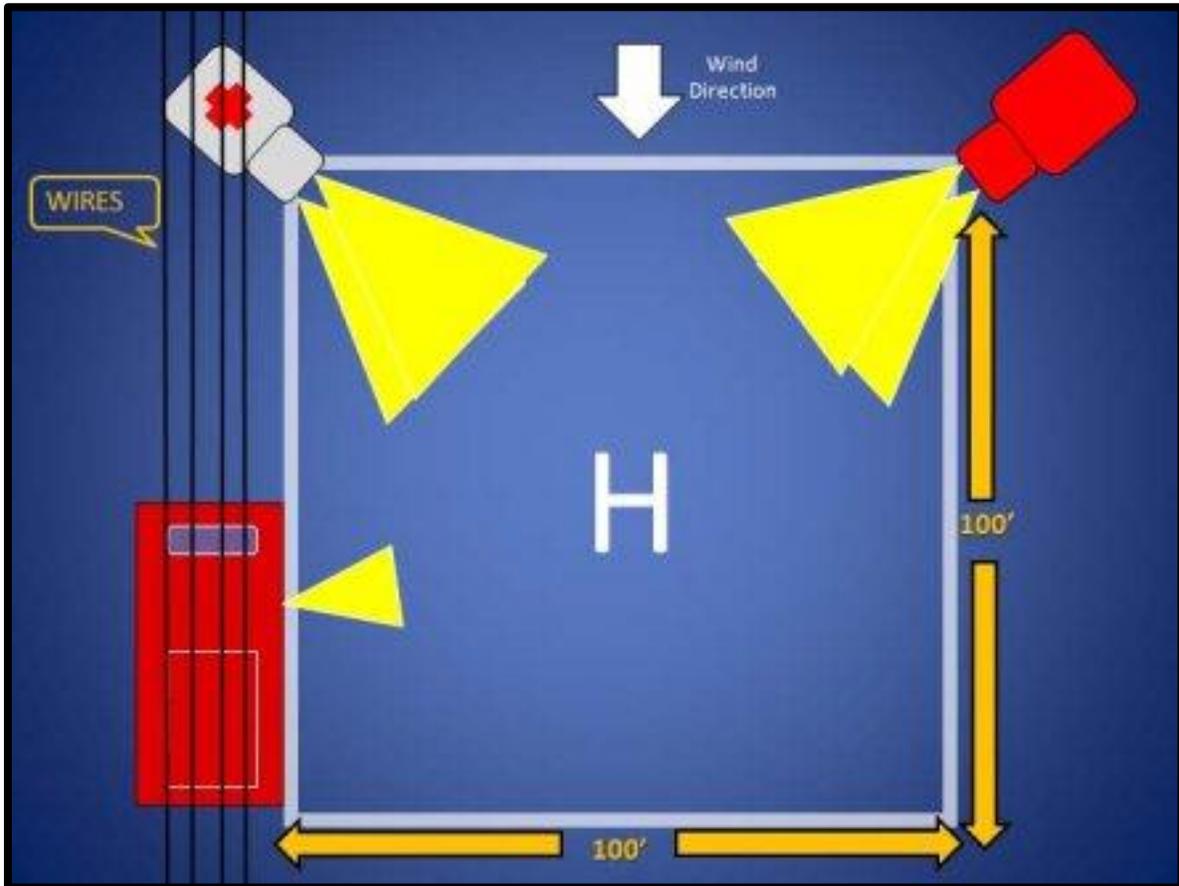
Multiple HEMS units respond to a scene in northeastern Oklahoma. Although creating problems for automobile traffic, use of highways for LZs is often the safest approach.

Specific air transport safety and aviation issues relevant to LZs

Some details for LZ setup change with different aircraft and situation. Larger LZs may be preferred for certain cases (*e.g.* larger aircraft, nighttime operations). Some services have pre-identified, Global Positioning System (GPS)-sited LZs for multiple possible landing areas in their service radius. These and other factors may impact the size and nature of the LZ setup for a given transport.

Rules for LZ setup do have constants. LZs should be cleared of debris (anything that can be blown). “Foreign object debris” (FOD) can endanger both personnel and the helicopter. Obstructions (*e.g.* power lines) must be pointed out to the air crew. For nighttime landings, no lights should be directed skywards; instead the ground EMS crews can position ambulances to create a well-lit LZ.

The increasing utilization of night-vision goggles by air medical aircraft may translate into HEMS crews' requests to decrease intensity of lighting. Key to this issue and others involving LZ setup and safe use, is ongoing communication between the HEMS crew and the ground personnel. One lesson should never be forgotten: communication between air and ground personnel is an absolute requirement for optimally safe operations.



An example diagram depicting preferred LZ setup for a HEMS service. Headlights are aimed in the direction of the wind. An additional vehicle is used to highlight overhead-wire hazards.

Ground personnel should monitor the LZ and its perimeter during aircraft approach, and keep the area secure before and during aircraft presence. Ground personnel should be reminded of safety items they hopefully learned in previous educational sessions. Aircraft engines will usually (but not always) be running; rotors may or may not be turning. At no time should anyone approach the aircraft without permission from, and optimally accompanied by, flight crew.

Ground personnel may be used by HEMS crews, to assist in the loading of patients into the aircraft. As with any other instance in which ground personnel approach the helicopter, ground crew participating in patient loading should follow the direct commands of air medical crew. Optimally, ground personnel will have had prior training in safe conduct around the helicopter. Ground personnel training includes such items as reminders that hats should be strapped down (or removed) and chin-straps secured. Potential FOD should have been removed prior to initial helicopter approach, but the area should be policed again prior to liftoff to assure lack of hazards.

Loading of patients onto the helicopter will proceed in different manner, depending on the type of aircraft. Some aircraft load from the side, whereas others load from the rear. Either method may be executed safely (or in an unsafe manner), but in either situation ground personnel must be made aware of (or reminded of, from earlier training) risks such as main rotor disk and tail rotor area. In general, helicopters should be ap-

proached from either the 3 o'clock or 9 o'clock positions. This makes it easier for air medical crew to accompany and guide personnel, and approach from these directions also allows avoidance of the tail-rotor disk.



(Above) For some aircraft, the loading approach is from the side

In situations of patient loading, HEMS crew direct patient movement and assure ground personnel are protected from the main rotor disk and tail rotors

(Below) For other aircraft, rear-loading doors (clamshells) are used



Other safety issues

There are other issues that arise, with respect to the AMT safety conversation. As these issues are largely outside the scope of this report, readers wishing further information are referred to external sources (e.g. the Association of Air Medical Services' website, www.aams.org).

In any setting – and certainly in Oklahoma – weather is a major factor impacting HEMS operations. Airplanes are affected less frequently, but even FW assets cannot fly in certain weather conditions. If there is one predictable aspect to the weather, it is that weather is a known variable that can preclude safe HEMS operations. One important step regarding HEMS safety with regards to weather, is to assure that the initial aviation decision as to whether a mission can be executed safely, is completely separated from (and overrides) the medical triage and decision-making process. It is important that pilots are blinded to the nature of the medical situation, when they are adjudicating whether weather conditions allow or preclude safe execution of a given mission. Only after the pilots have judged a mission as safe, should the medical triage decision-making be applied. (Of course, the medical and aviation triage can occur in parallel, as long as the latter process is blinded to the former.)

In an area as large as Oklahoma – and especially with the multitude of air medical assets that can re-

spond to many parts of our state – it is conceivable that weather may preclude response of one aircraft to a patient, but that meteorological conditions pose no problem for response of a different aircraft. This of course depends on where the bad weather is located, between a particular aircraft and the response site. While “helicopter-shopping” is potentially very dangerous, it is also the case that judicious evaluation of response capabilities may reasonably translate into varying ability of particular aircraft to make it safely to a patient.

Related to the weather issue, is the subject of whether pilots and aircraft are certified for Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) operations. Unplanned encountering of Instrument Meteorological Conditions (IMC) is a well-known and serious risk for HEMS accidents involving VFR-only pilots and aircraft. Of course, upgrading pilots and aircraft to IFR capability is expensive, and the data supporting this upgrade are not conclusive in support of favorable cost:benefit.

Of the many other safety-related issues, those unfamiliar with HEMS operations are often surprised by one of the most effective: slowing down. Applying a “speed limit” doesn’t mean flying slower. Rather, the concept applies to the crew, in responding to a mission. Gone are the days of receiving a call and rushing pell-mell to the helicopter to hurry mission commencement. Response needs to be professional and non-delayed – but not rushed.

Hospital helipads – Importance of on-site LZs

The National Association of EMS Physicians (NAEMSP) issued a Position Statement a few years ago, highlighting the importance of on-site helipads for hospitals using HEMS. The details of the on-site helipad advantages, as documented in the Position Statement Resource Document,⁴⁸ include critical patient safety as well as time benefits. Depending on the location of the offsite helipad, critical minutes can be lost while transferring patients from the helipad to the receiving hospital; critical minutes’ delay may also be incurred if the HEMS crew gets another call before they are back to the helicopter. Equally problematic to the time loss, are the extra stretcher transfers required for the additional transport leg. Such transfers incur risks ranging from inadvertent dislodgments of endotracheal tubes or intravenous lines, to significant patient discomfort/pain such as from jostling of fracture sites. (This has special relevance to Oklahoma cases where hospitals’ “on-site” helipads require ground ambulance transport to get to the receiving hospital unit.)



Rooftop helipads offer many advantages, but come at significant expense.

In Oklahoma on-site helipads are present at all of the high-level trauma and burn centers (all of which are located in OKC and Tulsa). While data are preliminary, and subject to errors due to hospital self-reporting, this report’s authors assayed LZ placement at the roughly 80 medical/surgical facilities in Oklahoma that seemed likely candidates for HEMS use. Although some institutions have not responded, or have unclear LZ placement, the vast majority (at least 66) have on-site helipads (including 6 rooftop pads). When the focus was shifted to our state’s Critical Access Hospitals, of the 36 hospitals, at least 30 had on-site LZs.

The importance of on-site helipads for Oklahoma cannot be underestimated. The efforts of our state’s hospitals to place HEMS LZs on-site, means that AMT benefits are more likely to be realized. Other than the time required for driving from off-site helipads to the receiving hospital, there is also time lost in effecting transfers of patients for the extra ground ambulance leg. These times and transfers must be considered in terms of logistics “costs” since the extra time periods and patient movements can reduce or even negate benefits of air medical transport.^{48,55-57} To the extent that finances and other barriers can be overcome, the desired solution for Oklahoma is for all hospitals/facilities that use HEMS, to have on-site helipads.

Hospital helipads: Neighborhood impact

There is general agreement that helipads are optimal from an operational and patient care standpoint. However, there are potential or perceived impacts of helicopter traffic on neighboring hospital helipads, that should be acknowledged. Two of the most important are safety and noise. (Cost issues are less of a problem. Urban hospitals for which situations dictate need for expensive rooftop helipads, tend to already have those pads. In less metropolitan areas where there is less congestion, logistics and resources usually allow for relatively easy placement of inexpensive, even *ad hoc*, landing areas such as those in parking lots.)

Overall HEMS safety issues are covered elsewhere in this report. For the purposes of this section, it is noteworthy that available data demonstrate no significant risks to near-hospital dwellers, from helicopter operations to a hospital LZ.⁴⁸



(Left) An article from The Journal Record describes community issues relative to HEMS operations. The issue of community relations requires significant resource expenditure for many AMT programs around the U.S.

Information gathered during our project is consistent with nationwide (and worldwide) experience: noise is the main problem for those living near hospital helipads. There are no easy, universal answers to the problem of aircraft engine noise. There is no denying that helicopters are loud, and that flights sometimes occur during hours when noise is least desired. Every helipad situation is different, but an initial approach of conversation and education is always a good start useful. For instance, in OKC the Oklahoma Heart Hospital’s South Campus helipad plan (at I-240 and Sooner Road) encountered initial community resistance based upon noise and related home value problems. As reported in *The Journal Record* (13 July 2011, “Seeking common ground” by April Wilkerson), hospital personnel met with community members. Discussions emphasized the medical importance of the helipad and pointed out the relative infrequency of its use. Hospital administrators worked with HEMS operators to modify aviation plans: aircraft approaches were redirected to avoid rooftops, and approaches from certain directions were required to maintain 500-foot altitude until within a half-mile of the helipad. The community’s concerns were answered and assuaged, and the helipad project proceeded, thus allowing the hospital to continue to optimally serve its patients who hail from nearly all of the state’s counties.

Just as occurred with the Oklahoma Heart Hospital situation for cardiac patients, similar discussions have occurred in other settings. For example, one of this report’s authors spent a year working with the Portland, Maine, City Council to address neighborhood concerns about helipad placement at Maine Medical Center. Successful completion of those negotiations led to on-site helipad placement at the only Level I center in a state in which – like Oklahoma – multiple rural areas depend on helicopter transport to extend the reach of high-level care.

In the end, concerns about safety, noise, and property values will always be a topic for discussion when the helipad subject arises. That said, consensus can often be reached. While the process of conversations regarding on-site helipads may be a lengthy one, the time savings and elimination of additional transport legs nearly always warrant the effort at discussion and problem-solving.



For many rural hospitals, the best placement for a helicopter LZ is in the parking lot. There are issues that must be addressed (e.g. crowd control, FOD risk, ability to quickly clear the lot when needed). As important as the helipad itself, is the safety of approaches (by the in-flight helicopter) to that helipad. If these problems are solved, “parking lot helipads” located close to the Emergency Department, can represent a safe, low-cost method to allow a rural hospital to optimize use of HEMS.

Appropriate utilization of air medical resources

Even the harshest critics of air medical transport tend to agree that, in some cases, use of the resource improves outcome.⁵⁸ Thus, the real issue for study is not the philosophical question of *whether* HEMS sometimes saves lives; it's the more practical question of *which* cases should go by air. There is a follow-up query, which is, "of those patients who went by air and turned out not to really need it, was that lack of AMT need predictable based upon information available at the time of vehicle selection?" This section addresses different approaches to handling these questions. The questions of triage, though complex, are definitely worth tackling, as outlined in a report from the National Highway Traffic Safety Administration:

"Better utilization of air medical services can produce reductions in mortality and morbidity of crashes. Such benefits can be achieved with faster response and transport times, higher quality care at the scene and in transport, and at the highest-level trauma center. The goal is to facilitate air medical care when needed, and avoid overutilization when not needed."⁵⁹

Triage is not simple

It seems absurd to state this fact, which is a truism to anyone who's ever been involved with care of potentially critical patients. However, this report's authors have heard for decades, all manner of ill-informed and non-evidence-based statements about how easy it should be to "fix the overtriage problem." As a NHTSA/CDC sponsored field trauma triage panel (upon which one of this report's authors served) concluded in 2010, after finding the overall level of relevant evidence was "low":

"In patients of all ages, who are victims of trauma and use 911 services, field triage criteria should include anatomic, physiologic, and situational components in order to risk-stratify injury severity and guide decisions as to destination and transport modality. The need for all of these components is dictated by: 1) imprecision in discriminatory ability of individual components' application, and 2) the need to maximize sensitivity (within reason) at a cost of specificity."

The above statement specifically addressed field (scene) trauma triage. Nonetheless, the same principles usually hold for interfacility transports. An additional conclusion of the panel was that patients transported by HEMS may have a longer scene time, but that this did *not* mean that HEMS was not indicated or useful for those patients. Triage is not simple.

Triage errors can run in two directions

Though most literature addresses overtriage, the fact is that *undertriage* is a well-recognized cause of increased morbidity and mortality in trauma patients.⁶⁰ In an era of increasing non-availability of surgical subspecialty coverage for trauma, AMT may play an increasing role in quickly evacuating patients (from scenes or community hospitals) when they are in a facility that cannot get them what they need.^{32,60,61} As previously noted, it is undertriage to transport a patient with potential need for specific surgical subspecialty care (*e.g.* brain injuries) to *any* hospital, regardless of trauma center level, that lacks access to an on-call subspecialist.⁶⁰

For trauma systems in general, in setting goals for triage to high-level trauma center care, the American College of Surgeons has stated that "an undertriage rate of 5-10% is considered unavoidable and is associated with an overtriage rate of 30-50%."⁶² The overtriage rate most commonly accepted in systems studies is about 50%, but studies report trauma systems overtriage rates ranging as high as 90%.^{63,64}

The previously mentioned levels of overtriage and undertriage have been cited as representing current system performance, by prominent traumatologists who have particular expertise in prehospital care systems.²² The current truth, according to these experts, is that there is *no* universally accepted rate of appropriate overtriage/undertriage; in fact, extant literature doesn't provide any gold standard for triage accuracy.⁶⁵

Prehospital Prediction of the Severity of Blunt Anatomic Injury

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Keith Young, Dip Frontline

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Physiologic Criteria	Sensitivity (%) (95% CI)	PPV (%) (95% CI)
Heart rate <50 >100	52.7 (44.1–61.2)	78.2 (68.3–85.6)
Systolic blood pressure <100 mm Hg	41.1 (32.9–49.8)	81.5 (70.2–89.2)
Respiratory rate <8 >20	50.8 (42.1–59.4)	73.6 (63.3–81.8)
Glasgow Coma Score <13	43.4 (35.1–52.1)	98.2 (88.6–99.8)
Oxygen Saturation <90%	10.5 (6.1–17.6)	100.0
Combination*	85.3 (78.1–90.4)	72.8 (65.2–79.3)
T-RTS	31.0 (23.3–40)	100.0

The tables above⁶⁶ and below⁶⁷ are typical of the limitations in trauma triage, that are achievable by prehospital providers. Keeping in mind that the goal for sensitivity is 90%, it is noteworthy that in the model above this goal was never reached. In the model below, the sensitivity goal comes at a very high “cost” of overtriage (positive predictive value 8% means fewer than 1 in 10 patients taken to trauma centers, were decided to have needed it).

Prehospital Prediction of Intensive Care Unit Stay and Mortality in Blunt Trauma Patients

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Prediction Tool		Sensitivity (%)	PPV (%)
Design data set	Complex model	72	19
	Categorical model	74	18
	Simple model	75	19
Trauma triage guidelines	Physiologic criteria	70	16
	Anatomic criteria	87	8
	Combined criteria	92	8

Commentators note that “substantial undertriage of serious trauma patients to trauma centers appears to be occurring, especially in older persons and in persons with brain injuries.”⁶⁸ The risks of undertriage are serious, and include “diagnostic and treatment delays, diagnostic and treatment errors, increased morbidity and mortality, decreased functional outcomes, or missed injuries.”⁶⁹ Triage decision-making should therefore include attention to the risks of both under- and overtriage.

The literature and previous paragraphs have dealt primarily with trauma triage, since this is the area for which HEMS use has garnered the most attention. One thing that is most interesting about HEMS utilization, is that the diagnostic area constituting the cornerstone of AMT – trauma – remains a “work in progress” in terms of triage. Meanwhile, the evolution of discrete, time-windowed therapy for patients with STEMI or CVA means that triage for these non-trauma populations may be more straightforward than dispatch decision-making for trauma. One result of the differences in triage difficulty between trauma and nontrauma, will be less tolerance for “overuse” in non-trauma, since times information should be prospectively calculable at the time of triage.

Translating triage difficulties into review for appropriate

HEMS should be used only in cases where there is some reasonable chance of significant benefit. Thus, air medical assets should be deployed only when there is a sufficient probability of benefit – as judged by information prospectively available at the time of dispatch decision-making. Benefit may be accrued by individual patients or by EMS systems as a whole, but some potential for gain must accompany each HEMS transport.

Given the inherent imperfection of identification of which cases are beneficial, a critical component of HEMS transport is the *a posteriori* review of every transport, to determine whether utilization review lessons can be learned and imparted. Of course, no guidelines for dispatch are ideal, and authorities on the subject recognize the inevitability – and necessity – of some degree of HEMS overtriage.⁷ *Post-hoc* determination that HEMS transport didn't impact outcome or benefit the "system" is a *necessary*, but not *sufficient*, requirement for defining a flight as unnecessary.

While there is clearly going to be inevitable overtriage, there are just as clearly areas where improvement can reduce overtriage to the point where "overtriage" doesn't necessarily translate into "overutilization" (*i.e.* overtriage that should have been predictable at the time of dispatch). The need for ongoing work on the national level is highlighted by findings such as those revealing, in some locations, complete absence of triage guidelines.⁷⁰ Other work that has understandably garnered attention, includes reports of overtriage as measured by low ISS and high rates of early hospital discharge.⁵⁸

To the end of rendering it clear that answers aren't always easy, it's worth pointing out that there are issues with both ISS and 24-hour discharges as measures of appropriate HEMS use. The problem with ISS use to determine appropriateness lies in both its retrospective nature and in the selection of the level defining appropriateness: while most trauma experts consider ISS levels of over 15 as indicative of "major trauma" there is good evidence suggesting that HEMS improves outcomes with ISS exceeding 11.⁷¹

With respect to the 24-hour-discharge variable, it is true that this outcome parameter has utility in line with its common-sense appeal. However, there is at least one *caveat*, related to the fact that 24-hour discharges (like ISS) are retrospectively defined. In many cases these "early discharges" are occurring only after intensive negative workup has assured trauma teams that no significant injury is present.⁷² Utilization review should incorporate a 24-hour discharge variable, but it's probably best to hone in on details of 24-hour discharge cases before they are immediately defined as "overutilization."

There is good news on the trauma triage and utilization front. A recent, very large-scale analysis of nationwide data (assessing over 250,000 ground and air scene responses) finds that HEMS patients are in fact far more acutely injured, and require far more hospital resources, than ground EMS patients.¹⁶ It is important to realize that triage is rightfully a focus for efforts at HEMS research...but it's just as important to realize that the system is, as a whole, working on the triage issue and there are some encouraging data.

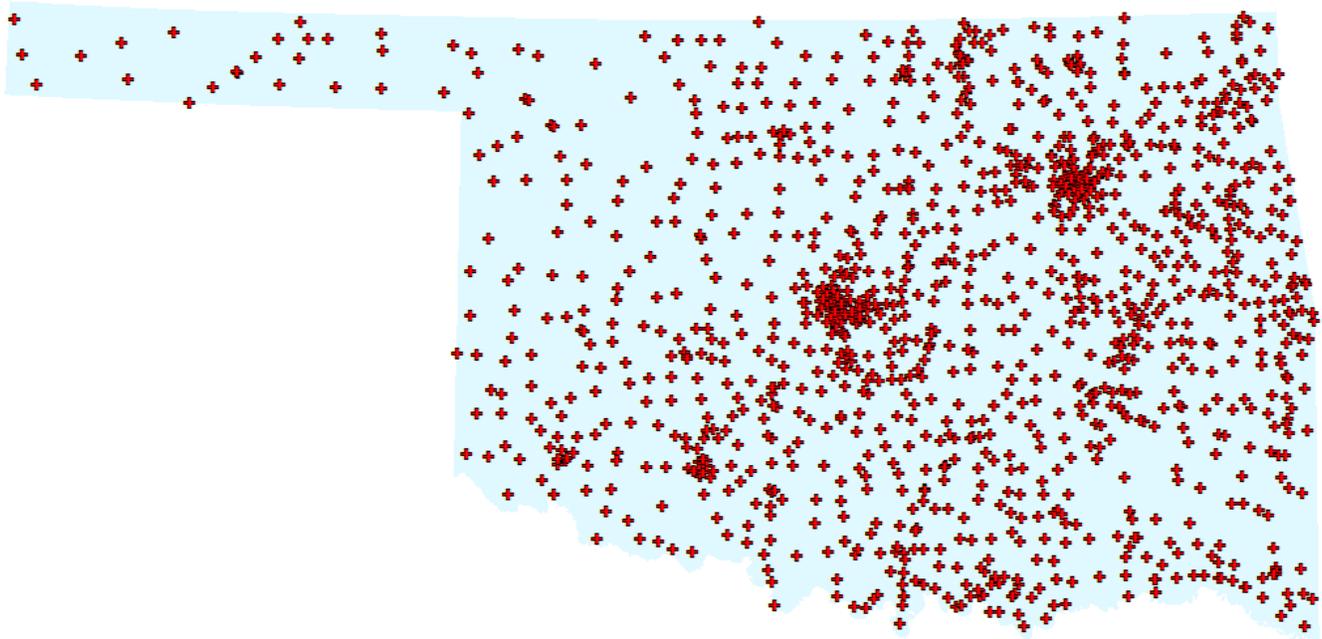
If triage is a focus for investigation, the next step is to consider *what* the topics are, upon which HEMS triage and utilization review efforts should focus. The general issues that come into play are both situational (including logistic) and patient-related.

Logistics factors and HEMS need

Time has traditionally been viewed as a major indicator for HEMS use. Because of its relationship with time, distance becomes a key issue. For the purposes of logistics considerations in rural states where traffic is not often heavy and terrain issues usually don't preclude ground vehicle access (*e.g.* Oklahoma), it seems fair to consider distance and time as closely intertwined.

One of the most important points to emphasize in the HEMS dispatch discussion, is the fact that rural regions may have few (or no) non-HEMS options for ALS-level transport of patients. The logistics discussion for AMT therefore may include the logistics of ALS coverage. Where distances are great, rural areas who use their ALS resources for transport may risk being without ALS coverage for many hours, when HEMS use would have preserved those ground EMS resources. The alternative to lack of ALS coverage, is to call in an extra shift – an option that incurs significant costs to rural EMS at a time when their finances are stretched.

The issues of rural EMS ALS coverage loss are not simply theoretical. They've been demonstrated in the literature,⁷³ and (more importantly) have been pointed out again and again, during this report's preparatory information-gathering visits with EMS throughout Oklahoma. Air Evac, a major provider of rural-area HEMS transport in Oklahoma, reports that "doctors are regularly taking the ALS coverage problem into account, when calling for helicopter transport."



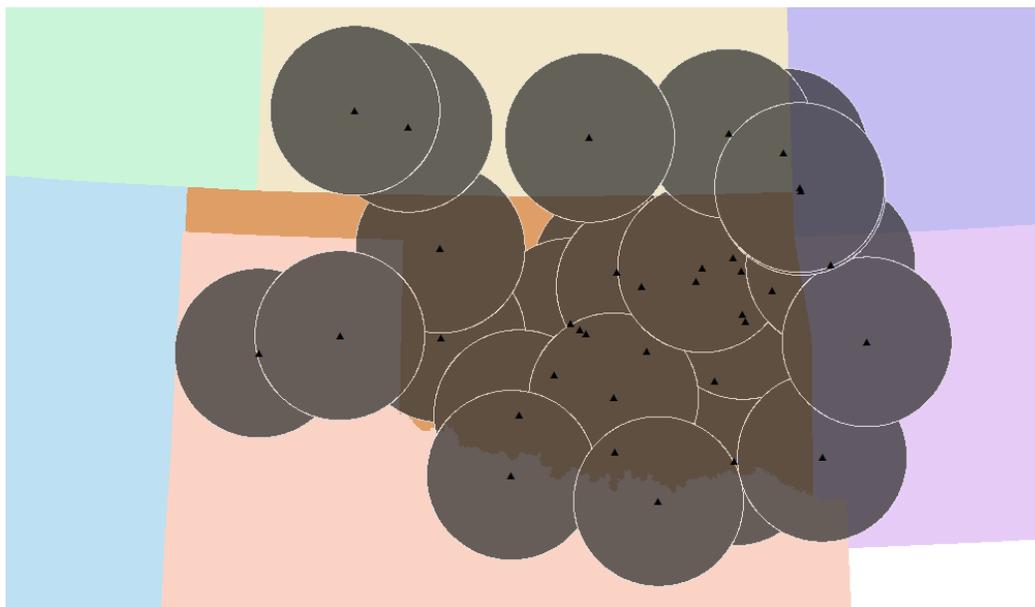
Fire stations in Oklahoma. Where the fire station icons are sparse (in rural Oklahoma), intervals between 911 call and first responders' arrival can be long. The coverage patterns for ALS will generally follow the dissemination pattern for the fire stations – but ALS coverage is much more sparse than that of BLS. ALS coverage can change for a given area, depending on daily staffing at a given base of operations.

While data for Oklahoma have not been analyzed for this report, it is quite likely that those data would demonstrate what's been found on a national basis: as distance from trauma centers increases, ISS of HEMS-transported patients goes down. In the largest database studied to date, the authors found that HEMS patients' likelihood of exceeding the critical ISS threshold for indication of serious injury (ISS 15) was directly related to transport distance. While 57% of HEMS patients in the nationwide NTDB study had ISS <15, this average ISS fell below this critical value only for those patients with transport times of over 2 hours.¹⁶

So what is the transport time (or distance), for which HEMS is needed? Unfortunately, there is no specific number that applies to all cases. For a patient with a developing tension pneumothorax or impending airway obstruction, even 5 minutes can be the difference between life and death. For most other cases, it's debatable as to whether saving 10-15 minutes is worth significant incremental cost over ground transport. Of course, the situation at the scene is not always so apparent to those who have to make the decision as to whether to call for air medical response.

With the *caveat* that things may be different in some cases, an assessment of some previous literature may be informative. Some have written that ground transport times of at least 30 minutes are consistent with need for HEMS transport for head trauma patients.⁷⁴ Others looking at trauma dispatch recommend using 45 miles⁷⁵ or 110 km (62 miles).⁷⁶ Still others⁷⁵ have written that simultaneous HEMS and ground EMS dispatch becomes time-beneficial when patients are at least 10 miles from the receiving trauma center; they acknowledge their scheme results in a canceled-flight frequency (55%) that would stretch resources at any HEMS program.

There is evidence that in at least some of these cases, the benefit of HEMS response is closely linked to the improved critical care skills and associated reductions in physiologic derangement and sequelae such as secondary brain injury.^{17,77} For these types of cases, the operative logistics driving benefit from HEMS response are probably much more related to the time it takes for HEMS to get to the patient, than to the time required for HEMS to get the patient to trauma center care. The flying radii of HEMS units stationed in and near Oklahoma, for a roughly 30-minute “time-to-patient”, are depicted below. As noted earlier, these flying-time radii are not exact, since aircraft speeds can differ.



Above circles represents areas within a 30-minute helicopter flying zone, within Oklahoma. This does not necessarily correspond to areas in which a helicopter can always be available within 30 minutes. Some areas are covered by only one circle; these areas of the state have limited back-up HEMS capability if the closest unit is in-use.

For non-trauma, there are good data driving the use of surrogate time endpoints as inextricably linked with mortality benefit. For example, data from the cardiology literature reveal that a half-hour’s streamlining of pre-PCI times for STEMI reduces mortality by 8-10%.²⁸ Large-scale studies have suggested that the time frame over which time savings to PCI reduces mortality, stretches from door-to-balloon times of about 45 minutes, all the way to about 225 minutes.²⁹

Considered in even finer time frames, data indicate that savings of as little as 15 minutes are important: for each 15 minutes’ time savings pre-PCI, STEMI mortality decreases by 6.3 lives per 1000 cases.⁷⁸ When these numbers are applied to actual transports in Oklahoma, the analyses are revealing. Results of a preliminary analysis (not yet published as of this writing) at Tulsa’s Hillcrest Medical Center (HMC) are provided to illustrate Oklahoma-relevant findings for STEMI transports.

In the HMC study, STEMI patients being transported for primary PCI were assessed, with special attention on logistics and timing. Transport distances for HEMS patients were nearly 40% greater than ground EMS distances. HEMS was instrumental in getting patients to PCI within 120 minutes. There were 15 cases in which HEMS transport got patients to PCI within the 120-minute target; ground EMS would have gotten patients to PCI within 2 hours in only 2 of those cases.

The Tulsa HMC data also revealed that overall time savings associated with HEMS use in those patients undergoing AMT was *at least* 30 minutes in 79% of cases. In no case was the time savings far from 30 minutes; the least amount of time saved was 24 minutes. Even if all cases accrued the lowest-identified time savings (of

24 minutes), about 1 life per 100 HEMS cases would be saved *solely related to time*. Since that single “save” may translate into 20 or more quality-adjusted life-years, the risk of triaging away from HEMS because “it only saves 15-20 minutes” becomes apparent.

Of course, one of the major differences between trauma triage and logistics considerations, and non-trauma patient decision-making, is that the latter group tends to currently come from hospitals rather than “scenes.” This may be changing. Substantial increments in time savings have been reported with prehospital activation of HEMS for STEMI and stroke patients.^{6,79} As Oklahoma moves with the rest of the U.S. toward assessing feasibility of prehospital activation of “non-trauma systems care” (e.g. for stroke or STEMI), logistics of air medical triage will likely evolve.

Cardiac and stroke patient logistics will be different from those attendant to trauma cases. As previously noted, there is no “magic number” that precisely demarcates a time- or distance-based envelope for HEMS. For scene trauma, a range of approximately 45 miles (or 45 minutes) from the trauma center is endorsed by some who have executed large-scale studies of HEMS scene response.^{16 48,57,80}

This report’s authors believe it sensible to consider “time savings with HEMS” as an important factor. If ground transport time is 45 minutes but HEMS can’t get to the scene within an hour then AMT is not the answer. Another point is that for scene and interfacility transports, on-site helipads at hospitals are critical. A CDC/NHTSA expert panel on trauma triage that met to review the evidence on HEMS use in 2010, concluded that the requirement for an additional transport leg (i.e. from a remote LZ) should cause prehospital providers to consider foregoing HEMS use. Fortunately, the preparation of this report has included a finding that nearly all hospitals that use HEMS with any regularity, have on-site landing areas.

Logistics and aircraft type

While helicopters certainly look different – and indeed have differing performance – the actual speed issues don’t usually come into major play in the triage decision-making process. The helicopters in use in Oklahoma move with speeds that are within 20-30 mph of each other; this difference does not translate into sufficient time differences over a typical transport, to change vehicle triage or direct use of one service over another.

Airplanes represent a different sort of transport, in terms of logistics. The NAEMSP Guidelines for Air Medical Dispatch include relevant recommendations for FW transport.⁸¹ Advantages of airplanes include long range (hundreds or even thousands of miles). Airplanes require airports, and incur an extra set of transfers (i.e. to and from the airport), but as distance increases these time costs are offset by flying speed.

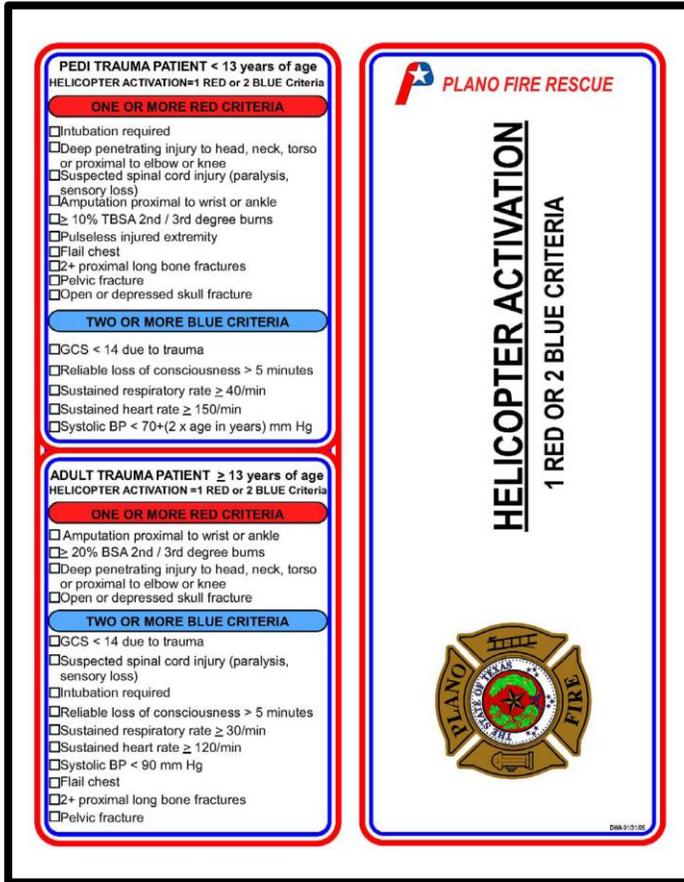
One item of importance, is the understanding of *all* logistics associated with various transport types. Though a FW air medical asset can move fast (speeds vary widely with aircraft), the time savings must be offset against the need for ground transport legs. As in many decisions regarding air transport decision-making, the optimal approach is to have the triage assisted by someone with appropriate experience and expertise.



This dedicated air medical transport plane cruises 400+ mph and has a range of 1500 miles. Aircraft commonly used in Oklahoma have substantially lower speed and lesser range, but more flexibility for use in rural areas; runway lengths required to accommodate jets such as the above, are uncommon in much of Oklahoma.

Patient factors and HEMS need

Of course, activation of HEMS resources is based upon factors other than logistics. For trauma and non-trauma air medical transports, there are certain situational and patient-related data that come into play. The issues to be considered deal with scene and interfacility requests. Indeed, the evidence suggests that physicians requesting HEMS transports are no more likely to be consistent (or use HEMS appropriately), than ground EMS providers.⁸² Available data demonstrate that prehospital triage (for trauma) appears to be just as good – or poor – as triage by physicians, as defined by similar ISS, Revised Trauma Score, ICU and hospital lengths of stay, or disposition.⁸³ (As outlined and discussed later in this report, the Oklahoma experience is similar. ISS and 24-hour discharge data suggest that scene triage may even be better than interfacility triage.)



(Left) Agreed-upon dispatch protocols reduce chances of overutilization and render triage straightforward for on-scene providers. Protocols such as the one at left, which was generated in part by one of this report’s authors when he was an EMS Medical Director in Plano, TX, outline anatomic and physiologic triggers for HEMS activation.

The full Plano protocol includes logistic issues as well. The protocol starts with a reminder that the main goal is to get the patient to the most appropriate hospital in the shortest time period.

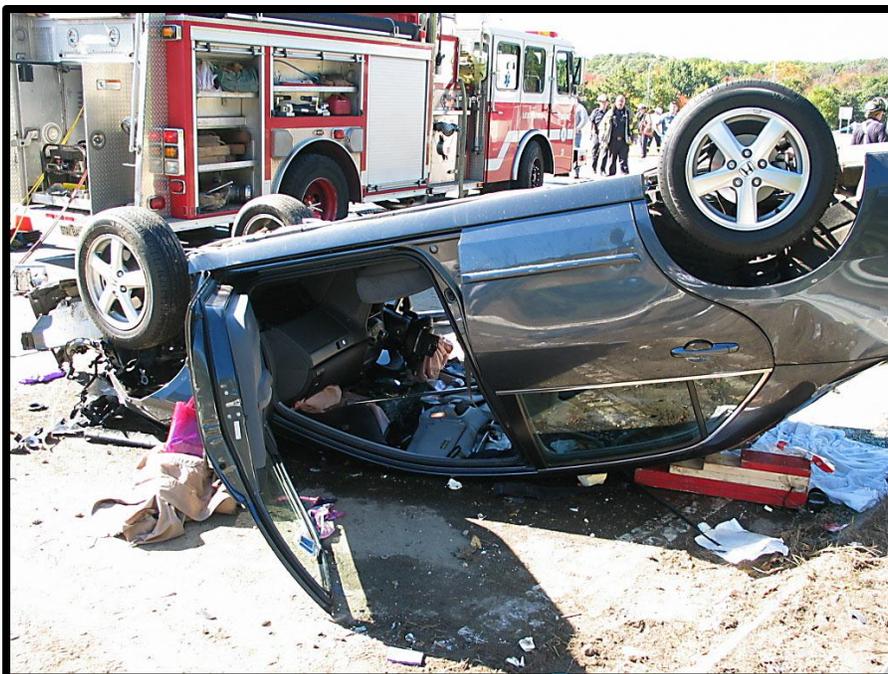
There are few, if any, nationally disseminated guidelines available for assisting specific-case triage decisions. Recognizing this deficit, the CDC’s Injury Control Center has charged an expert panel with generating such specific guidelines by mid-2012. (One of this report’s authors serves on the CDC panel.)

Protocols such as the one in Plano allows for HEMS to be put “on standby” by public safety personnel, but no helicopter dispatch occurs until a paramedic assessment. The protocol wisely recommends medical director contact for unclear cases. In terms of logistics, the Plano approach disallows HEMS dispatch when there is longer than 15 minutes’ “wait time” for HEMS (*i.e.* when ground EMS could be transporting the patient, but instead they wait with the patient at the scene, for helicopter arrival). This point requires some consideration, since the CDCNHTSA expert panel recommendation that prolongation of scene time should *not* automatically translate into non-use of HEMS. Other points in the protocol include strong recommendations against cancelling HEMS when it’s already been called, due to confusion if the helicopter needs to be re-dispatched to the same scene if the situation changes. Like most protocols, Plano’s recommends against calling for HEMS in cases of cardiorespiratory arrest. These specific criteria may or may not all be the right criteria for every region in Oklahoma, but the presence of agreed-upon rules guiding HEMS dispatch is a necessary component of any system that strives to function with the best achievable balance between overtriage and undertriage.

It is easy to argue that any currently extant HEMS dispatch criteria result, in some cases, in deployment of the helicopter for patients who in retrospect did not require AMT. What is far more difficult to do, is use available evidence to support specific changes to currently used triage guidelines.⁸⁴ The question is how to use *prospectively available information* (i.e. not retrospectively calculated scores such as ISS) to maximize triage sensitivity while maintaining acceptable positive predictive value.

The question of using prospectively available information to triage, has proven difficult. The authors of one paper highly critical of HEMS overtriage⁵⁸ state that “future studies should critically evaluate each mechanism of injury and physiologic criteria to determine the best predictors of helicopter usage.” That statement is reasonable, but it must be interpreted in light of existing trauma triage evidence. For instance, the critics⁵⁸ suggestion of using GCS and heart rate (in the manner of a speculation by Moront *et al*⁸⁵) manages to combine a poorly sensitive variable (GCS) with a parameter (heart rate) that is quite nonspecific; this approach has demonstrated nonviability in trauma triage (see Henry *et al*⁸⁶, among others).

It is well known that limiting triage decisions to anatomic and physiologic variables results in dangerous and inappropriate levels of undertriage, and that some level of prehospital provider judgment (and mechanism of injury incorporation in triage) is necessary to optimize outcomes.^{32,61,64,87-92} On the other hand, it is just as clear that some of these additional triage markers inevitably lead to overtriage.⁸⁴ The situation is easily identified as one in which help and improvements are needed, but again, it is not so easy to generate and test solutions. Hedges wrote in mid-2006 of the triage problem: “Primary (i.e. field) triage systems based on physiologic and anatomic injuries will always be limited because vital signs and neurological status are variable in the pre-hospital setting and/or may be altered by drugs or alcohol, and injuries may be relatively occult with delayed development of physiologic derangement despite the presence of major underlying injury.”⁶¹ (In fact, just as paramedic judgment remains an important component with demonstrated potential to improve prehospital triage,⁶¹ “physician discretion” remains an important part of secondary/physician triage.³²)



(Left) First responders such as fire services, are faced on a daily basis with difficult decisions in the execution of field triage. With minimal medical training, prehospital responders are often left in a tight spot as they try and help patients while avoiding overutilization of scarce HEMS resources.

Ongoing work is clarifying contributions from already-studied aspects of triage. The many previous studies of field triage have been overviewed in a review by Lerner.⁶⁵ Some of the highlights of

the extant literature (as depicted in *J Trauma* papers pictured earlier in this report) include relatively consistent findings that, to achieve sensitivity in the 95%-or-higher range, positive predictive value falls to under 10%.⁹³ In an air medical transported patient population, the ACS triage criteria were associated with an admirable 97% sensitivity – but at a cost of specificity of 8%.⁹⁴ In HEMS cases studied by Wuerz *et al*, limitation to anatomic and

physiologic triage criteria yielded suboptimal sensitivity (87%) and poor specificity (20%).⁹⁵

Population-based New York trauma registry analyses reported by Henry *et al*⁸⁶ revealed many telling findings. Many mechanism criteria (*e.g.* crash speed >20 mph, >30-inch vehicle deformity, axle displacement) incurred substantial specificity cost while adding little sensitivity. Even anatomic and physiologic criteria, combined with “mechanism” criteria known to be useful (*e.g.* same-vehicle passenger death), had limitations when attempts are made to increase sensitivity to the 90-95% range that is optimal. Analysis of the New York data revealed that, to improve trauma triage sensitivity from 85% to 95%, approximately 100 additional (overtriaged) patients would have to be transported for each “true positive” patient picked up by the loosened triage criteria.

Heart rate provides an example of the triage conundrum. The State of New York made a decision to incorporate as independent physiologic triage criteria, pulse rate of <50 or >120; this was based upon the fact that 26% of the patients in the registry who had pulse abnormalities as their only criteria, required major operative intervention. It must be acknowledged up front, that using heart rate to trigger HEMS response seems (and may be) a poor use of resources. However, the 2010 gathering of trauma triage experts convened by NHTSA and the CDC, in reviewing the available evidence (judged to be of “low” level), concluded that “tachycardia may meet the requirement for HEMS use instead of ground transport.”

The NHTSA/CDC panel also concluded, again based upon a low level of evidence, that in children a GCS less than 12 could be considered a trigger for HEMS use. This appears to be one marker that is not controversial, especially when considered in the context of pediatric patients.

Finally, the New York experience revealed that anatomic and physiologic criteria alone failed to identify 43% of patients requiring operative intervention. Henry *et al*⁸⁶ concluded that the suboptimal performance of anatomic and physiologic criteria alone “highlights the need to use mechanism criteria and the need to accept overtriage.” They also reiterated the importance of utilizing “other” criteria such as age>55, cardiac and respiratory disease history, coagulopathy, Type I diabetes, cirrhosis, and morbid obesity.⁸⁶



Mechanism of injury must be incorporated into trauma triage. In one population-based study, nearly half of the patients requiring operative intervention lacked anatomic or physiologic triggers for trauma center triage.

Some situational criteria may be encountered, that are not independent triggers for HEMS but which

can contribute to transport mode decision making. For example, it is worth noting that many prehospital providers interviewed for this report pointed out the fact that prolonged ground ambulance rides can be extremely painful for certain patients (*e.g.* those with fractures). This has also been addressed in the trauma orthopedics literature.⁹⁶ It may not be the case that an isolated femur fracture patient warrants HEMS, but the comfort of the patient may reasonably combine with other factors (*e.g.* maintenance of rural ALS capability) to render rural Oklahoma prehospital providers more likely to call for HEMS transport.

(Right) Even if HEMS time savings won't likely impact orthopedic endpoints, AMT of patients with painful fractures may accrue major gains in patient comfort.

The triage of trauma patients has recently been the subject of significant scrutiny, by an Expert Panel of the Centers for Disease Control (CDC). A few years ago, the CDC panel published the most up-to-date trauma center triage criteria.⁹⁷ Some members of that panel (including one of this report's authors) have been recently tasked with taking those criteria – which form the basis of trauma triage in Oklahoma – and translating them into national-level criteria for HEMS trauma use; these updated HEMS criteria should be available in mid-2012.

Who should dispatch HEMS?

As previously noted, even when HEMS is requested by physicians (*i.e.* for interfacility transfers), triage is far from optimal. Moving dispatch to the field, even when using highly trained flight paramedics, still results in substantial loss of specificity (*i.e.* overtriage). Using a composite indicator of “serious injury” that comprised such variables as ISS exceeding 15, need for >24 hours' ICU stay, or urgent operative intervention, a group of Australians reported that flight EMTs were able to identify serious trauma status with 97.7% sensitivity, but with only 28.2% specificity. Even with the best-trained prehospital providers performing the triage, the overtriage rates in the Australian study ranged (depending on endpoint definition) from 31-47%.⁶⁴

If flight paramedics tend to overtriage up to half of the cases, it's hardly reasonable to expect precision from those with lesser training and experience. Some regions have addressed the issue by requiring physician contact for *any* HEMS use. This seems both unnecessary and even wasteful of time; there are very few data to support the position that physicians in an ED – who may or may not have experience with helicopter triage – can act upon information given to them by on-scene providers and meaningfully add to the decision-making process. Where there does appear to be a role for physician consultation, is the process of physician involvement for those cases that are not the highest-level cases (as outlined in a previously prepared protocol). This involvement of physicians in the intermediate cases has resulted in decreased HEMS overutilization in Maryland (physician involvement was implemented based upon a recommendation by an expert triage panel convened by Maryland's governor, after a fatal HEMS crash; one of this report's authors served on that panel).

At least one service operating in Oklahoma (Air Evac) has a 24/7 flight nurse-staffed triage center that



reviews all transports at the time they are requested. Company officials report that these triaging flight nurses, located at Air Evac's Missouri headquarters, screen all flights and decline as many as 20-25%. Air Evac officials admit that refusals must be handled very delicately, since "on-the-spot refusals just promote helicopter shopping." Those at Air Evac, like most others involved in actual patient care, are reluctant to take triage decision-making out of the hands of the physician at the bedside.

Triage was yet another discussion arena in the overall AMT discussion, in which there was mention of sparse ALS coverage. Air Evac reports they do "ALS-level" calls that could have been performed by ground EMS, but for which treating physicians explicitly dictated that patients be flown because EMS was either unavailable in timely fashion, or the physicians did not want to use ground EMS and be without local ALS coverage for hours.

On the other end of the spectrum from requiring physician input before HEMS dispatch, is the practice of "autolaunch." Autolaunch means different things in different EMS regions, but as a general rule it applies to the launch of HEMS assets based upon preliminary reports from (trauma) scenes. Helicopters lift based upon passer-by reports or similar information, with the understanding that paramedics arriving on the scene may cancel the aircraft.

Autolaunch is important to consider in Oklahoma, as it is an important part of the daily practice of at least one major HEMS provider in our state. Officials at the highest corporate levels of Air Evac have indicated that they strongly believe in autolaunch as a means to effect life-savings reduction in time-to-HEMS, for those patients whose accident scenes may not be reached in timely fashion, by ground EMS providers. It is important, that any system for dispatching HEMS for scene trauma, take into account not only where helicopters are stationed, but where they are actually located at the time a HEMS-versus-ground decision is made; autolaunch costs money (for canceled flights) but it may also position an autolaunching HEMS service as the "closest air asset" for cases in which the helicopter is already en-route to the scene.

Minnesota's use of autolaunch, while associated with only a 21% mission completion rate, was found to have favorable cost-benefit analysis.² The Minnesota report emphasized a number of factors designed to insure judicious resource utilization (e.g. medical oversight, cancellation by first responders arriving on-scene, strict utilization review). They have also predicted that automated information recording and reporting capabilities (e.g. OnStar) will combine with Global Positioning System technology to improve autolaunch cost-effectiveness.²

For HEMS in Oklahoma, one of the major areas of work moving forward, will be in the realm of dispatch. This area is covered in a later section of this report. It seems likely that some components of autolaunch will be incorporated (since the private HEMS services will do this anyway), and some components of physician contribution to decision-making may be useful. Perhaps the most important part of the process, is the analysis of what seems to be working in Oklahoma, and what doesn't apply here; this process of utilization review is covered in this report's next section.

Air Evac, which could be described as having been "active" in its earlier history, in its encouragement of citizens to call HEMS directly, has changed policy as of the past 3-4 years. Senior officials with the company report that all direct calls from patients are now routed through to 911, with Air Evac personnel staying on the line to be available for dispatch if 911 decides this is the correct procedure.

Utilization review – Closing the loop

Regardless of the specifics of HEMS use guidelines developed for an area, one absolute requirement is monitoring of compliance with those guidelines after they're implemented. It's well-known that different areas within a given region, will have varying degrees of compliance with "agreed-upon" protocols for HEMS use. The broad variability in HEMS use, in areas operating under the same triage guidelines, has been demonstrated from areas as disparate as New England and the Netherlands.^{98,99} Thus, as important as it is for HEMS services (and EMS regions) to establish triage guidelines, it is just as important for regions to assure that their constituent HEMS activators actually follow the existing criteria applicable to their use of air medical resources.

HEMS services operating in Oklahoma are already providing some degree of utilization review, since such is required by the accrediting body for air medical transport (CAMTS). Discussions with these services have

rendered it clear that they are performing at least a minimum level of review of transports for appropriateness. The difficulty for the services in Oklahoma – as in other locations throughout the U.S. – is the fact that they get precious little assistance from receiving hospitals (e.g. trauma services) as to HEMS utilization issues. Utilization review without meaningful feedback is not effective utilization review. Some mechanisms for potential improvement in utilization review for HEMS in Oklahoma, are provided in a later section of this report.

Preliminary information – in fact, a draft report of a manuscript provisionally accepted for publication – indicates that at least one HEMS service’s internal utilization review is yielding high rates of transport compliance with CAMTS guidelines. Admittedly the CAMTS guidelines could be argued to be broad (in order to minimize undertriage), but the service’s finding that about 95% of flights are compliant is promising. The particular service (Air Evac) also reports a plan for follow-up: if a particular provider (or hospital) triggers “overutilization” parameters for over 5% of their utilizations, feedback as to the problem’s existence is provided. If the level of overutilization reaches 10%, in-person education occurs.

For utilization review, the good news is that attention to detail pays off. Well-executed studies reporting years of experience, demonstrate that the correct use of these triage guidelines, even in the most rural settings, can result in optimal HEMS triage even without requiring base station contact.¹⁰⁰

HEMS triage – Overarching conclusions

We are in an era in which experts freely acknowledge that “current triage criteria are wanting in terms of sensitivity and specificity of identifying severely injured patients, or more accurately stated, patients who would most benefit from Level I trauma center care.”¹⁰¹ The many previous studies of field triage have been overviewed by others.⁶⁵ Highlights of the literature include consistent findings that, to achieve sensitivity in the desired 95%-or-higher range, positive predictive value falls to under 10%.⁹³

If we don’t know with any precision, who needs high-level trauma care, how can we possibly expect prehospital providers (or anyone else) to know who needs a helicopter? The consideration of these issues is well underway at a national level, but this report’s authors – who are participating on the generation of these national-level HEMS triage criteria – suspect that the available evidence will not allow generation of precise criteria.

Considering the triage issue, there are some overarching points that must be kept in mind. First, is the fact that rapid transport to trauma centers saves lives.¹⁰² Second, is the fact that much of the U.S. population can *only* reach high-level trauma centers in timely fashion by HEMS.^{33,103} Expert panels have recognized the significant importance – from both the time-delay and the cost standpoint – of using the helicopter to “overfly” the non-trauma center and get the patient directly to high-level care.

Similar evidence exists for the critical role of HEMS in providing availability for time-critical burn,¹⁰⁴ cardiac,¹⁰⁵ and stroke¹⁰⁶ care. Third, there are existing criteria that focus on appropriate HEMS use, that have been endorsed by a broad variety of professional medical groups. The National Association of EMS Physicians Air Medical Services Committee (chaired by one of this report’s authors) generated Guidelines for Air Medical Dispatch in 2003.¹⁰⁷ These Guidelines have also been endorsed by the Air Medical Physician Association (AMPA) and the Association of Air Medical Services (AAMS), as well as the American Academy of Emergency Medicine (AAEM) and the American College of Emergency Physicians (ACEP). The guidelines are certainly not definitive, and in fact are probably too broad, but they do serve as an excellent starting point for regional planning.

The full helicopter dispatch guidelines (including explanatory text) are available and accessible without charge from the website of NAEMSP (<http://www.naemsp.org/positionpapers.asp>). Given the constraints imposed by the nature of the available evidence, the Guidelines probably represent the best and most up-to-date resource for those wishing to optimize HEMS dispatch. Appended to the end of the Guidelines is a general set of questions which may be useful for determining optimal vehicle response in a given situation. As has been noted in both the initially promulgated guidelines and in other writings of trauma triage experts, it is of vital import for a given region to adapt triage guidelines as indicated by their particular circumstances.⁶⁰

Employment of any guidelines should be part of a nationwide, cooperative process that incorporates all

affected parties (from EMS to community hospitals to receiving centers). Furthermore, the *a posteriori* follow-up of HEMS utilization is clearly critical to determining whether the ongoing utilization of HEMS in a particular region is optimal. Utilization review is not just a process to make sure everyone follows the guidelines – it’s also an opportunity to get information from HEMS users, as to how the guidelines may need to be adjusted to accommodate for region-specific needs.

One individual interviewed for this report said, “these companies are savvy. They’ve got the assets in place and it makes sense for them to do as many flights as possible.” An air medical provider was heard stating at a recent state conference, “Don’t blame us for overutilization. You call, we have to respond.” This is the case with air transport services in most states: refusals of calls do incur risks to the air service provider and it’s often tricky to practice such refusals on an “on-the-spot” basis. It does not appear either appropriate, or likely to succeed, to expect the air medical providers to be responsible for policing utilization.

Triage needs to incorporate patient factors, mechanism factors, logistics, and sometimes other parameters (e.g. weather, road conditions). The decisions are far too complicated to be oversimplified, but some level of simplification is helpful to prehospital and rural healthcare providers who are trying to do the right thing. The time to address these challenging triage issues is “off-line” – in the systems planning phase, rather than in an *ad hoc* basis as calls come in. While there should be capability to consult physicians on an as-needed basis, for “bubble” cases (as has been successfully executed in Maryland), the optimal approach is to pre-define which types of patients need which vehicles, and then follow system performance while criteria are constantly reviewed and improved.



Triage decision-making is complex, involving selection of hospitals as well as transport modality. In most cases, triage is most efficiently performed when well-trained prehospital providers use previously agreed-upon criteria. Occasional physician consultation may be of assistance in borderline cases, but this is the exception, not the rule.

Cost-effectiveness of air medical transport

Some of the most useful medical investigations in today's dollar-conscious healthcare environment, assess an intervention's cost as compared to its accrual of dollars (cost-benefit), lives (cost-effectiveness), or "quality-adjusted life-years" (cost-utility). The calculations entailed are quite complicated, and for HEMS (and FW transport) are limited by disagreement on both the costs and the outcomes variables. However, a brief overview of this subject is provided here, to guide the reader interested in this arena.

Of note, most of the available data address used of RW AMT. There are some studies assessing FW transport and associated capabilities,^{36,108} but truly definitive cost-effectiveness information is lacking. It does appear quite likely that FW transport is at least as cost-effective as RW transport, because airplanes can cover such a substantially larger area with a single asset (and cost per mile tends to be lower with long-distance flights).

Introduction to available data

Those who have delved into the detailed economic analysis required for truly rigorous cost-benefit calculations have noted the difficulties in apparently simple maneuvers such as assigning value to human life.¹⁰⁹ Fortunately, some rigorous and independent analysis of HEMS cost and benefit data has been conducted. A Canadian Institute of Health Economics report notes that "air medical services appear to be expensive on a single-case basis but not at a system level."⁷ Detailed reproduction of economic analysis is beyond the scope of this discussion, but following is a brief overview of some of the data underlying conclusions about HEMS costs and benefits.

Some of the most rigorous investigations of cost-effectiveness come from Scandinavia. One study, calculating cost-benefit for the entire spectrum of HEMS transports, concluded: "The analysis indicates that the benefits of ambulance missions flown by helicopters exceeds the costs by a factor of almost six."¹⁰⁹ Another group from the region estimates that HEMS contributes to the cost-effectiveness of primary percutaneous coronary intervention (PCI); even when patients were transported from longer distances (and by air), the cost-effectiveness of primary PCI over time is maintained.¹¹⁰

The Norwegians' estimate (a benefit-to-cost ratio of 5.87:1) indicates that the HEMS operations quite easily paid for themselves, and in fact reaped a substantial "return on investment" for society. In a study conducted in nearby Finland, authors calculated that the cost of HEMS, per beneficial mission, was roughly \$30,000.¹¹¹ The arrival at these numbers entails economics analyses that are difficult to quickly summarize, but the importance of the topic warrants its incorporation into any discussion of HEMS outcomes.

As a final introductory note to the cost-effectiveness section, it is helpful to consider that excellent cost-effectiveness studies have in fact been done, in areas with "real-life" trauma triage imprecision. It is noteworthy that some of the same investigators who have identified major need for improvement in triage, have also found (in the same population in whom suboptimal triage was being applied) that HEMS was indeed cost-effective.³⁵ Therefore, any refinements in triage will only improve the cost-effectiveness of HEMS.

General application of cost-effectiveness to the question of HEMS vs. other transport modalities

As just noted, HEMS certainly appears to be an expensive method to transfer patients. In fact, the cost of the average helicopter is much greater than the cost of an average ground ambulance. Unfortunately, the true situation is far more complicated, since the costs should be applied for a given regional system – one in which a relatively few air medical assets provide advanced level care (and usually more rapid transport capability) that would require a large fleet of ground EMS units.

Exploration of the "regional view" in which "costs to cover an area" are calculated, has resulted in at least one economic study concluding that HEMS is *less* expensive than development of a wide-ranging fleet of ground EMS vehicles.¹¹² Furthermore, some of the cases in which HEMS may have the most true benefit (*e.g.*

isolated geographical conditions) are characterized by both high cost for HEMS and high differential cost-effectiveness if HEMS is compared to alternative transport modalities.

Complex cost considerations are beyond the scope of this discussion, but there has been excellent work recently, that paints a picture of the myriad factors that should be considered when trying to adjudicate true costs of EMS systems and components.¹¹³ The healthcare economist assessing costs and benefits of HEMS should consider, as one of many examples, that HEMS-associated outcome improvements for head-injured patients are particularly well characterized, and doubtless save substantial sums in long-term care costs.¹¹⁴

Cost-effectiveness determinations also become tricky when one considers uses for HEMS for transports that would either simply not occur (as with high-risk obstetrics transports)³⁴ or would not occur within a critical time window (as for stroke or cardiac transports).^{79,115} There is no ground transport option capable of rapidly moving through rush-hour traffic in Los Angeles;³⁴ there is no realistic surface vehicle option for stroke or cardiac patients on Martha's Vineyard who need timely transport to neurointerventional or PCI suites.¹¹⁵ Similarly, there is little ground EMS capability for timely transport in many parts of a rural state such as Oklahoma. Thus, it becomes obvious that *some* form of HEMS is a "must-have" for some parts of Oklahoma.

If some level of HEMS is dictated by a region's geographic circumstances, there is direct bearing on cost-effectiveness calculations. If a region must have air medical assets for some group – however small – then it's probably best to use those assets as much as appropriate in order to spread the "overhead" costs among a large group of patients (some of whom may have lesser, although still significant, benefit from AMT). Put another way, if western or southeastern Oklahoma must have a helicopter to annually transport time-critical trauma patients to the city, cost-benefit planning should incorporate the fact that the helicopter is already "bought" for these patients; uses for other populations, for whom benefits are real but not as substantial, may contribute to overall cost-effectiveness.

Increasing amounts of data show that the best mechanism for improving trauma mortality is to get significantly injured patients directly to a tertiary trauma center.^{102,116} Transporting such patients to a lower-level trauma center as an intermediate step before Level I care not only risks worsening outcome, but also incurs significant costs. Studies suggest that the extra hospital "stop" adds about \$700 to per-patient transport expenditure,¹¹⁷ and an equivalent cost (at least) in repetition of laboratory and radiology evaluation.¹¹⁸ This does not of course include the hospital-based costs for evaluation of patients at the initial receiving center; these costs would obviously run to many thousands of dollars. Retrospective review of one system's experience with direct-from-scene (HEMS) transport directly to tertiary care, versus ground transport to rural facilities (with frequent subsequent transfer to trauma centers), finds that HEMS and ground modalities have equal *cost* (the authors do not address *benefit* of direct-to-trauma center transport).¹¹⁷ Thus, direct-to-tertiary transport should enter into cost-benefit calculus, just as it should be considered in discussions on HEMS outcomes.

Specific calculations for HEMS cost-effectiveness

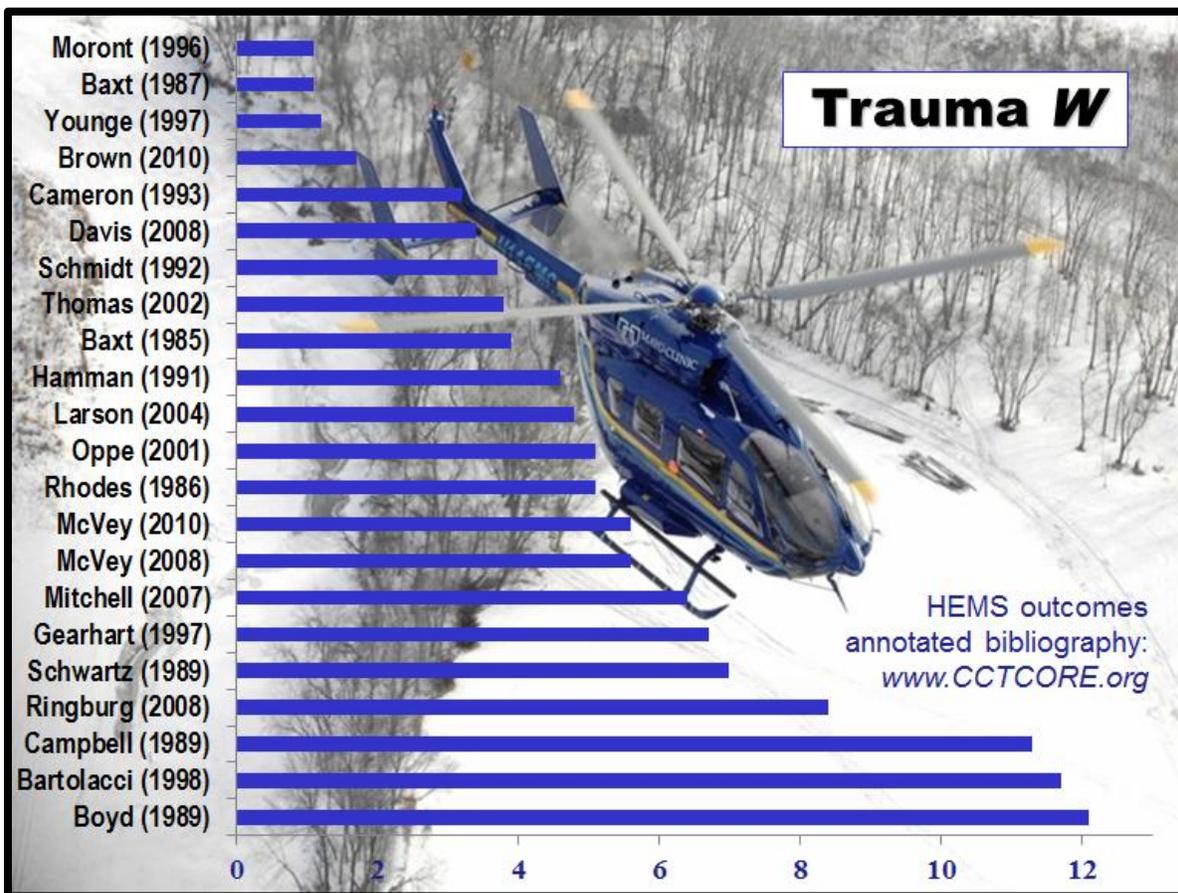
It is clear from the preceding discussion that true costs of HEMS operations are not easy to study, given complexity of the HEMS programs and the difficulty of ascertaining *incremental* costs of HEMS over "critical care-trained ground EMS." This probably explains why there are not a large number of cost-effectiveness studies.

Further complicating things are the existence of incomplete data sets, which likely suffer from selection bias. An example is the latest (just published in November/December 2011) critical care transport workplace survey, from the *Air Medical Journal*.¹¹⁹ This methodologically sound survey's results suffer from the overall response rate of well under 50%. The survey does offer data that can be used in subsequent cost-benefit analyses. For instance, the median salaries of responding programs' paramedics and nurses are provided (about \$48,000 and \$67,000, respectively). This survey, or data like its results, are required for anyone attempting to embark upon rigorous financial analyses that include the costs of operating a HEMS program (*e.g.* personnel costs). The picture is less complete, unfortunately, if one seeks to find detailed surveys (with acceptable response rates) that outline HEMS services' total actual costs and charges.

The good news is that there *is* guiding literature, and it is informative. In fact, given the infrequency with which existing data are cited, the reader may be forgiven for some surprise upon finding that the extant evidence is consistently in favor of cost-effectiveness of reasonable HEMS use. Some examples of that literature will be discussed in this section.

In 2005, a California HEMS group identified an incremental cost of fuel and maintenance (*not* including fixed costs) of \$650 per flight hour.⁷⁵ This is not inexpensive, but the number must be considered in the context of other healthcare expenditures for the HEMS-transported population. Investigators have executed economic analyses and concluded that HEMS response to the scene, with direct transport to trauma centers, is beneficial and also cost-effective.¹¹⁷

While the reader is referred to other sources^{95,120} for detailed explanation, a general estimate of cost per life-year saved for adult trauma transports can be calculated to be well within acceptable range given the industry-standard transport cost and a *W* estimate (*i.e.* lives saved per 100 transports) of 5.⁸ The estimate compares favorably with many other healthcare interventions.^{95,121} For example, Dutch traumatology and healthcare economics experts have written that HEMS' cost-effectiveness compares favorably to that of heart, lung, or liver transplants (with cost/QALY ranging from about \$50,000-100,000 in US dollars).³⁵



W (W_s when standardized due to too-low *M* statistics) estimates the number of lives saved per 100 HEMS flights. While varying methodology renders formal meta-analysis difficult, there is consistency in the results from the existing literature; this consistency is especially obvious, when one considers that in the figure above, the abscissa scale is 0 to 100 (lives saved/100 flights). A Cochrane Review addressing HEMS trauma scene response, coordinated by Johns Hopkins with co-authorship of one of this report's authors, has been accepted in its abstract form and is currently being prepared.

Interestingly, the estimates for cost-effectiveness are generally consistent across different countries and investigators. In a report prepared for the British government's Department of Health,¹²² Nicholl and colleagues reported that the cost per QALY was \$10,000-30,000 (after currency translation to dollars). They noted that this was consistent with estimates from Norwegian studies, and that the estimated cost per QALY was within the UK's "acceptance threshold" of about \$35,000. While the U.K. "acceptance threshold" deals with acceptance by government policy-makers, other Europeans have assayed the "acceptance threshold" of individual citizens. Data from the Netherlands¹²³ indicate that, when the public is surveyed, there is willingness to pay far more (nearly \$20/household/month) than the actual costs of HEMS provision. (*N.B.* This \$20/month translates into an annual cost that far exceeds the subscription fees of the AMT services operating in Oklahoma.)

Perhaps the most rigorous of all of the cost-effectiveness analyses come from different groups of investigators in the Netherlands. Independently, these authors report that, depending on the specific mathematical models used, HEMS is associated with cost-effectiveness of between \$10,000 and \$50,000 per QALY.^{35,124}

Interpretation of these cost-benefit studies can be daunting for those without a bent for economic analysis. Further complicating the issue is that HEMS costs should probably fairly be compared as *incremental* costs over ground EMS provision of care. In urban settings, where ground EMS coverage is plentiful, those costs may be small, but the story is different in many rural areas. In fact, one economic study has calculated that covering a broad expanse with rapid-response, high-level care is actually *less* expensive with HEMS than it would be with similarly advanced ground EMS resources (per-patient costs in 1991 dollars: \$4475 HEMS vs. \$2811 ground EMS).¹¹² (That analysis is predicated, by the way, upon an assumption that the skills attained by highly trained air medical crews and practiced daily, would not be diluted if HEMS crews were replaced by a fleet of ground ambulances.) Unfortunately, the job of assessing HEMS' cost-effectiveness is made more difficult by the extremely limited amount of information on cost-effectiveness of ground EMS itself.¹²⁵

Though most extant information addresses use of HEMS for trauma, it should be pointed out that cost-effectiveness calculations are increasingly being applied to other patient populations. One of the best examples of such work is that of Silbergleit *et al*,¹²⁶ who demonstrated HEMS cost-effectiveness for patients with acute ischemic stroke (for thrombolytic therapy). Preliminary work (not yet published) indicates that HEMS deployments for primary percutaneous intervention are likely cost-effective as applied in Oklahoma; the savings of at least 1 life per 100 transports in an eastern Oklahoma study translates into reasonable costs per life-year saved in Markov modeling of the preliminary Oklahoma data (unpublished as of this report's preparation).

Further parameters in calculating HEMS cost-effectiveness

If HEMS cost-effectiveness and cost-benefit are to be assessed with precision, there are other points that must be mentioned. This section outlines a (very) few of those points, with the goal of merely highlighting other topics for consideration.

One of the most important considerations in the HEMS cost-effectiveness debate, is the non-mortality benefits that may (or may not) be accrued with air transport. Some of these endpoints, while repeatedly arising during the preparation of this report, are "soft." Examples include patient comfort due to a less-bouncy ride and (much) better analgesia provision associated with air transport.¹²⁷ Other non-mortality endpoints are much more concrete. One example of these endpoints was provided by a Bryan County EMS official (*Durant Daily Democrat*, 4/28/2008), who related a story of an injured teenager with a pulseless leg, who would have lost his leg had the helicopter not been available to take him to a Dallas hospital with an available surgeon.

With respect to interfacility transports, HEMS allows for rural hospitals to be able to initially stabilize, and then transfer, patients with time-critical or higher-acuity diagnoses. Air medical services operating in Oklahoma told this report's authors, that they are frequently performing transports when there is simply no coverage available at the referring hospital. These situations may include coverage types that are sometimes available (*e.g.* during weekdays), but which are too expensive for that rural facility to have on a 24/7 basis. Along these lines, AMT providers noted that it's more cost-effective to support HEMS transport, than it would be to cover rural hospitals' costs that would be incurred in taking care of patients with the breadth of illness and injury, who

are transported to Tulsa or Oklahoma City. Though some data are highly suggestive (*e.g.* spike in less-urgent HEMS transports on Fridays), there are insufficient data to allow detailed analysis of this question at the current time. However, the literature does suggest that HEMS allows for regionalization of resources (and cost-effective concentration of spending).¹¹⁰ It is certainly fair to point out that there is common sense in the notion that rural hospital resources (*e.g.* to pay for overnight/weekend surgical subspecialty or PCI call coverage) are very stretched, and thus HEMS allows for a cheaper method than provision of full-scale coverage, to be able to participate in care for many types of higher-level patients.

Conclusions on cost-effectiveness literature applied to HEMS in general

Detailed economical analysis is beyond the scope of this discussion. The data presented in this section are intended only to familiarize the reader with some basic concepts, and to provide some tools that might be useful in executing further, more rigorous, cost-benefit analysis. Nonetheless, it is hoped that the data presented will allow the reader to appropriately evaluate such broad-based claims as “the helicopter is expensive” from a rational, health-policy standpoint. HEMS represents a resource-intensive effort, and both common sense and available data support the notion that the best cost-effectiveness will be achieved by a rational (evidence-driven) transport process that involves both air and ground modalities.¹²⁸

The “recommendations” area of this report includes some steps that would help elucidate true cost-effectiveness of HEMS as provided in our state. Truly, the cost-effectiveness question is the sole question at the heart of understanding HEMS (or any medical resource). The only way to ascertain that information, is to account for *all* of the incremental costs of HEMS (including such items as safety and rural-area ALS preservation) while assaying *all* of the potential benefits (in other words, not just mortality). Among the items that such an overarching cost-effectiveness analysis would need to entail, is the fact that there is such overwhelming evidence for *some* HEMS benefit, that the “fixed cost” of getting HEMS capability in a state like Oklahoma, is likely unavoidable if the aim is to improve healthcare for our citizens.



In a rural state, there will always be complicated patients (such as this case, involving an explosion burn and blunt injury) that need HEMS in order to receive timely specialist care that is unavailable in small facilities.

Air transport physiology, in-cabin care, and related air medical limitations

Although physiology is not the central focus of this report, there are some points that have relevance in the overall consideration of advantages and disadvantages of air medical transport. Fortunately, Oklahoma is sufficiently close to mean sea level (MSL) that altitude considerations are not complex; they are therefore outlined in brief, with specific mention of altitude physiology and its effects on air-medical care limitations.

Gas laws

Perhaps the most important of the gas laws is *Boyle's Law*, which states that a gas' volume is inversely proportional to the pressure exerted upon it. As altitude increases (and atmospheric pressure decreases), the molecules of gas move farther apart and the gas volume expands. Expansion and contraction of gases within the body can occur with altitude changes. "Squeeze" on descent, and "reverse squeeze" on ascent, occur when decrease in ambient barometric pressure leads to an increased volume of the air trapped within physiologic spaces. Depending on the particular space in the body, exertion of pressure on adjacent structures may cause, for example, sinus pain or enlargement of a pneumothorax. Medical equipment containing closed air spaces (e.g. tubes for balloon tamponade of bleeding from esophageal varices) can also be affected. Intravenous flow rates can change, since glass containers for infusions are not recommended and air inside plastic infusion bags can expand and contract. Also, the pressures (and volumes) in air splints and in pneumatic antishock garment suits may be altered with altitude (although there is limited evidence as to the clinical significance of these changes).¹²⁹

It is noteworthy that, like larger commercial airline flights, AMT by fixed-wing are usually executed with effective in-cabin altitudes thousands of feet above MSL (e.g. 5000-7000 feet is a common pressurization altitude for commercial flights). Thus, "pressurized" cabins in fixed-wing aircraft do not obviate the need to pay attention to altitude-related issues as previously outlined.

Charles' Law follows from the volume effects of *Boyle's Law*, and states that temperature and volume of a gas are directly related. Molecular dispersion seen with increases in gas volume at altitude means there is less heat produced from the naturally occurring molecular collisions – thus temperature decreases as altitude increases. The maintenance of desired patient temperatures is sometimes challenging in the air transport environment, and attention must be paid to proper provision of insulating blankets when hypothermia is a risk. Furthermore, absolute humidity decrease associated with low temperatures can cause problems with thickening of respiratory secretions. Hydration should be paid particular attention during air transport.

Dalton's Law states that the total barometric pressure at any given altitude equals the sum of the partial pressures of gases in the mixture. This accounts for the decrease in partial arterial oxygen tension as altitude increases. Since patients are usually on supplemental oxygen, Dalton's Law ramifications are crew-focused (i.e. need for occasional supplemental oxygen – a non-issue in Oklahoma but potentially encountered in mountainous regions).

Henry's Law states that the mass of gas absorbed by a liquid is directly proportional to the partial pressure of the gas above the liquid. This has particular application to dive medicine, where decompression sickness results from rapid ascent (gases to come out of solution into the bloodstream). In general, this is not an issue with air transport, although sudden decompression at altitude (i.e. in a FW transport in a pressurized cabin) can cause the same dysbarism seen in too-rapid ascent when diving.

Environmental limitations in air transport

As noted earlier in this report, in-cabin care challenges are surmountable with appropriate education, training and preparation. These challenges are mentioned here, in order to emphasize the unique nature of in-transport care.

Early concerns about vibrations and their possible ramifications with respect to bleeding after thrombo-

lytic therapy, have not been borne out for either cardiac or stroke patients.^{42,44} Vibrations may contribute to crew fatigue, but there is no evidence they pose a risk to patients. Larger-scale movements of the aircraft may result in motion sickness, both for crew and for patients. In some cases (e.g. trauma patients with cervical spine immobilization), intratransport emesis can be problematic and prophylactic antiemetics may be wise.

The helicopter cabin is loud. Crew and patients should have hearing protection, and crew may not be able to auscultate effectively.³⁹ Most crew members have learned to use other physical examination or related clues (e.g. ventilator pressures) to mitigate the information loss from auscultation, but esophageal stethoscopy may be useful on occasion.¹³⁰

The physical size and layout of aircraft cabins differ widely with varying HEMS vehicles. Ergonomic issues include possible impairment of performance of advanced medical tasks such as intubation and chest compressions.^{131,132} Flight crew training includes these individuals' becoming accustomed to the positioning issues (of both patients and crew) that must be dealt with in the intratransport setting.



(Left, AS365N2 cabin) Interiors of helicopters or airplanes represent challenging environments for provision of critical care.^{133,134} Each cabin poses different issues; crews' medical care approaches may differ depending on the cabin in which they are flying.^{133,135,136} The in-cabin differences are one of many reasons that special training is required before even the most experienced healthcare providers can become effective air medical crew. Other aircraft cabins are depicted for comparison purposes, on the next page.

Medical care and decision-making impact from the air medical environment

In some cases anticipation of HEMS transport dictates the need to perform certain pre-flight interventions. However, it is also true that some "traditional" pre-flight interventions (e.g. intubation, tube thoracostomy) may have occasionally been performed when unnecessary. The in-cabin situation, as well as other factors (e.g. transport time), will need to be considered by air medical crews as they make judgments as to which interventions really need to be executed prior to flight.

For FW transport, pre-flight interventions and planning are probably more affected than with HEMS. This is less a function of the in-cabin air care setting, and more a function of the airplane's "isolation" (it can't quickly land at an intermediate hospital if patient deterioration occurs).

This report is not intended to overview all medical issues, but some altitude and in-cabin care issues will be provided to serve as examples. Of course, there will be situational variation, depending on the aircraft and other factors (e.g. nighttime versus daytime operations may make a lighting difference in some aircraft).

The two most common issues are "the HEMS crew intubates everyone" and "everyone with a pneumothorax needs a chest tube because of Boyle's Law." The decision to perform pre-flight "prophylactic" intubation is quite complex, and in fact is far outside the scope of this report. It should be acknowledged, however, that the most detailed examinations of pre-flight versus in-flight intubation, are by nature limited by their retrospective (non-randomized) nature. The largest studies suggesting that in-flight airway management is safe, specifically mention that one reason in-flight intubation works well is because air medical crews wisely triage difficult airways to pre-flight intubation.^{137,138}

Another clinical issue, tube thoracostomy, is similar to the intubation question in that pathology can be

difficult to identify and intervention difficult to execute. In fact, for years there has been an aphorism that clinicians opting for AMT in the setting of any pneumothorax “need to put a chest tube if the patient will be flying.” Like many “time-proven” aphorisms, this one is often incorrect. Over a few decades’ time, the writers of this report have seen a lot of chest tubes inserted pre-flight, that simply didn’t need to be placed. Trauma patients may indeed need tube thoracostomy pre-transport, but this is more likely due to the difficulty in monitoring patients during transport, than it is due to altitude physiology...and flight crew are fairly savvy at in-transport monitoring, especially in relatively low-risk situations.



Interior views of a small twin-engine helicopter (BO-105, left) and a CitationJet airplane

A consultation with any physics text will demonstrate the lack of logic in presuming that large pneumothorax volume changes will occur at the low altitudes encountered during standard HEMS operations. As is the case with every rule, there are exceptions. Most notably, any time a patient with a pneumothorax is on positive pressure ventilation, pre-flight chest decompression should be the rule. Also, instrument flight rules (IFR) operations may result in need to move to higher altitudes (*e.g.* 5000 feet or higher), where volume-pressure relationships become more relevant. The best message for this point, is that decisions about care needed “in order to put patients in the helicopter” should be made in consultation with persons with AMT experience.

Other issues that arise with respect to HEMS (and FW aircraft that don’t pressurize to MSL) tend to be related to Boyle’s Law. Endotracheal tube cuff pressures may rise due to low ambient pressures.^{129,139} The clinical impact of this pressure rise is unknown, but the difficulty of testing for cuff-related sequelae, and the ease of application of cuff manometry to prevent those sequelae, render this monitoring reasonable. In situations in which an exact pressure is critical (*e.g.* the esophageal component of a Minnesota tube) manometry is required.

Another consequence of altitude-related physics, is that higher-altitude, colder air contains less humidity. In adults, this is not such a problem in most cases. However, in neonatal transports of patients with an airway diameter in the range of 3mm, inspissation of secretions can be a major threat to oxygenation and ventilation. Hydration (and suctioning frequency) may need adjustment in these cases.

For FW transports, the issues are related to both altitude (see above notation about cabin pressurization) and lack of access to intermediate hospitals. Helicopters have the capability – although uncommonly used – to land at an intermediate location, should patient deterioration occur in-flight that reaches a certain level of criticality. Airplanes do not have this luxury; by the time an airplane finds an alternative airport at which to land, effects a landing and taxi, and has its patient transported by ground to the nearest hospital, the window for most time-critical care has closed. In practice, this often means that patients who undergo FW transport need to be a bit more stable, than those being transported by helicopter. Pre-flight planning for FW flights needs to incorporate more contingency considerations than may be the case for HEMS operations.

Government and regulatory issues

Since this report is being prepared for a government agency, we include an overview of some government issues in Oklahoma and the U.S. The level of detail to be provided is somewhat superficial - discussion of the ramifications of the Airline Deregulation Act (ADA) alone would require a separate report that could exceed the length of this one. There are some topics that can be introduced, that will play into the recommendations suggested by this report's authors. These topics tend to focus on safety and monetary issues.

Governance of AMT

Dan Hankins of Mayo Clinic, outgoing president of the Association of Air Medical Services (AAMS), has lamented this year (2011) that there is still no strong central oversight over the medical aspects of critical care transport (e.g. triage, what constitutes a "critical care flight crew").¹⁴⁰ What has occurred, is that HEMS crashes have brought media and government scrutiny on AMT operations. This scrutiny has – fairly or not – painted a picture of an industry that is operating with minimal government oversight or control.

Many have argued that the free-market system should be allowed to play out in AMT; others have posited that market forces don't always work in AMT (e.g. areas with rare, but critical, need for AMT). Competing factions have established their own association-like groups, and a major question for AAMS, is how the industry as a whole will move forward. The authors of this report don't offer the answers (since they're not known to anyone). Rather, we believe it important to point out that this is a turbulent time in terms of AMT governance.

Aviation and safety

Aviation and safety are the areas in which government regulation is clear. Safety has been addressed earlier. This section addresses the regulatory and government-affairs components of safety.

The Federal Aviation Administration (FAA) is responsible for establishing and assuring compliance with myriad rules regarding safe aviation operations. The pertinent regulations are as numerous as they are important, and address everything from pilot training to aircraft modifications. Information relevant to HEMS and fixed-wing operations can be found at www.faa.gov.

Aviation crashes are investigated by an independent federal agency, the National Transportation Safety Board (NTSB, www.nts.gov). The NTSB is charged with assessing the causes for a given crash, and also is tasked with making recommendations for future improvements in safety. For instance, the NTSB website can be accessed to obtain information on the 2010 crash of an air medical helicopter near Kingfisher, Oklahoma (NTSB report CEN10FA424).

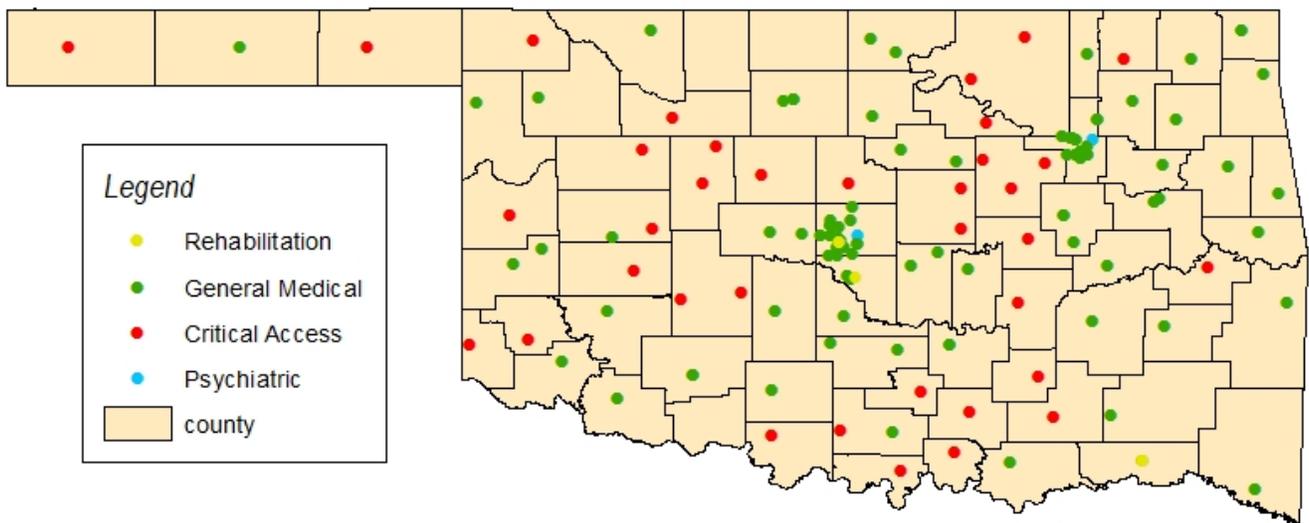
The Kingfisher crash was the first that involved a fatality in our state, but safety has been an area of intense scrutiny over the past decade. In fact, until recently, HEMS safety was on the "most wanted" list of highest-priority items for NTSB. Information from NTSB relevant to HEMS safety can be found at their website (www.nts.gov), which provides links to documents such as the 2009 NTSB special report on HEMS safety (www.nts.gov/doclib/speeches/sumwalt/ACEP-10052009.pdf). The findings in that report included such items as endorsement of night vision goggle use.

Utilization

NTSB has been working with the Department of Homeland Security Federal Interagency Committee on Emergency Medical Services (FICEMS). After 2009 NTSB hearings (prompted by 2008's being HEMS' deadliest year ever), NTSB recommended FICEMS develop national guidelines for the use and availability of HEMS. In response to that request, the National Highway Traffic Safety Administration (NHTSA) and the Centers for Disease Control and Prevention (CDC) are collaborating on an expert panel approach to generate guidelines for appropriate air medical utilization. The panel, which includes one of this report's authors, is early in its work in taking the approach of adapting HEMS into the previously published CDC National Field Triage Guidelines.⁹⁷

SECTION III: AMT IN OKLAHOMA

HOSPITALS IN OKLAHOMA

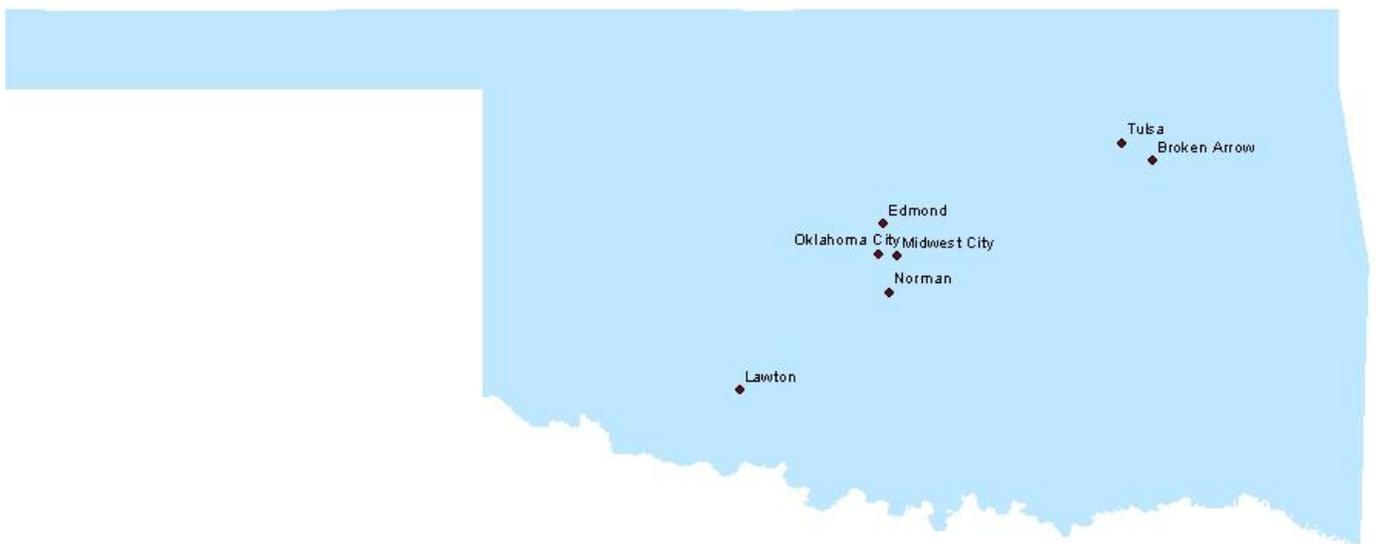


AMT providers in Oklahoma

The next parts of the discussion attempt to summarize the current picture of HEMS and FW transport in Oklahoma. Geographic, administrative, crew positioning, administrative and cost structures, and related information is presented. The opening section will outline the providers operating in Oklahoma. Even this picture can become complicated, since out-of-state aircraft often provide transports into (or out of) Oklahoma. This section commences with an overview of Oklahoma’s healthcare geography, before moving to outlining of AMT providers and locations.

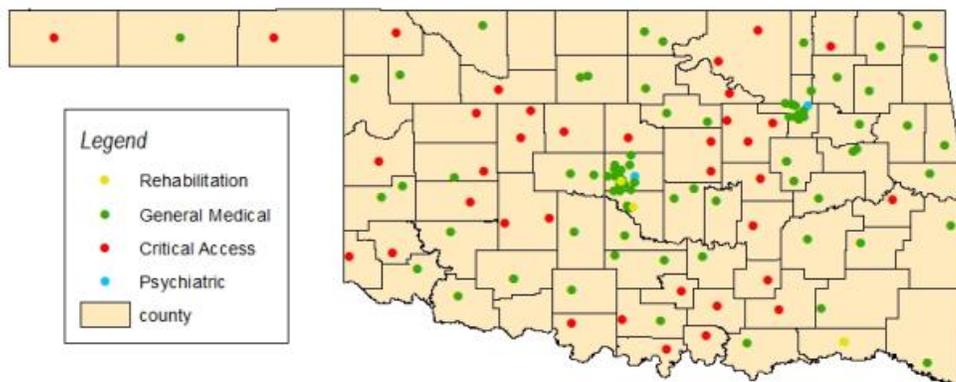
Cities and hospitals in Oklahoma

The map below depicts the larger population areas in Oklahoma. The map’s intent was to display the largest cities in the state. There is certainly room for imprecision, but the general message of the map should be correct: there are lots of “empty space” areas in the state, in which access to “city-type” healthcare is limited.



Hospitals in Oklahoma

A larger map providing information about Oklahoma hospitals is depicted on the preceding page. Perusal of the map will lead to a conclusion that hospital concentrations generally follow population bases above.



Air transport providers and aircraft serving Oklahoma

There are three services that are regular providers of HEMS in Oklahoma. Two of those services also have capability to provide FW transports. A fourth Oklahoma-based service provides only FW transport (much of it outside of the Oklahoma area). Services' aircraft and placement are subject to ongoing modification, so the information presented in this section may change soon.

The HEMS operations all involve single-engine aircraft. The standard crew configuration, which can vary depending on circumstances, is nurse and paramedic. Out-of-state services (*e.g.* CareFlite from Dallas) do provide Oklahoma transports (and may be OK-licensed). These services' transport numbers are not negligible, but they are a relatively small proportion of Oklahoma's overall AMT volume.

The three corporate entities operating HEMS in Oklahoma are: 1) Air Evac Lifeteam, 2) Air Methods, and 3) EagleMed. Air Evac has FW capabilities in neighboring Missouri, that could occasionally be deployed in Oklahoma. EagleMed also offers FW transport out of Yukon (and also occasionally from either of two southern Kansas bases). Air Methods operates two Oklahoma programs: MediFlight and Tulsa Life Flight.

Air Evac and EagleMed are owned by the same parent company (which also owns other transport services, that do not operate in Oklahoma as of this writing). As noted by senior officials with the company, though, the services are considered "competitors on the local level." They report some use of EagleMed assets by Air Evac (*e.g.* FW capabilities, which are lacking in the latter service), but there are no standard protocols or joint training or medical oversight.

In addition to the providers above, a FW transport service, AeroCare MTI, is based in Tulsa. While that service operates a number of aircraft (including jets), contact with them confirmed their emergency-type Oklahoma regional transports nearly always involve use of a twin-engine turboprop Cessna Conquest 1 with performance envelope (cruise speed 300 mph, range approximately 800 miles) between helicopter and jet aircraft.

Characteristics of the HEMS and FW aircraft are provided in tabular form on a following page. Some notes regarding the aviation aspects of transport follow on this page.

There are 14 total Air Evac helicopters that are positioned such that transports would be expected to occasionally involve Oklahoma. Eight of those helicopters are located within Oklahoma; there are also three in north Texas and three in western Arkansas. With the sole exception of a Decatur, TX-based Bell 407 that occasionally makes flights into Oklahoma (with speed of 143 mph and range 430 miles), the Air Evac aircraft are Bell LongRanger 206 models with cruise speed of 136 mph and range 390 miles.



(Left) Air Evac Lifeteam executes nearly all Oklahoma flights in a Bell 206.

Air Evac operates a FW aircraft in Missouri, that could theoretically be used for Oklahoma transports. This aircraft is not included on the map as there are other FW resources (see next paragraph) that are far more likely to be tapped.

Air Methods operates Eurocopter EC130 helicopters with a speed and range of 150 mph and 379 miles, respectively. These include one aircraft (stationed in Oklahoma City) that performs only neonatal transports. There are thus five helicopters with Air Methods – a pair in the central/western part of the state and three in the eastern part of the state – that provide general scene and interfacility AMT.



Air Methods (EC130, above) and EagleMed (AS350, below) helicopters



EagleMed operates nine AS350 A-Star helicopters (speed 138 mph, range 403 miles) in the Oklahoma area. Five of the EagleMed A-Stars are stationed in Oklahoma, with one in Joplin MO and 3 others in southern Kansas. EagleMed fixed-wing transports are provided in the twin-engine turboprop King Air C90 (speed 275 mph, range 1266 miles).

EagleMed operates the state's only FW aircraft that's available 24/7 for emergency responses; it's located in Yukon. EagleMed also has bases in southern Kansas, that are involved in FW transport in Oklahoma. While there may be RW assets located in some of the southern Kansas bases, these Kansas helicopters are not included in this section as they are far less likely to be used, than the bases' FW assets.

Air medical assets and airframe characteristics

The major providers of air medical transport in Oklahoma are denoted below. Characteristics of RW and FW aircraft are provided; FW operations are **green-highlighted**. Assets based within Oklahoma are in **red font**.

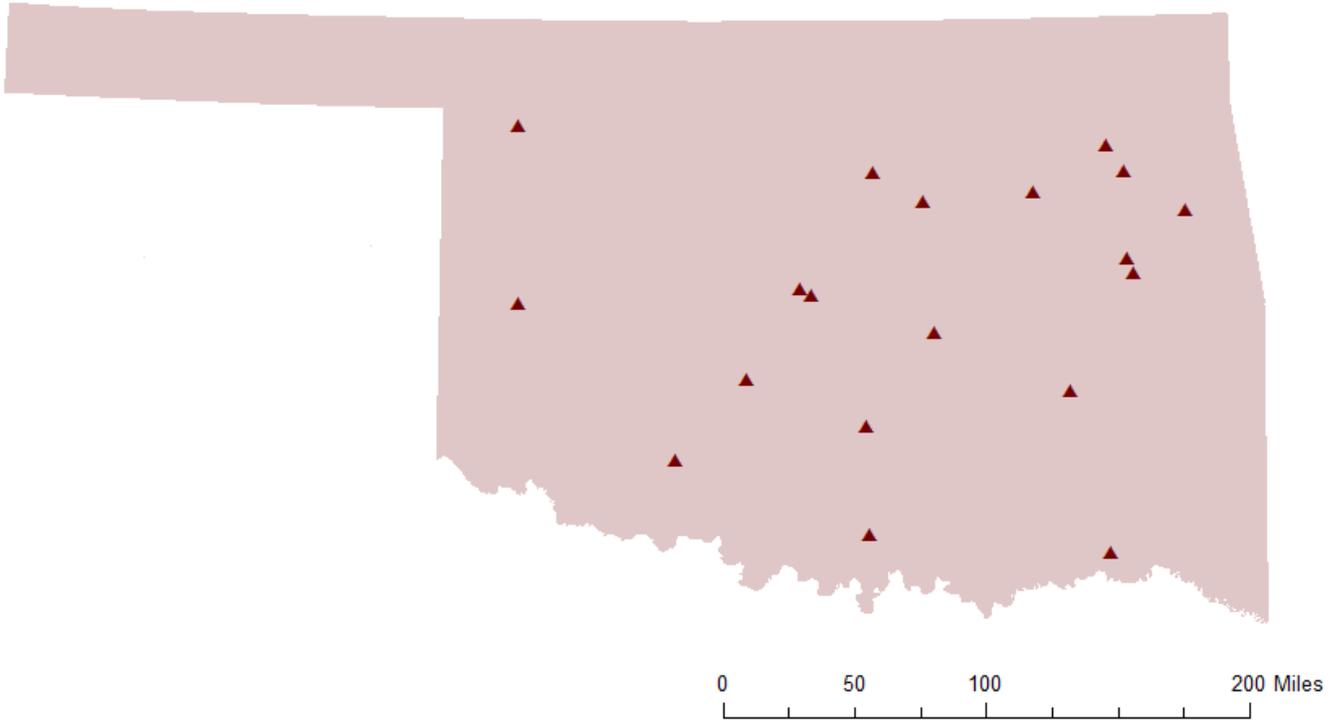
Company	Identifier	Aircraft	Speed	Range	Base city	
Air Evac	Lifeteam 70	Bell 206 LongRanger	136 mph	390 miles	Woodward	OK
Air Evac	Lifeteam 21	Bell 206 LongRanger	136 mph	390 miles	Elk City	OK
Air Evac	Lifeteam 25	Bell 206 LongRanger	136 mph	390 miles	Lawton	OK
Air Evac	Lifeteam 34	Bell 206 LongRanger	136 mph	390 miles	Wichita Falls	TX
Air Evac	Lifeteam 65	Bell 206 LongRanger	136 mph	390 miles	Sherman	TX
Air Evac	Lifeteam 26	Bell 206 LongRanger	136 mph	390 miles	Pauls Valley	OK
Air Evac	Lifeteam 36	Bell 206 LongRanger	136 mph	390 miles	Cushing	OK
Air Evac	Lifeteam 29	Bell 206 LongRanger	136 mph	390 miles	Claremore	OK
Air Evac	Lifeteam 83	Bell 206 LongRanger	136 mph	390 miles	Muskogee	OK
Air Evac	Lifeteam 6	Bell 206 LongRanger	136 mph	390 miles	McAlester	OK
Air Evac	Lifeteam 73	Bell 206 LongRanger	136 mph	390 miles	DeQueen	AR
Air Evac	Lifeteam 4	Bell 206 LongRanger	136 mph	390 miles	Springdale	AR
Air Evac	Lifeteam 22	Bell 206 LongRanger	136 mph	390 miles	Paris	AR
Air Evac	Lifeteam 22	Bell 407	143 mph	403 miles	Decatur	TX
Air Methods	Tulsa Life Flight	Eurocopter EC130	150 mph	379 miles	Tulsa	OK
Air Methods	Tulsa Life Flight	Eurocopter EC130	150 mph	379 miles	Keefeton	OK
Air Methods	Tulsa Life Flight	Eurocopter EC130	150 mph	379 miles	Pryor	OK
Air Methods	MediFlight	Eurocopter EC130	150 mph	379 miles	Chickasha	OK
Air Methods	MediFlight	Eurocopter EC130	150 mph	379 miles	Seminole	OK
Air Methods	Air Kids One	Eurocopter EC130	150 mph	379 miles	OKC	OK
EagleMed	EagleMed 8	Eurocopter AS350 A-Star	138 mph	403 miles	Stillwater	OK
EagleMed	EagleMed 7	Eurocopter AS350 A-Star	138 mph	403 miles	OKC	OK
EagleMed	EagleMed 21	Beechcraft King Air C90	275 mph	1266 miles	Yukon	OK
EagleMed	EagleMed 17	Eurocopter AS350 A-Star	138 mph	403 miles	Ardmore	OK
EagleMed	EagleMed 18	Eurocopter AS350 A-Star	138 mph	403 miles	Hugo	OK
EagleMed	EagleMed 6	Eurocopter AS350 A-Star	138 mph	403 miles	Tahlequah	OK
EagleMed	EagleMed 12	Eurocopter AS350 A-Star	138 mph	403 miles	Joplin	MO
EagleMed	EagleMed 15	Eurocopter AS350 A-Star	138 mph	403 miles	Pittsburg	KS
EagleMed	EagleMed 14	Eurocopter AS350 A-Star	138 mph	403 miles	Chanute	KS
EagleMed	EagleMed 1	Eurocopter AS350 A-Star	138 mph	403 miles	Wichita	KS
EagleMed	EagleMed 4	Beechcraft King Air C90	275 mph	1266 miles	Dodge City	KS
EagleMed	EagleMed 3	Beechcraft King Air C90	275 mph	1266 miles	Garden City	KS
AeroCare MTI		Cessna Conquest I	300 mph	800 miles	Tulsa	OK

Notes

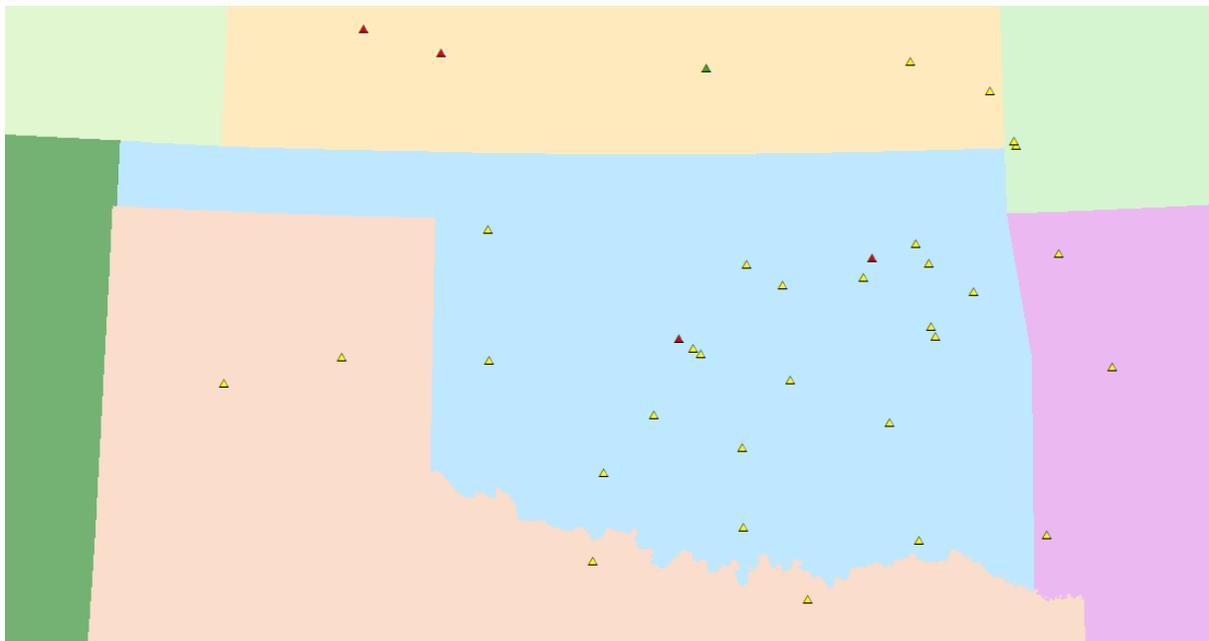
- Total rotor- and fixed-wing assets available for OK transports: 33 aircraft (29 helicopters; 4 airplanes)
- Total rotor- and fixed-wing assets based within OK: 21 aircraft (19 helicopters; 2 airplanes)
- There are cases in which Oklahoma AMT is provided by assets not shown (e.g. AMT programs in Dallas)

Mapping AMT resources in Oklahoma

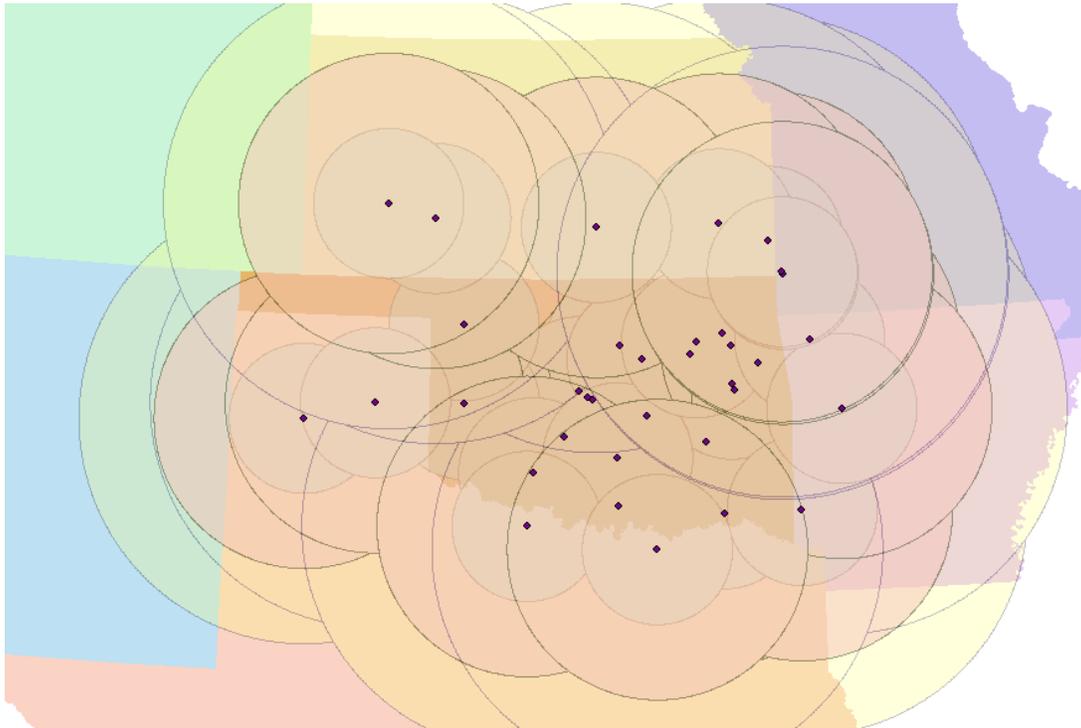
The information in the preceding table is depicted on the maps below. The initial map shows the location of helicopter aircraft resources in Oklahoma. The bottom map shows the helicopter and FW resources in Oklahoma and in border regions of surrounding states.



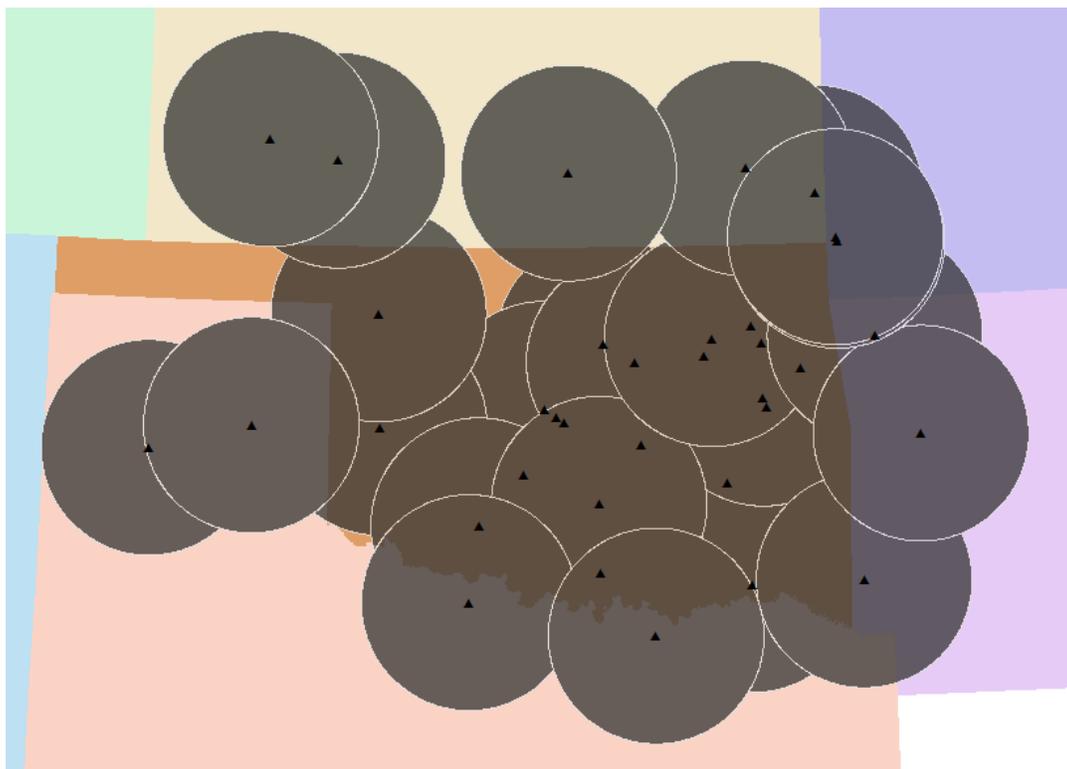
The map above depicts helicopter air medical resources stationed in Oklahoma. The map below depicts OK-area helicopter (yellow triangles) and FW (red triangles) resources.



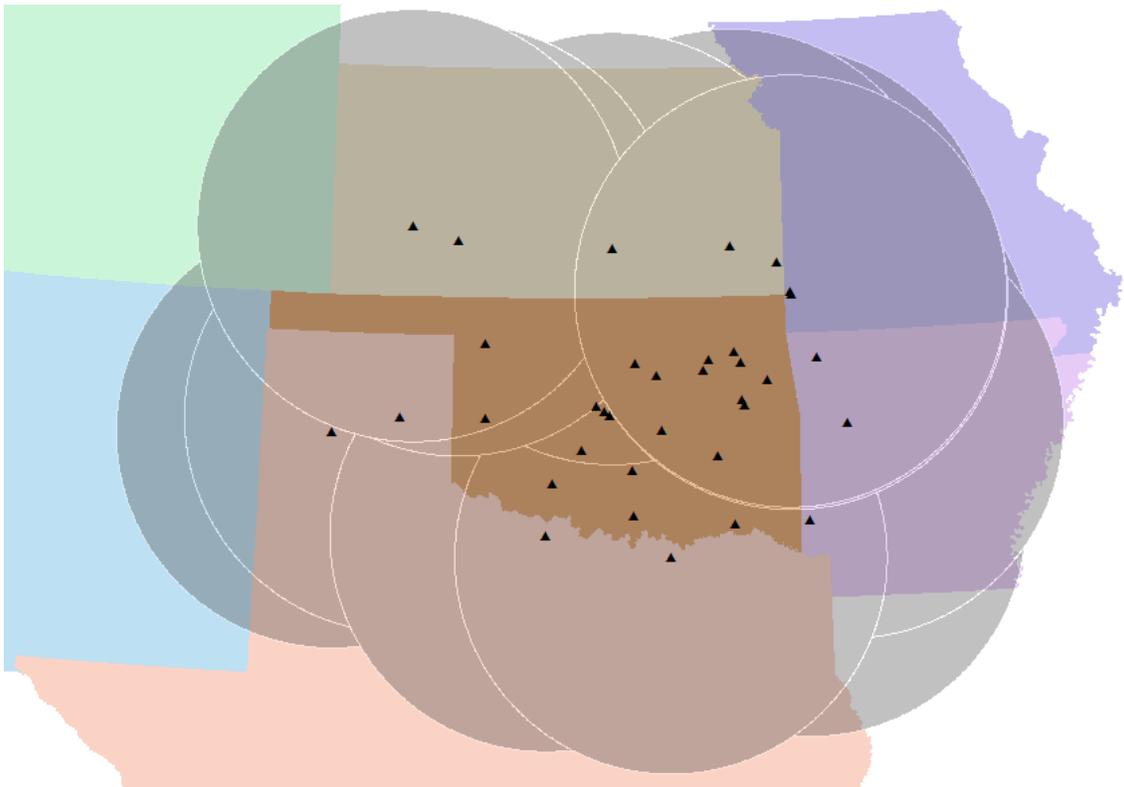
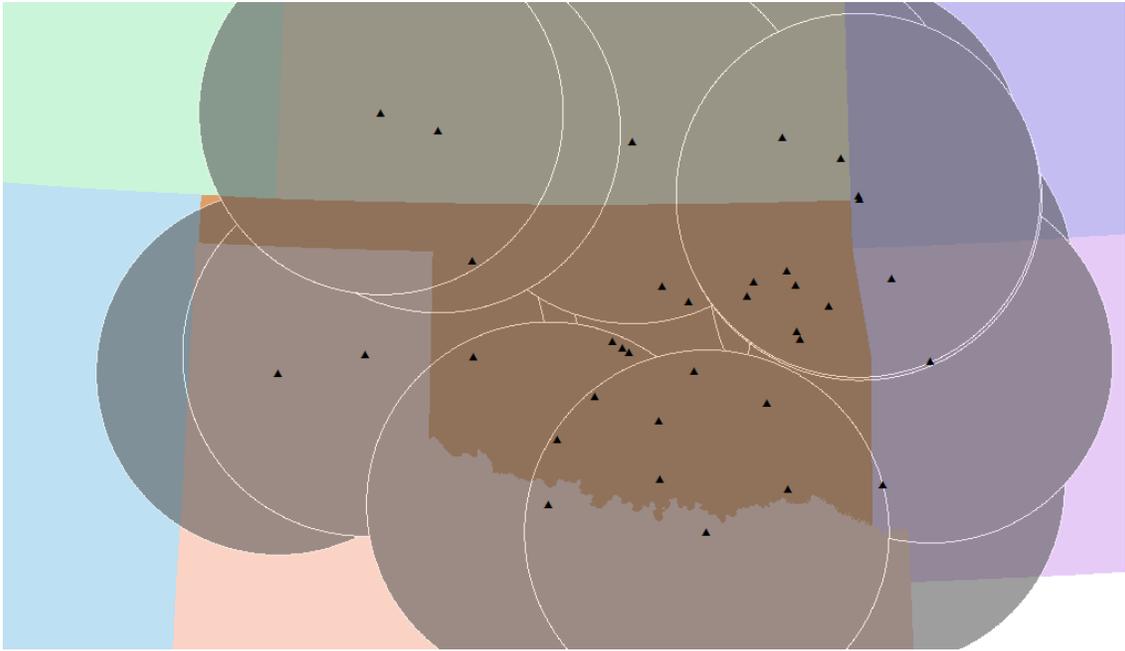
With the important *caveat* that there are many occasions in which AMT is located at a position other than “home base,” the maps on this page depict approximate flight radii for AMT resources.



Approximate from-base flight radii are shown above (30, 60, and 90 minutes) and below (30 minutes).



Maps below depict approximate flight radii (from home-base) of 60 and 90 minutes.



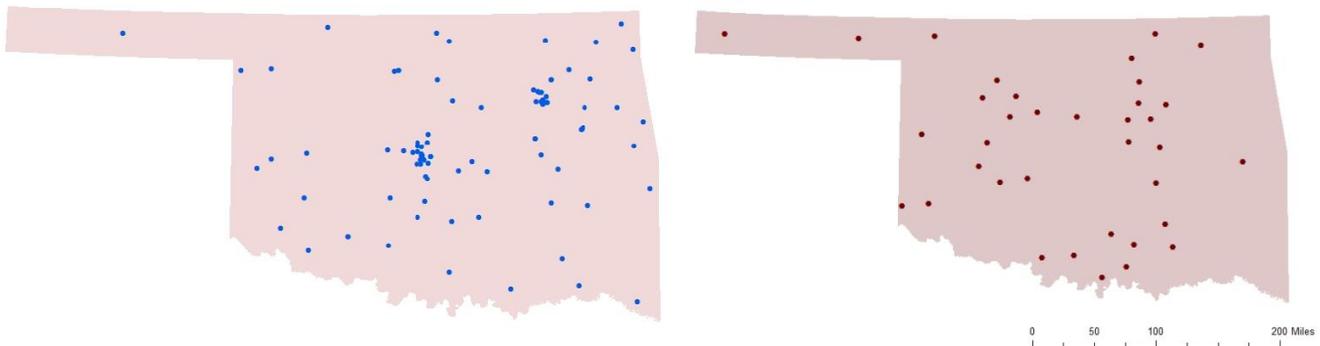
Distribution of flight volumes around the state

The next question may reasonably be, “who is doing the actual transporting, and how many patients are being transported by a given AMT base?” The following table addressing that question is based upon information provided by Kenneth Stewart PhD. The table includes Oklahoma transporting services for 2009 and 2010 (n = 19387 flights by over 40 agencies).

Agency	Calls	%	Agency	Calls	%
EM7-OKC,OK	1546	7.97	LF3-Tulsa,OK	331	1.71
LF2-Pryor,OK	1458	7.52	LF3-Muskogee,OK	327	1.69
AE6-McAlester,OK	1308	6.75	Unknown Location	239	1.23
EM17-Ardmore,OK	1104	5.69	AE73-Dequeen,AR	213	1.1
EM18-Hugo,OK	1026	5.29	EM11-Wichita,KS	193	1
EM6-Tahlequah,OK	1017	5.25	AE65-67-68-Sherman,TX	150	0.77
AE70-Woodward,OK	963	4.97	Aerocare-Tulsa,OK	97	0.5
EM8-Stillwater,OK	932	4.81	CareFlite-Dallas,TX	94	0.48
AE25-Lawton,OK	883	4.55	EM4-Dodge City,KS	86	0.44
LF1-Tulsa,OK	868	4.48	ArchAir-Joplin,MO	73	0.38
MF2-Seminole,OK	779	4.02	EM23-Liberal,KS	56	0.29
AE83-Muskogee,OK	757	3.9	AE4-Springdale,AR	53	0.27
MF3-OKC,OK	682	3.52	EM20-Wichita,KS	51	0.26
AE29-Claremore,OK	677	3.49	EM3-Garden City,KS	47	0.24
AE21-Elk City,OK	670	3.46	EM15-Pittsburg,KS	42	0.22
MF1-Chickasha,OK	620	3.2	EM14-Chanute,KS	22	0.11
AE36-Cushing,OK	547	2.82	EM16-Wichita,KS	17	0.09
AE26-Pauls Valley,OK	510	2.63	EM24-Goodland,KS	5	0.03
EM12-Joplin,MO	487	2.51	EM-Bentonville,AR	2	0.01
LF1-Muskogee, OK	453	2.34	EM9-Hays,KS	2	0.01

Oklahoma’s acute care (left) hospitals and critical access hospitals

Maps below are provided to compare previously noted AMT locations with Oklahoma hospitals.



Oklahoma’s acute care (left) and critical access (right) hospitals. AMT can be expected to be needed from any of these hospitals, which are by definition located around the state.

Aircraft considerations

With regard to the specific aircraft being used for air transport in Oklahoma, it has been acknowledged by corporate providers of HEMS services, that these airframes were chosen in part for their optimizing cost-effectiveness. Some points regarding the specific aircraft used in Oklahoma will be provided here. One goal of this discussion will be to ascertain whether there seems to be a critical need for wholesale replacement of the current (smaller) helicopter fleet with larger (more expensive) models.

The first issue to address is always safety. The question relevant to Oklahoma, is whether single-engine aircraft are inherently less safe than twin-engine helicopters. With the previously mentioned *caveat* that this report's scope does not include safety details, it is reasonable for us to point out that there is no consensus as to whether single-engine aircraft are less safe. While the issue is discussed and debated within the air medical industry, the bottom line for now is that there are insufficient data to support a definitive conclusion that twin-engine helicopters are safer. There is obvious allure to the idea that "two engines are better than one" but the fact has been pointed out to us during preparation of this report, that some crashes have been *caused* by having two engines. The safety issue is as complex as it is important. Fortunately, there is ongoing and intense government scrutiny as to how to optimize air medical transport safety. The best recommendation for now, is to follow the regulatory bodies' recommendations as they emerge.

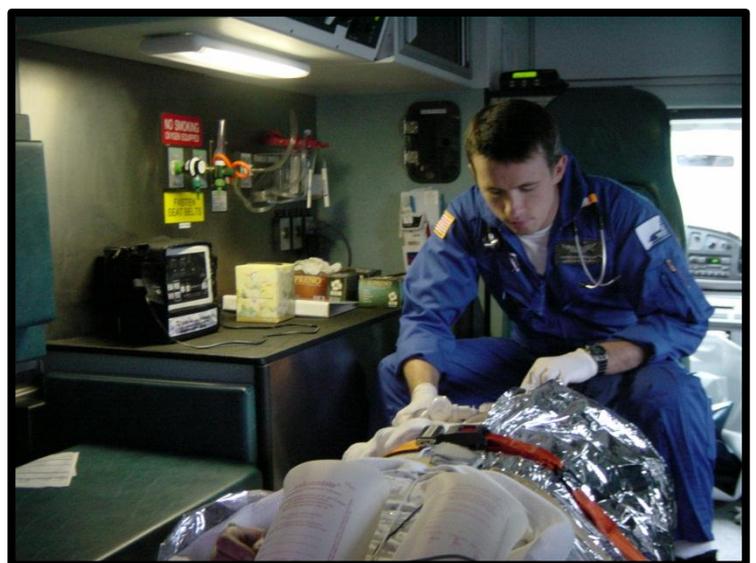
With the safety issue defined as *not* driving a decision toward or away from a specific aircraft type, the only other variables (besides cost) are space and speed. In proportion to the actual (not perceived) relative importance of these two variables, the discussion will consider space first, and then speed.

Even if single-engine aircraft are as safe as twin-engine helicopters, they are usually not as roomy. The difference may be small or even nonexistent, depending on the specific aircraft being compared. To complicate things further, sometimes larger aircraft have particular ergonomic quirks that render certain procedures more difficult than when performed in smaller helicopters.¹³¹

Some cabin images have been included in an earlier section of this report (the Section II discussion on in-cabin care). A typical interior image of an in-flight helicopter (BK-117) is provided below, next to a photo of a crew member in a ground ambulance unit.



This pair of photos illustrates differences in space between a helicopter (BK117, a mid-size twin) and ground ambulance.



One author of this report has experience with HEMS using aircraft (AS365N2 Dauphin, BK117, S-76) that are larger than those currently used in Oklahoma. It was therefore with some trepidation, that an inspection of Oklahoma's aircraft was undertaken. The results of a visit to MediFlight, with examination of the interior of the single-engine EC130's interior, were surprisingly positive. There is a reason that crew always want more space; in an ideal world there would be in-cabin room to spare. However, the EC130 and its movable stretcher base provided an ergonomic set-up that seemed quite suitable.

In fact, this report's senior author found the interior of a MediFlight EC130 far more ergonomically conducive to patient care, than the cabin of a light-twin BO-105. That said, it is true that movement from twin-engine aircraft towards more economical single-engine helicopters often means providing patient care in a smaller space – and the decrease in space can impact medical care.¹⁴¹ As mentioned in a previous section of this report, flight crews are able to work around the limitations in nearly all cases, and in some cases a larger cabin doesn't necessarily translate into easier patient access for critical procedures such as intubation.¹³¹

As long as referring and receiving EMS personnel and physicians understand that flight crews need to practice transport medicine, and this is sometimes impacted by cabin configuration, it appears that cabin space issues don't dictate a need for universal deployment of larger aircraft in Oklahoma. For cases involving extra flight crew members, or those in which extra weight is required for other reasons (e.g. certain types of equipment), there appears to be a benefit to having a larger aircraft, but the economics become complex when deciding how many of (and where) those larger helicopters need to be. Regardless of the potential basis for wishing a return to the days of larger Oklahoma-based aircraft (e.g. BK117 C1, or the new BK117 C2 – also known as the EC145), discussions with HEMS companies provided no basis for presuming that there is a plan to move back to those larger helicopters.



The interior of this EC130 operated by MediFlight (Air Methods) has workspace characterized a moveable stretcher. Air medical crew at the base reported no major problems in getting to patients for in-flight care.

In speaking with crews providing care in Oklahoma, none have expressed major distress over the aircraft they use. It is true that some of the flight crew with whom this report's authors spoke, have no experience in larger aircraft (e.g. BK-117, EC145, S-76, AS365). On the other hand, it's also true that some programs in the state used larger aircraft, before transitioning to less expensive – less expensive – single-engine models. Tulsa Life Flight had BK-117 models, including the new C2, before changing to EC130s. In speaking with a few crew (again, not a scientific sampling) they of course preferred larger helicopters but have accepted with equanimity the EC130 move. In a fashion typical of flight crew (no strangers to challenges), air medical personnel have simply adapted to the new models. As one former Tulsa Life Flight crew member put it, “a smaller aircraft that doesn't go out of business, is better than an EC145 in a program that ceases to exist.” Crews at MediFlight (formerly OU MediFlight) indicated during interviews for this report, that they felt quite able to provide excellent care in their aircraft – although many expressed interest in moving to a larger ship if the economics allowed.

The final aspect in terms of medical care and logistics, that relates to the single- versus twin-engine issue, is that of speed. There are certainly no data demonstrating differences in patient outcomes with faster helicopters. However, the importance of speed may play a role in considering cost-benefit and cost-effectiveness issues, when time-to-intervention (e.g. for primary PCI or stroke care) becomes a surrogate endpoint. The aircraft used in Oklahoma have cruise speeds in the range of 136 mph for the Bell LongRanger, to a few mph faster for the A-Star (AS350), and up to 150 mph for the EC130.

Given the relatively small differences in speed in Oklahoma's aircraft, there is no logic in arguing that the difference is critical for a relatively short transport time. However, if savings of 15 minutes directly translates into savings of 6.3 lives per 1000 ST-elevation myocardial infarction (STEMI) transports for PCI,¹⁴² then speed differences between aircraft *may* become relevant with long transport distances. In a state as large as Oklahoma, aircraft are necessarily responding from relatively far away to reach either scenes or rural/referring hospitals. It is not impossible to imagine a scenario in which the speed difference between a LongRanger and an aircraft moving 30+ mph faster (e.g. AS365N2 Dauphin, Agusta 109) could conceivably translate into earlier definitive care and thus cost-effectiveness. These time intervals are short, though, and not easy to test – and the more expensive aircraft can incur millions of dollars in additional costs.

The faster, larger twin-engine aircraft will always be preferred by any (honest) air medical crew. However, these aircraft are so much more expensive to obtain and operate, that further modeling must be executed to determine whether their additional speed and space advantages are worth the price tag.



The Agusta 109 is a notably fast light-twin helicopter; its maximum cruise speed approaches 180 mph.

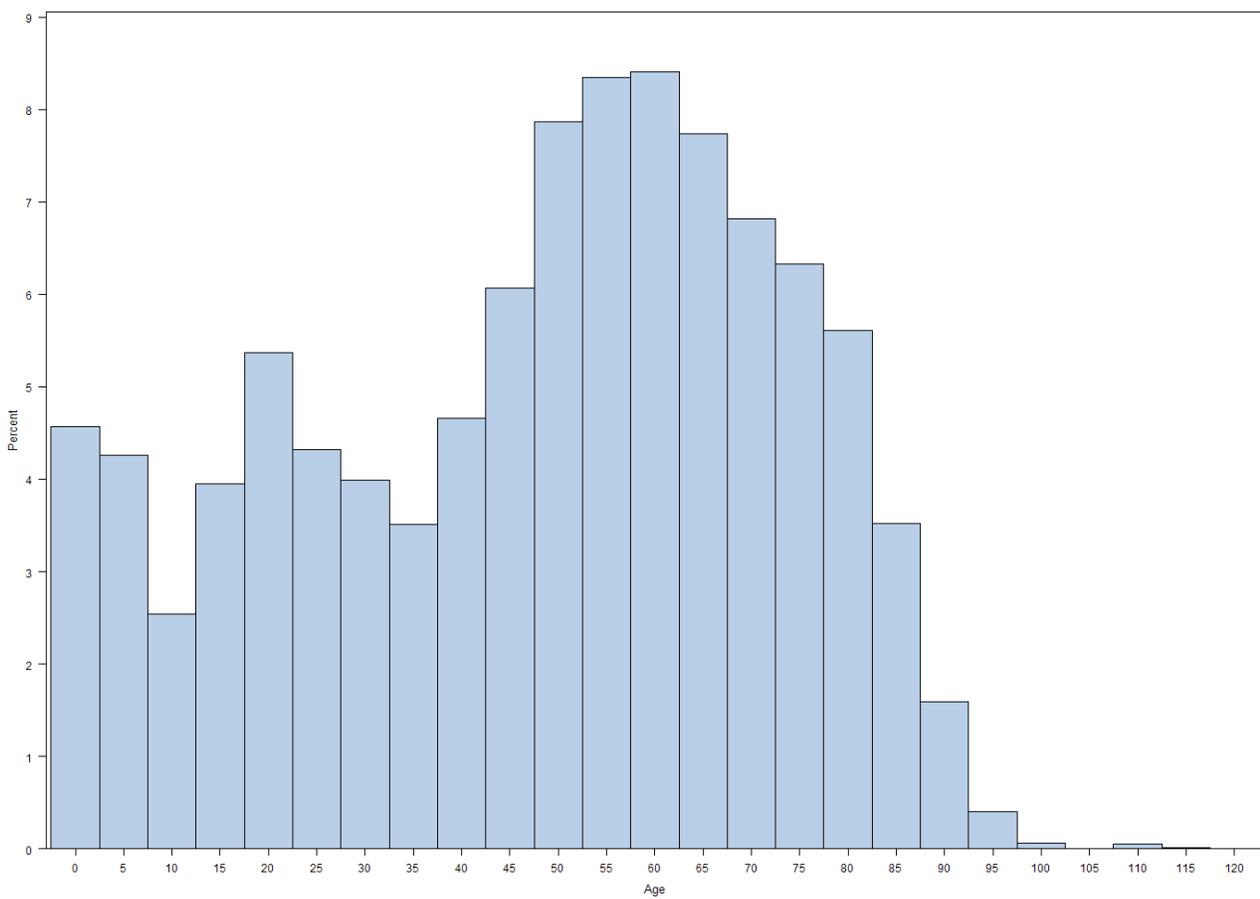
Characteristics and performance of air transports in Oklahoma

With the assistance of Dr. Kenneth Stewart at OSDH, some information about patients undergoing AMT in Oklahoma will be presented. The aim is not to present detailed breakdown of the AMT population, but rather to provide an overview of some general findings and trends. The goal of providing an overarching look must be emphasized, as precise analysis is not allowed by data composition and presentation (*e.g.* use of standard deviations for potentially non-normal data).

Patient ages

The profile of patients flown in our state begins with an age range that is broader than the traditional “trauma” subset. As shown in the histogram below, there is a spread of patients flown, and by no means are those undergoing HEMS transport restricted in age to the young-adult group traditionally constituting trauma patients.

The figure below depicts substantial numbers of patients at both age extremes. The large numbers of geriatric patients are consistent with the general aging of the population. Older patients are more likely than young adults, to have time-sensitive disorders such as stroke or STEMI. Additionally, the increased trauma and nontrauma mortality seen in older patients is likely a contributor to smaller centers’ tendency to transport geriatric patients to larger hospitals. The histogram also demonstrates a large number of pediatric and neonatal patients undergoing AMT in Oklahoma. The utility of HEMS in extending the network reach of neonatal and pediatric care, long demonstrated elsewhere, appears to be well-known in Oklahoma.



Histogram of air-transported patients in Oklahoma (courtesy of K. Stewart PhD)

Patient diagnoses

Specific information on all-patient diagnoses for Oklahoma's AMT population were not obtained for this report. A subsequent part of the discussion does include numbers on trauma patients; this group comprises nearly all scene runs, and a large portion of interfacility transports.

It seems likely that optimization of system performance would be assisted by carefully tracking non-trauma patients with time-critical disease processes. Pending that analysis, the next part of the discussion provides information on time-based performance of AMT.

Time-based performance in Oklahoma, 2009 and 2010 – Response times

As previously noted, speed is not a *sine qua non* for AMT benefit, but speed is nevertheless important in many cases. Therefore, information on AMT (usually RW) times performances is provided here. The times (again provided by Dr. Kenneth Stewart) allow both a snapshot of overall system performance, and also provide insight as to intra-state variations that may represent areas for improvement. This part of the discussion will outline the response times seen in 2009/2010 HEMS transports in Oklahoma, as identified in OSDH data.

Response time is defined as the time elapsing between initial HEMS service contact for a confirmed flight request, and helicopter lift-off. Another way to consider "response time" in the context of HEMS, is "launch time." In the analysis, response times of 0 were eliminated; these indicated cases in which data were low-quality or cases in which the helicopter was already airborne at the time of the call. Either way, the inclusion of response times of 0 would have detracted from the true goal of analyzing response times.

Data points indicating response times exceeding an hour were also eliminated. While these cases could represent important instances of failures in system readiness, the sense from those who know the data, is that there was high potential for these "long" response times to simply indicate errant data entry.

For the overall set of transports in 2009 and 2010 for which response times were between 1 and 60 minutes ($n = 14258$), the mean time was 9.2 minutes with standard deviation (SD) 6.8. The breakdown for scene versus interfacility transports is informative, although it must be emphasized that the limitation to response times 1-60 minutes renders any conclusions preliminary.

The scene response time of 7.1 ± 4.1 minutes, was significantly shorter than the interfacility response time of 9.9 ± 7.9 minutes. In this sense, "significantly" denotes statistical significance (at the $p = 0.05$ level). The large numbers in the dataset allow for generation of robust estimates for 95% CIs: scene response time 95% CI was 7.0 to 7.2 and interfacility response time 95% CI was 9.7 to 10.1. The t test comparison for these response times indicated that scene response times were significantly faster than interfacility response times ($p < .0001$).

How do Oklahoma response times compare with national benchmarks? Before this question can be answered, there must be an examination of what benchmarks exist. As for other parameters discussed in this report, there are really no truly national benchmarks. Rather, the discussion will draw upon experience and practices elsewhere, as a baseline upon which to compare and contrast Oklahoma performance.

Response times have actually been *de*-emphasized in recent years, due to safety issues. As noted earlier in this report, HEMS crews should respond quickly – but not hurriedly – to dispatch. Savings of 2-3 minutes in lift-off time, is not worth compromise on safety. Thus, the "response time" targets at many HEMS programs are actually less aggressive than they were a decade ago. A typical standard, as provided in the example dashboard later in this report, is for the interval between HEMS service call and dispatch to be <3 minutes, with the interval between dispatch and lift-off <8 minutes. Depending on how the response times are truly measured in the OSDH database (*e.g.* depending on how accurately and consistently they are recorded by various reporters), the overall response times for Oklahoma appear to be in line with those found elsewhere in the U.S.

It is true that scene and interfacility response times differ, but the 3 extra minutes required for interfacility transports are of uncertain significance. Additional attention to reasons for the difference in response times may be useful, but investigation of this difference is not, in our opinion, a high priority.

Another parameter by which response times can be parsed is diagnosis. It is tempting to break down response times for "time-critical" and "not time-critical" diagnosis. Of course, such delineation would often en-

tail subjectivity.

Since diagnostic breakdown is not feasible, and scene versus interfacility response times should ideally be the same, further analysis of response times in this report does not include stratification by diagnosis or mission type. Response time analysis incorporating these parameters may be useful for future studies.

One parameter in terms of response times that is a worthy item for analysis, is the assessment for any relationship between response times and state region. It makes sense to set a response-time standard and aim for each region to meet that standard. One of the first steps in this sort of analysis, is to determine the degree (if any) to which response times currently differ across Oklahoma regions.

While the available data preclude optimal (adjusted) comparison of response times across the various regions, some indications of possible heterogeneity are reflected in the data. Following are mean and SDs for response times in 7 of Oklahoma’s 8 EMS regions.

Region (n)	Response mean	SD
Region 1 (1925)	8.6	6.1
Region 2 (1238)	9.7	5.7
Region 3 (1287)	10.5	7.7
Region 4 (2025)	10.1	5.8
Region 5 (918)	7.5	6.0
Region 6 (no data)		
Region 7 (1994)	9.1	5.5
Region 8 (4871)	9.0	7.9

Time-based performance in Oklahoma, 2009 and 2010 – Scene times

The next timing parameter, scene time, offers similar possibilities (with similar limitations) for learning about HEMS performance in Oklahoma. On-scene times for those transports in 2009 and 2010 with reported (database) times between 0 and 120 minutes were assessed, with “scene time” being defined as the time spent by the air medical crew with the patient. (It must be acknowledged that “on-scene” times may sometimes incorporate “non-patient-care” time such as that required between landing and reaching the patient. The quality of the available data do not allow for definitive definition of “on-scene” times one way or another, as it’s likely that different users of the database handled the “scene time” definition slightly differently, regardless of the OSDH-provided definition.)

For 14846 observations in the OSDH prehospital database with scene times between 0 and 120 minutes, the mean scene time was 30.7 with SD 18.1.

Region (n)	All-run scene time	SD
Region 1 (2126)	30.1	17.8
Region 2 (1302)	26.5	12.7
Region 3 (1316)	31.5	19.3
Region 4 (2132)	30.7	16.8
Region 5 (952)	33.9	15.9
Region 6 (no data)		
Region 7 (2089)	28.2	16.4
Region 8 (4929)	32.2	20.4

The scene time summary data are in many ways like the data for response time. The overall numbers are in general line with general national norms – although of course there are differences depending on patient and hospital factors. Some programs use a cutoff for trauma scene times of less than 10, 15, or 20 minutes, depending on patient and situational factors. One of the more common is a landing-to-liftoff goal of 18 minutes or

less (see sample scorecard from Boston MedFlight, below). The summary estimate for scene responses for Oklahoma met this goal (for $n = 3371$ scene transports, the scene time mean \pm SD was 18 ± 11.6 minutes).

There does appear to be some heterogeneity across regions, for scene times. Although the clinical significance of the few minutes' difference in on-scene times is uncertain, further work in this area might focus on reducing inter-region variance in on-scene times.

As the time frame defining "on-scene" time is further defined, efforts at following and reducing those times (if appropriate) can be conducted. The 95% confidence interval for on-scene times for scene missions, includes a fairly narrow range that is within reasonable parameters: 17.6 to 18.4 minutes. Analysis of on-scene times for scene missions, depicted in the table below, does indicate some potential heterogeneity across regions. A p value for demonstration purposes alone, indicates significant difference between Region 8 and Region 5 (t test comparison $p < .0001$). This finding is not surprising, but it may be more surprising other, apparently smaller, absolute differences are also significant by t testing (*e.g.* Region 1 times are significantly faster than those for Region 2, $p = .03$).

There may be a good explanation for the 10-minute prolongation in on-scene times for scene runs in Region 5 as compared to Region 8, but the finding of such a difference should prompt further study and possible intervention. As with other inter-regional comparisons, the general goal is to investigate, account for, and where possible, correct, any variances that are confirmed as "real" with proper statistical analysis.

Region (n)	Scene-time mean (scene runs)	SD
Region 1 (323)	17.4	11.6
Region 2 (449)	19.1	9.9
Region 3 (314)	20.2	14.6
Region 4 (395)	22.0	10.1
Region 5 (142)	23.8	13.2
Region 6 (no data)		
Region 7 (363)	19.6	8.7
Region 8 (1168)	14.7	9.9

The corresponding 95% CI for interfacility transports is also narrow (a function of large n), running 36 to 37 minutes. The requirement for half-hour of "scene" time for interfacility missions may represent an area for improvement, especially for those transports involve moving patients for specific time-windowed interventions such as PCI or stroke lysis. Long experience has taught the lesson that it's difficult to get patients to be "packaged" by giving instructions in an individual case. Perhaps some standardized OSDH-sponsored educational efforts would be in order to help improve performance on this parameter.

Region (n)	Scene-time mean (interfacility runs)	SD
Region 1 (1145)	35.5	16.4
Region 2 (610)	32.2	12.0
Region 3 (699)	36.9	17.7
Region 4 (315)	33.2	11.1
Region 5 (686)	37.2	15.4
Region 6 (no data)		
Region 7 (98)	31.8	20.5
Region 8 (3688)	37.7	19.5

Time-based performance in Oklahoma, 2009 and 2010 – Total times

The final time parameter to be addressed in this report is “total time” – the time from dispatch to patient hand-off at receiving centers. This variable is closely linked to distances: the distance from which the helicopter responded, and also the distance over which the patient. Because of the initial part of the “total time” variable (*i.e.* dispatch time), the times cannot be used as a direct surrogate for transport distance.

The total times as reported here are perhaps most useful to give an idea of the time period for which a given HEMS asset is “taken out of circulation” for a transport. The overall estimate for total time for the 14,406 2009 and 2010 patients for whom data were available, was 92.4 ± 37.4 minutes. Given the large n , the corresponding 95% CI is right at the 92-minute time frame (91.8–93.0). Thus, when considered overall, it should be counted on that a helicopter dispatched for a transport, will be “out of service” (unavailable for another call) for about an hour and a half. Region-specific calculations should be made, which will assist with system organization of asset placement, management, and backup plans.

AMT dispatch in Oklahoma

As previously discussed in this report, the question of “does HEMS benefit anyone” should be modified to its more appropriate form: “For which patients will HEMS have sufficient probability of improving outcome, to warrant its use?” In practice, therefore, the question of dispatch becomes central to efforts at judicious use of the HEMS resource.

The first thing that should occur with respect to dispatch, is that *a priori* guidelines should be in place. As difficult as it is to imagine, there are areas of the U.S. where there is *no* regional structure or guidance to pre-hospital HEMS request.⁷⁰ Given the obvious inadequacy of this approach, the first step in the dispatch process, is to convene discussions that include the appropriate experts and stakeholders, and generate regional HEMS use guidelines.

For Oklahoma, there are no set and standard rules for calling for HEMS. As pointed out in a recent publication from OSDH’s Kenneth Stewart PhD,¹⁴³ there is no statewide set of guidelines for HEMS dispatch. The Oklahoma Trauma Education Program (OTEP) identifies air medical triage as an important facet of prehospital and hospital early trauma evaluation, but notes that the guidelines are set within the regional trauma advisory groups (RTABs). Additionally, each air medical service has promulgated guidelines for HEMS use. These guidelines are similar, but are not identical, and it is probably not ideal to leave dissemination of guidelines to the services that are – fairly or unfairly – perceived as “trying to drum up business.” Another perception – fair or unfair – that was encountered throughout this report’s fact-gathering, is that HEMS dispatch in Oklahoma is inconsistent, proceeding with little pre-dispatch guidance and even less post-utilization feedback regarding dispatch appropriateness.

During the preparation of this report, the authors were a bit surprised to find that cost issues were *not* the main area of debate and disagreement. Rather, there was broad concern, from Hugo to Boise City, and from Miami to Sayre, about HEMS dispatch. The questions didn’t simply revolve around the always-difficult problem of when to call a helicopter. Rather, there were just as many questions about the mechanics of calling for HEMS, and predicting when HEMS would arrive when it was called. With the repetitive but important *caveat* that this report’s preparers did not conduct a scientifically rigorous survey, some interviews on the dispatch subject yielded opinions and comments that follow.

The subject of estimated times of helicopter arrival (ETAs) arose repeatedly. Said one hospital administrator from a north-central Oklahoma region that frequently uses HEMS: “We have a major issue with the helicopter services’ estimated times of arrival. I’m not saying they’re dishonest – I’m just wondering if they can tell time.” A clinician in southwestern Oklahoma echoes the administrator’s concerns: “Sometimes we call for the helicopter that’s close by, and it doesn’t show up when we expect it. We call back and are told that it’s going to be another 20 minutes because the crew wasn’t available or they had to get another helicopter from further away. This stuff was supposed to stop a year or two ago, but these cases are within the last month. If they’re going to be that late, we’d be faster just sending people by ground.”

The remark about helicopter “source-switching” supposedly stopping a year or two ago was in reference to an OSDH policy that HEMS services are to inform requestors which helicopter asset is responding (*i.e.* from which location). The rule does make common sense, although the ETA is far (far) more important than the actual location from which the aircraft is responding. In any event, switches of aircraft after dispatch as already been effected (and an ETA has already been given) should be a seldom-occurring event. The ongoing nature of the problem is reflected in comments from ED personnel in a south Oklahoma hospital: “We’re very happy with the level of care helicopter crews provide, but we’re not sure they dispatch the closest helicopter. If their close-by aircraft isn’t available, they’ll send a distant one rather than transfer the call to a closer aircraft from a competing service.”

No one expects HEMS ETAs to be spot-on in every case. Additionally, it is understandable that in some instances an initial HEMS unit becomes unavailable to respond after initial dispatch, thus necessitating a change in asset sourcing. However, ETAs that are off by 20-30 minutes, and changes of helicopter sourcing to further-away aircraft, should be rare events that occur with justifiable reason. Even if delays are not avoidable or harmful, there is damage done to the perception of system functionality, and this damage warrants further attention.



(Left) Different telephones at a pre-hospital station in northeastern Oklahoma, provide direct lines to two regional HEMS services. Prehospital personnel describe being “on both phones at once, making sure they aren’t sending us an out-of-state helicopter for a trip that takes 20 minutes by ground.”

The dispatch confusion in Oklahoma impacts response times, in a way that’s not reflected in the data. While the preceding portions of this report have analyzed data on dispatch time and response time, those data do not include the delays that occur during the *pre*-dispatch time frame. Specifically, these are the time frames during which prehospital or hospital personnel who wish to arrange AMT, are trying to find the closest and most appropriate transporting unit. With three different HEMS services, and sometimes multiple ground EMS transport options to consider, field and ED personnel are sometimes faced with major transport logistics and communications multitasking, when time would be better spent in patient care. The following quote from a hospital administrator in southwestern Oklahoma was delivered in light-hearted manner that belied his (rational) belief that the system is broken:

“First we call Air Evac. If they’re busy, we try to figure how long they’ll be, and have them hold while we call MediFlight. Depending on MediFlight’s ETA, we may have to think about just going with EagleMed’s airplane. Of course, if EagleMed’s Yukon airplane is busy we then have to decide whether their Kansas airplane can get here faster than Air Evac or MediFlight’s helicopters.”

The dispatch issues will be further addressed in the “Recommendations” section of this report. A final thought on the subject for this portion of the discussion, summarizes the situation well. This refrain was heard over and over, from prehospital providers, physicians, hospital administrators, and just about everyone with whom we spoke: “Oklahoma needs a centralized dispatch center – one phone number – that can provide assistance with triage, transport, and destination assignment.” As a panhandle-area official put it: “State-subsidized HEMS out here would be fantastic – and state-run dispatch would be wonderful.”

Before leaving the overview of dispatch in Oklahoma, there is an additional question to be addressed: Who can call a helicopter in Oklahoma? In the past, patients who were subscribers to some of the air medical services (in particular, Air Evac) were encouraged to call directly for air transport. Discussions with senior officials at Air Evac have rendered it quite clear, that the company has evolved beyond this practice. The website of another air medical service provider points out that “EagleMed can be activated by your local EMS, Fire Department, State, County or Local Police, Hospital or your physician.” MediFlight and Tulsa Life Flight have never been “citizen-activated” so there should be no issue with patients’ self-triaging to HEMS in Oklahoma.

As noted on the EagleMed website, non-EMT responders can call HEMS. At some accident scenes, police are on-site long before any EMS providers. In a panhandle location in which the sheriffs usually arrive first, and then Oklahoma Highway Patrol (OHP), EMS has to be on-scene before HEMS is activated. Occasional panhandle law enforcement officers depart from this guideline, when there are exigent circumstances; in even the worst cases, though, OHP or sheriffs are supposed to discuss the case first with EMS before calling for HEMS.

Interviews with OHP troopers have indeed confirmed that some have called for HEMS response to some trauma scenes, but even the troopers who have exercised this authority agree that it’s generally best to have air medical resources called for – when logistically feasible – by prehospital EMS providers. Other regional Oklahoma troopers said they didn’t have the capability to call for HEMS without discussing things first with EMS. One said, “We wouldn’t use the direct-call very much, but it sure would be nice to be able to on those rare occasions.” With some OHP troopers acknowledging they are empowered to call HEMS directly, and others stating regret they lacked that capability, there is room for education and standardization to reduce confusion (and perhaps occasionally improve patient outcomes).

Overall, dispatch is the major area of potentially “fixable” problems in Oklahoma HEMS. (Cost is another area, to be discussed below, but this is a trickier problem.) The possible areas for further investigation and systems modification to optimize dispatch are discussed in the report’s “Recommendations” section.

Use of HEMS for long-distance transports from rural Oklahoma to city-center hospitals

As previously mentioned, one of the major uses for HEMS in a rural state such as Oklahoma, is the fact that ground transport distances can be prohibitively long. This has deleterious effects on the patients, the ground EMS services (in terms of finance), and even the rural-area citizens who are left with thinned (or absent) ALS coverage during their only unit’s round trip to Tulsa or Oklahoma City.



At locations such as Sayre, HEMS provides a highly valued capability for rapid patient transfer to higher care.

During this report’s interviews, the “helicopters for long-distance to preserve EMS” issue came up again and again; it was mentioned by both prehospital and hospital-based personnel. The salient points about this subject have already been mentioned, in an earlier section in this report dealing with HEMS in general (the problem is nationwide). Following is a relevant summary quote on the subject, from a senior administrator at an isolated northwestern rural hospital:

“I’ve been here 30 years, and I can tell you that it takes forever – almost always 2 or 3 hours – to get a ground ambulance here for interfacility transport. The problem is lack of EMS coverage. Our plan is to call for an ambulance from the neighboring county, and when that ambulance gets to 20 minutes’ distance from here (so it’s available to respond as back-up EMS), we send our ground unit. We have to do this for every ground transport, because otherwise we’re out of any ALS coverage for the 5 hours it takes our ALS to get to and return from Oklahoma City.”

It’s not necessarily a good or bad thing that HEMS is being used to “back up” ground ALS coverage in many parts of Oklahoma. For the purposes of this report, the authors wish to emphasize that the occurrences are common, and that they should be acknowledged as a significant part of the current system. Whether the goal should be to endorse or restrict that HEMS use, is of course up to others. This report’s later section dealing with recommendations, further expands the authors’ opinions.



One of this report’s authors photographed this wildfire during a trip to interview western Oklahomans for this project. Nearly 20 miles down the highway, the author witnessed firefighter response units proceeding toward the (far-away) scene. In regions that are this isolated, it seems highly likely that HEMS represents the most cost-efficient mechanism to “cover” rural Oklahoma’s occasionally critical needs: rapid access to high-level care, and expedited transport to major hospitals.

Utilization review (UR)

This topic has been previously mentioned in the report. In this part of the discussion, some additional aspects relevant to UR will be mentioned.

There is a system by which UR can be initiated for any deployment of AMT. As pointed out by Dr. Peter Hedburg, then-Medical Director of Bryan County EMS, in the *Durant Daily Democrat* (5/14/2008), any person can initiate a question to the state advisory committee that provides oversight for trauma transports. There doesn't appear to be any such mechanism for cardiac, stroke, or any other types of transports.

While some mechanisms for UR are in place from both the state perspective and the perspective of at least some HEMS providers (see above), no evidence for application of this UR process was identified during interviews for this report. It should be stressed that the sampling of prehospital and ED providers was not scientific, and certainly incomplete. It is nevertheless a bit troubling that in speaking with dozens – if not scores – of individuals we never heard of a case where the state or the HEMS program gave negative UR feedback. Those cases must be extant, but the process appears to occur quietly. This would be understandable, given the importance of not appearing to be admonishing prehospital personnel who are trying to make the best decisions for their patients. It's also understandable that physicians as a whole, don't often take back-end criticism very well; the risk of them "taking their HEMS business elsewhere" was mentioned and is probably justified.

It's understood that some of the UR unease may be due to "sampling error" in the interviews for this report. As mentioned elsewhere, there are data from at least one AMT service (accepted for publication in *Pre-hospital Emergency Care* but not yet in print), that indicate very low rates of noncompliance with national-level (CAMTS) guidelines for HEMS use.

An additional question that arose during this report's interviews, was the fact that UR isn't including patients who get multiple transports. In a rural eastern section of Oklahoma, prehospital providers contended that "many patients we fly out, just stop off at one hospital and then get flown again. Since the first stop-off hospitals tend to be in Arkansas, no one tracks the problem." Data-gathering identified intermittent availability of certain subspecialists (e.g. neurosurgery, plastic surgery) at initial receiving centers as one cause of secondary transports after an initial flight. Another problem reported by southeastern Oklahoma EMS providers is the fact that, "almost every day, there comes a time in the afternoon or evening where there are just no beds available. Patients are then flown to the first hospital and then flown again to Tulsa."

Policy shouldn't be changed or generated based upon anecdote. That said, some statements from experienced prehospital providers with years of HEMS use, were telling. Said one prehospital provider who's been in Oklahoma for over two decades' service in varying eastern and western Oklahoma regions: "I've never heard of any inappropriate flights. I don't think overutilization is a problem. With that being said, I can't remember that we've ever, ever had any feedback about helicopter-calling from the trauma centers, the state, or the air transport folks. If any utilization review is going on, it's not including us. We've never gotten any feedback one way or the other."



Burns and hand injuries are examples of cases that sometimes require transport by either air or ground, to assure appropriate care is accessed.



AMT and communication in Oklahoma

Regardless of the system for determining who can access HEMS, and when helicopters should be called, the capability for reliable communications is important. This part of the discussion will highlight some findings and possible questions, related to communications issues we identified during the project.

One item that came up, was the fact that sometimes rural Oklahoma scene responders are not able to communicate – with anyone. While generalizations should not be overextended, it appears that along the major interstate highways (where much trauma occurs) there are no communications problems. Once off the beaten path, however, prehospital personnel identified some holes in communications coverage. In the southeastern corner of the state, for instance, prehospital personnel reported “there’s a lot of dark territory. Sometimes we have to ride 15-30 minutes just to get to pavement and cellphone access.”

As they tend to do for many problems, prehospital providers tended to “roll with the punches” on the communications issues. In the panhandle, for instance, it was reported that “the 450 system is used a lot here, and communication isn’t any problem – if we’re in range.” The concept of being able to communicate “if in range” is not new to prehospital personnel, but it is important to assure that when the helicopter is approaching there is clear capability for communications between ground and air EMS.

In western and central Oklahoma, this report’s authors encountered no reports of prehospital personnel having difficulty communicating with approaching HEMS units. In northeastern Oklahoma, however, there was a hint of a potential system problem. Some prehospital personnel expressed understandable concern that, because an out-of-state HEMS service (ARCH, from Joplin) did not have 800-band capability, they couldn’t communicate with approaching AMT units. A regional EMS chief said the issue appears to be ARCH’s inability to “work with Tulsa to get authorization to use the frequency.” This seems a potential problem, as noted by the EMS chief: “When ground personnel can’t talk to the helicopter that’s landing on their scene, it’s a bad thing.”

OSDH personnel have indicated that, if HEMS is called, they must coordinate with ground EMS prior to landing. This coordination actually varies, and in some cases is limited to notification of landing. It must be stressed that the details of communications engineering are beyond the scope of this report, but the issue is highlighted if for no other reason than to allow others to investigate and see if there are problems.



(Left) As HEMS approaches an LZ, the ability of air and ground personnel to communicate is critical, from the perspective of safety as well as for patient care.

Of course, there is more to communication than equipment. As is the case with other arenas in medicine, communication is both a potential strength and weakness for any process. As an example of a non-technical communications issue, the following quote from a major hospital’s CEO is illustrative: “We never know when they’re going to get here, or even if they’re really coming by helicopter. Sometimes we think the helicopter is bringing someone, and then we’re waiting on them and then only later find out that they are coming by ground due to helicopter unavailability or weather. One thing we really need from the helicopter services, is better information such as reliable ETAs.” Again, this was just one quote, but it does seem possible that the current systems for transport-related communications could be improved.

The more attention anyone pays to communication, in just about any endeavor, the more important this subject appears to be. The overarching finding in this report, with respect to communication, is that it’s not consistently identified as impairing outcomes but that there is some potential room for improvement. Efforts may be well-directed towards optimizing information exchange for both scene and interfacility flights. The results would have favorable impact on both aviation safety (for scene runs) and medical care.



The scene is not the only venue in which good communication is desirable. Updating of receiving facilities with patient and logistics information is regularly identified as a “best practice,” allowing those centers to coordinate medical resources and streamline care upon patient arrival.

HEMS and trauma care in Oklahoma

The trauma care system in Oklahoma has been assembled with much hard work on many fronts. There are well-defined “trauma regions” in the state, with regional governance activities on an ongoing basis. In addition to the trauma regions, there is a central referral center, the Trauma Referral Center (TReC), that serves as a clearinghouse for trauma consultations and referral assistance. A statewide trauma education program (OTEP) has been recently completed, to assist in educational efforts guiding prehospital and non-trauma center hospital providers with trauma decision-making. A number of state-level regulators and advisory boards meet on a regular basis, to review and “QA” the state’s trauma system. In short, it appears that trauma care has been effectively advanced in Oklahoma, through admirable cooperation between state officials, hospital administrators, physicians, prehospital personnel, and others. The main job left at this point seems to be the closure of whatever gaps might exist, between the trauma plans’ intent and their actual execution by on-the-spot providers.

Trauma centers in Oklahoma: The AMT perspective

When assessing trauma regional organization from the AMT perspective, one of the first questions is: Where are the major trauma centers? The answer, for Oklahoma, is: Oklahoma City and Tulsa. This report is not the place to address trauma center needs for the state. However, it does seem fair to point out that during interviews for this project, the authors frequently encountered individuals who felt that Oklahoma doesn’t have a “full slate” of American College of Surgeons (ACS) trauma centers. In fact, only OU Medical Center (ACS Level I) and St. John Medical Center (ACS Level II) are ACS-certified – and SJMC has been certified only for a few years.

Certainly, there are other hospitals that serve as receiving centers for major trauma: Saint Francis Hospital in Tulsa is a state-level certified Level II facility. Occasionally, when OU Medical Center is on divert, other hospitals in Oklahoma City take trauma patients. We understand the trauma center designation and resource-allocation issues fall outside this report’s scope. However, as AMT system planners, we can’t help remark that we agree with others (e.g. hospital administrators, physicians, EMTPs) who’ve indicated desire for our state to somehow get the resources to “grow” the Oklahoma trauma system’s capacity for high-level trauma care.

The reason for initiating the trauma discussion with focus on receiving centers, is that the HEMS patient population is by tradition, largely constituted of injured patients. The more centralized trauma care is, the more critical it is to have capabilities to quickly move patients to those central trauma centers. Of course, the need for speed must be balanced by judicious resource allocation in a healthcare system in which dollars are stretched.

As noted previously in this report, there are multiple factors that play into the “appropriateness” judgments about HEMS response. The “golden hour” concept has now been around sufficiently long for its scientific basis to be questioned, as the pendulum swings back and forth on the issue, but no one argues that time isn’t important in those with severe injuries. As stated by trauma surgeon Dr. Peter Hedburg, then-Medical Director of Bryan County EMS, in the *Durant Daily Democrat* (5/14/2008), HEMS time savings remain critical here:

“Through the years I’ve been involved with trauma care, I have seen significant changes in the country’s trauma systems and our ability to save lives and limbs after injuries. One of the most important improvements is a more robust helicopter system which can transport patients to a facility appropriate for their injuries in a time as close as possible to the all-important ‘golden hour’ after the incident. This is particularly critical in a rural environment where local facilities can not provide care for all injuries 24/7/365.”

Trauma triage in Oklahoma

Given the available data, it seems difficult (or impossible) to track triage appropriateness with precision. The lack of state guidelines means that the regions and/or HEMS services generate their own recommendations. Having a situation in which guidelines for use are disseminated from more than one direction has been identi-

fied by many we interviewed, as a potential area for confusion. The actual difficulties have been minimal, according to those we interviewed, but digging further into the Oklahoma trauma triage question uncovered some unsettling opinions. These opinions, which deal with the lack of feedback to prehospital and ED “triagers” to HEMS, have been outlined in a previous part of this report.

The difficulties inherent to precise trauma triage have also been addressed in an earlier portion of this report. In Oklahoma, the triage problem is not much different than it is elsewhere: trauma triage remains an imprecise operation, with high stakes on either side (overutilization and overtaking of trauma care resources including HEMS, versus worsening in patient outcomes due to underutilization).

As previously noted, trauma surgeons have written that helicopters allow rural Oklahomans to benefit from high-level trauma care that they would not otherwise be able to access in timely fashion. Dr. Hedburg also wrote in the same letter, that “Our goal is perfection, but since we know that is not absolutely achievable, we would rather err on the side of occasional overuse than underuse where a life or limb might be lost by the error.”

Trauma destinations in Oklahoma

In Oklahoma, trauma destinations are clearly established by existing guidelines. There seems to be little if any doubt, in any location of the state, where the “system” wishes to have patients go. This is presented as a “positive” finding, for this report. There are some occasional bumps in the system, but the hard work in establishing Oklahoma’s trauma system is reaping rewards.

One area of interest in terms of trauma destinations, surrounds the fact that some patients who are undergoing HEMS transport to a distant center, may not need air transportation at all. It does seem true that, once a patient is undergoing HEMS transport, a Level I or Level II center will usually be the logical destination – but some patients are perfectly suitable for ground transport to Level III hospitals, as outlined in the current destination protocols for the various regions.

As previously mentioned in this report, the state’s limitation in locations of Level I or II care (*i.e.* in just two cities in a large state) does place some stretch on system capabilities. The trauma designation and destination issue is larger than this report, but any planning to expand the state’s trauma system should include consideration of attendant costs (or cost savings) reaped due to the effects of expansion on HEMS.

Given constraints of time, economics, and other resources (*e.g.* physicians), it seems unlikely that there will soon be a major change in the trauma center status of Oklahoma. Pending any developments along the lines of growing the trauma system, it is advisable to adhere to standing recommendations of the Oklahoma trauma triage system; those recommendations include guidance as to which patients are suitable for Level III hospital care (and therefore would not likely benefit from HEMS transport).

This report is not intended to definitively outline the controversy as to “inclusive” versus “exclusive” trauma systems, but it is important to acknowledge the debate and the potential impact on systems planning. In fact, the literature on direct transport from scenes to trauma centers (which has been addressed in detail in an earlier section of this report) includes data from Oklahoma and OSDH. One study which adds significantly to the information about direct trauma center transport, is the *Journal of Trauma* paper from Garwe *et al*, who found that “severely injured patients should be transported directly to tertiary trauma centers.”¹⁴⁴

The most recent data from Oklahoma (Stewart *et al*,¹⁴³ published the month of this report’s final preparation) support the concept of getting patients directly from trauma scenes to trauma centers. The “bottom line” for this study, was that after adjusting for propensity for HEMS use (calculated in a logistic regression model), RTS, ISS, and distance, HEMS was associated with a 33% mortality reduction. Using the actual numbers in Oklahoma for trauma registry patients, the mortality reduction corresponds to roughly 2.4 lives saved per 100 HEMS transports. The fact that this number is squarely in the range of the existing literature (as outlined earlier), supports a notion that HEMS triage “efficacy” in Oklahoma is generally in line with that of the rest of the country (and indeed the world).

It does not appear that there are sufficient data available for analysis at this time, that can draw defini-

tive conclusions about the level of “inclusivity” that would be optimal for Oklahoma’s trauma system. The previously cited work by Stewart *et al* points the way to next steps. A detailed analysis of “direct-to-trauma-center” HEMS operations would need to include myriad factors, ranging from cost savings from prevention of repetitive imaging, to costs incurred by stretching resources at receiving centers. Oklahoma does appear, based upon the data that exist and the interest and experience at OSDH, to be in a prime position to be a leader in the next phase of this type of trauma systems research.

Trauma transport numbers from trauma registry

The remaining portion of the trauma discussion for Oklahoma HEMS is based upon data provided from the OSDH trauma registry (courtesy of Dr. Kenneth Stewart). The data cover the years 2009 and 2010, and include all registry-entered cases. The initial analysis addresses some demographics and acuity; the “endpoint” of 24-hour discharges is addressed next.

The overall number of trauma transports for Oklahoma is provided in the table below. The table also provides information categorizing cases as scene or interfacility missions. This information is intended as a “snapshot” of what’s currently occurring in our state.

Transports		N	Category n	Proportion
Total trauma registry flights		3074		100%
Scene flights		1547		50.3% of 3074
	ISS <9		200	12.9% of 1547
	ISS 9-15		528	34.1% of 1547
	ISS 16-24		425	27.5% of 1547
	ISS >24		394	25.5% of 1547
Interfacility flights		1527		49.7% of 3074
	ISS <9		421	27.6% of 1527
	ISS 9-15		530	34.7% of 1527
	ISS 16-24		309	20.2% of 1527
	ISS >24		267	17.5% of 1527

Analysis of the ISS casemix comprising the combined 2009-2010 data above, reveals a statistically significant association ($p < .001$ for chi-square assessment of the 4x2 table) between mission type (scene or interfacility) and ISS grouping. The data are interesting in that they reveal a *higher* ISS for scene transports, as compared to interfacility transports. The latest high-quality data seem to indicate that HEMS is useful when ISS exceeds 11.⁷¹ Since this breakpoint is not available, use of the more usual (and more conservative) breakpoint of ISS exceeding 15 yields further results of interest.

Of the 1547 scene missions, ISS exceeded 15 in 819 cases (52.9%); the corresponding number for the 1527 interfacility transports was 576 (37.7%). Univariate analysis confirms this difference as statistically significant (chi-square $p < .001$). The risk ratio with 95% confidence interval, for chances of calling for HEMS for a patient with ISS under 15, was 0.76 (95% CI .71 to .81). This means that interfacility transported air medical patients were about 25% less likely to be “significantly injured” (as defined by ISS at least 15).

Information for some 2009 and 2010 parameters are available, from the trauma registry data. One of the more important relates to the utilization review parameter assessing whether patients transported by HEMS, are discharged from the receiving hospital within 24 hours of arrival. While this parameter has some disadvantages,⁷² it is a reasonable dashboard item that ought to be followed within a system. The table below provides information on 24-hour discharges, as compared for scene and interfacility transports, occurring in 2009 and 2010.

24-Hour discharges		N	Category n	Proportion
Total trauma registry flights		3074		100%
2009 flights		1454		47.3% of 3074
Scene		738		50.8% of 1454
	24-hr d/c		55	7.5% of 738
Interfacility		716		49.2% of 1454
	24-hr d/c		110	15.4% of 716
2010 flights		1620		52.7% of 3074
Scene		809		49.9% of 1620
	24-hr d/c		41	5.1% of 738
Interfacility		811		50.1% of 1620
	24-hr d/c		114	14.1% of 811

Analysis of the information in the table above, reveals no associations that reach statistical significance at the $p < .05$ level. These findings included a lack of significant change in overall rates of 24-hour discharges between 2009 and 2010 (11.4% in 2009 and 9.6% in 2010, $p = .11$). For both scene and interfacility transports, the rates of 24-hour discharge slightly declined. The interfacility 24-hour discharge rates declined from 15.4% to 14.1% ($p = .47$). For scene transports, the decline (from 7.5% to 5.1%) came quite close to reaching statistical significance ($p = .052$). When 2011 data become available, OSDH will be in good position to use specific biostatistical testing (e.g. Cochran-Armitage 1 *df* testing) to assess whether the rates of 24-hour discharges are truly decreasing with passage of time.

How do the 24-hour discharges compare to national goals? As is the case for most other criteria, there are no concrete “gold standards” for this parameter. Commonly used goals are for fewer than 15% of scene runs, and fewer than 10% of interfacility runs, to be discharged within 24 hours. By these standards, Oklahoma is definitely doing quite well on the scene front, and acceptably well on the interfacility front.

The 24-hour discharge issue is, of course, integrally related to triage and dispatch. These topics have been discussed earlier in this report, but as is the case with the issue of direct transport, it is important to acknowledge the existence of Oklahoma-based data. A group led by Kenneth Stewart PhD found that “with the exception of Glasgow Coma Score <14, injury etiology was more strongly and consistently associated with the decision to transport by air than were patient-related factors.”¹⁴⁵



In Oklahoma City, the major trauma center (OU) is backed up by other hospitals when the Level I's resources are stretched. It seems likely that any HEMS triage changes that increase the load on OU, will risk overtaxing that institution and the system.



HEMS and cardiac care in Oklahoma

The first diagnosis to consider when thinking of HEMS patients, has historically been “trauma.” Increasingly, though, nontrauma patients are comprising a major portion of AMT patients. The data for this report, as previously presented (overall patients and trauma patients) render it clear that nontrauma patients comprise many HEMS transports. No specific diagnostic registry-type information was obtained for this report, but many of those nontrauma patients are doubtless cardiac flights (others are for stroke, considered in the next section).

Oklahoma AMT and potential cardiac benefits

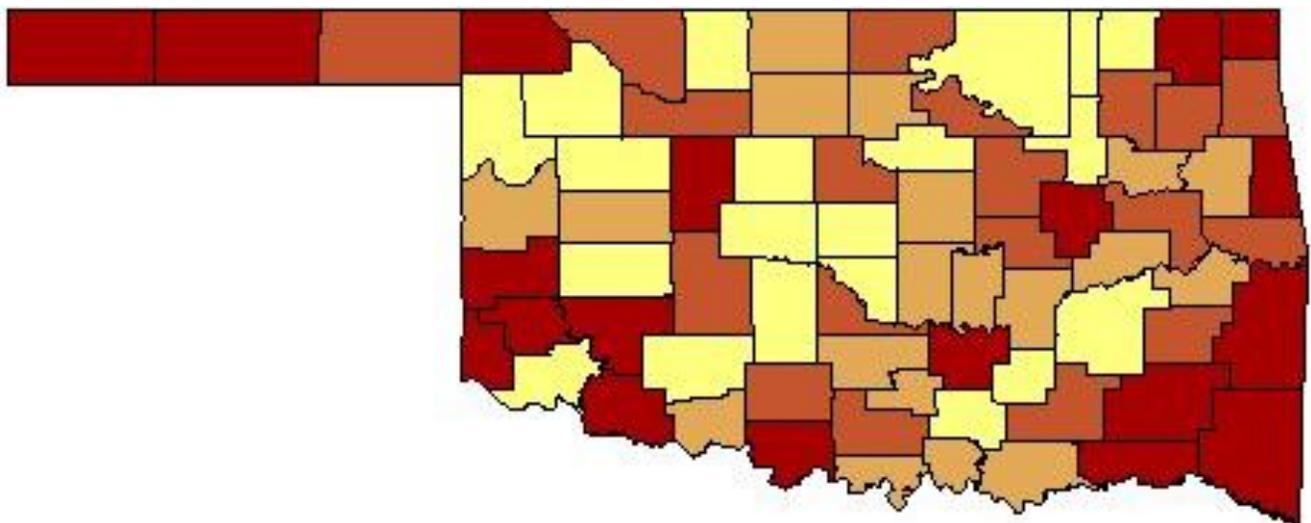
There are multiple potential benefits for AMT in cardiac patients. Therapeutically, there are occasional cases in which HEMS crews can correct care deficits at referring hospitals. Data describing some of these deficits do exist, as presented in abstract form (at the Society of Critical Care Medicine’s 2001 meeting: Orf J, Wedel S, Thomas SH, “Aspirin administration and right-sided lead EKG performance in cardiac patients undergoing critical care transport: Room for improvement in the referring hospital ED”).

AMT can also be useful for patients whose cardiac conditions simply can’t be handled locally. There may be complicated rhythm disturbances, persistent congestive heart failure (CHF), or a variety of other situations involving cardiac disease that requires rapid high-level transport. Patients with high acuity, including those on intra-aortic balloon counterpulsation, have been transported by HEMS crews for decades.^{146,147}

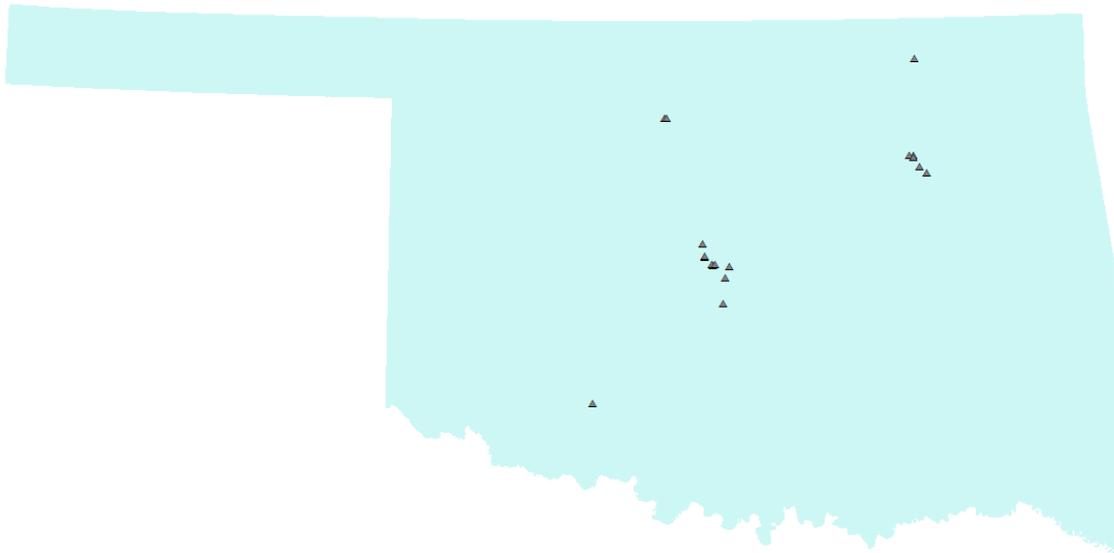
Oklahoma’s helicopters are well positioned to participate in the regional care systems for a variety of heart patients. Further analysis of HEMS’ role in cardiac care may focus on improvement – both mortality and morbidity – in outcomes for serious conditions such as CHF.

One of AMT’s most important, and certainly one of the most easily measured, cardiac care contributions is time savings. Particularly in the case of patients needing time-windowed interventions such as primary PCI, the degree of time savings (or the lack thereof) should inform decisions as to AMT use.

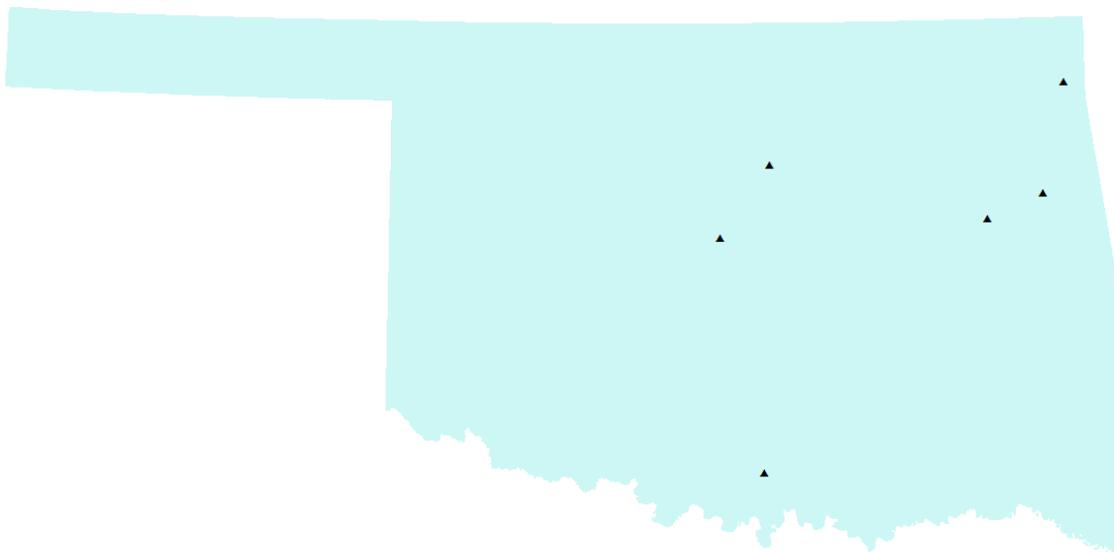
The rural nature of Oklahoma means that there are many parts of the state that are quite far removed from PCI suites. During the daytime hours, there are a few additional PCI labs open. The maps below depict acute coronary artery disease mortality in Oklahoma (below) and (on next page) locations of the “all-hours” and “day-time-only” PCI labs in Oklahoma. It’s notable that cardiac mortality is high (the first map is “reddest”) in those areas with limited access to PCI.



Acute myocardial infarction mortality in Oklahoma (darker = worse), 1999-2007 (courtesy of Dr. Tim Cathey)



All-hours (above) and daytime-only (below) PCI centers are depicted in these two maps. HEMS may be a mechanism to “equalize the colors” on the preceding page’s map, by better extending the reach of these PCI centers to the areas of Oklahoma with the highest acute STEMI mortality.



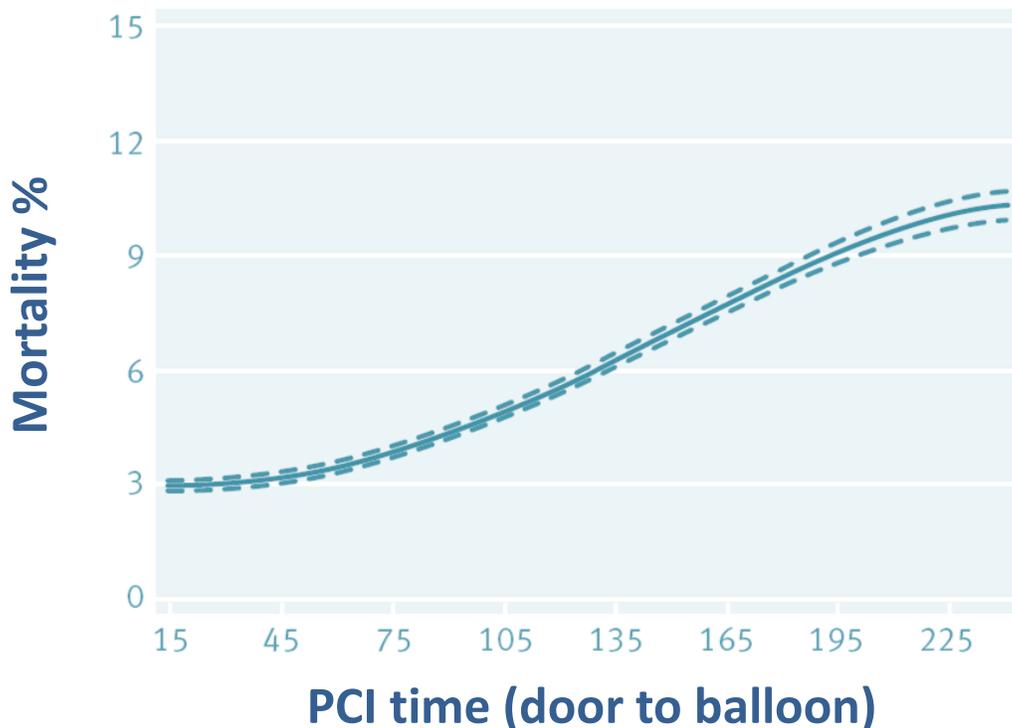
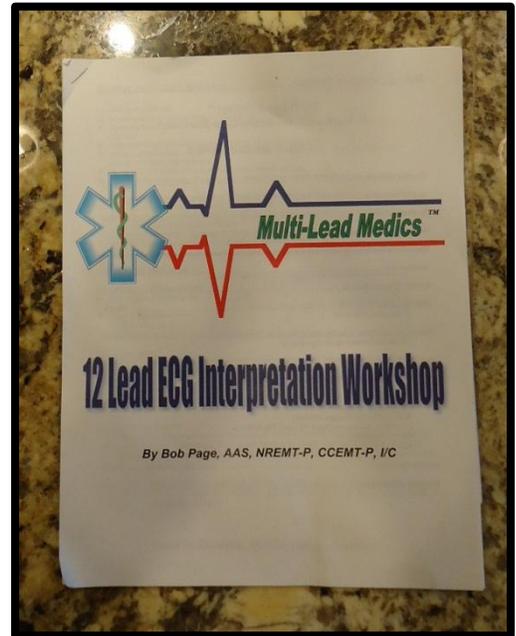
Potential benefits for HEMS in Oklahoma may be similar to benefits reaped in other rural states. An excellent recent example is found in a recent report from Kentucky.¹⁴⁸ In the northern Kentucky case, a helicopter was dispatched to a STEMI scene (prehospital diagnosis of STEMI was made by paramedics), resulting in savings of 25 minutes’ pre-PCI time. Time savings doesn’t require HEMS scene response and direct transport to the PCI suite (although this is likely the fastest approach). The literature also demonstrates that prehospital EKG interpretation by those with training similar to that in some areas of Oklahoma, can result in earlier helicopter dispatch and PCI suite preparation to receive patients, even when those patients initially stop off at a local rural

hospital (for confirmation of the prehospital EKG read and institution of some basic therapy).¹⁵

Important cardiac-patient time streamlining is possible in Oklahoma. More and more prehospital providers are training, using programs such as one used in northeastern Oklahoma and depicted in the figure at right. At minimum, the EKG training is allowing prehospital providers to obtain and interpret EKGs for acute ischemia of a magnitude warranting primary PCI (*i.e.* STEMI or no STEMI).

Interviews for this report found that EMS personnel believe – with good reason, based upon the literature – in the time-savings possibilities attendant to prehospital identification of STEMI and immediate transport (or HEMS dispatch) for primary PCI. In many isolated regions of Oklahoma, the very early identification of STEMI could potentially save substantial amounts of time and streamline PCI. As emphasis shifts from “door to intervention” to “symptom onset to intervention,” the capability for acting on prehospital providers’ EKGs is becoming more and more important. Oklahoma appears to be in prime position to benefit from these advances.

When considering potential HEMS benefits to cardiac patients in Oklahoma, it should be remembered that time-savings advantages are not limited to simply getting patients to PCI within the traditional 90- or 120-minute benchmarks. Data from a *British Medical Journal* article²⁹ confirm, as shown below, that the benefits of time savings are spread over a large span of time-to-PCI. In fact, the inflection points of the time-savings benefit curve are close to the 45- and 225-minute marks. This means that, theoretically, time savings associated with more-rapid transport to PCI could be accrued along a breadth of time-to-PCI intervals. Depending on the absolute magnitude of benefit, more-rapid transport to PCI could result in significantly improved outcome as long as patients arrive at PCI within 45 to 225 minutes of symptom onset.



National-level cardiac time savings benchmarks

Times for cardiac transports are usually discussed for the subset of patients with STEMI, undergoing transport for primary PCI. For these patients, the traditional time goals for door-to-PCI are 90 or 120 minutes. Even though time intervals measurement is evolving to “symptom onset to intervention” (or “first medical contact to intervention”), the traditional time intervals remain the most important benchmarking goals.

There are no concrete “standards of care” for times for HEMS and cardiac transports. What there are, are general guidelines that are widely – but not necessarily universally – used by HEMS programs in the U.S. Some of these times are actually related to, and were generated in parallel with, times for stroke patients (who also need to be transported quickly, in order to be eligible for time-windowed therapy). The times presented in this report are not universal standards, but rather represent goals used by many programs. Both the “standard” (*i.e.* times required to perform within national norms) and “best-practice” (*i.e.* best that’s realistically achievable) times are presented here. (Appreciation to Kenneth Panciocco, Director of Communications at Boston MedFlight, for assistance with assembling these numbers.)

Standard on-scene times for cardiac (and stroke) patients are optimally 20 minutes or less for hospitals with on-site landing areas (as is the case in nearly all Oklahoma hospitals using HEMS). If there is a remote pad, an extra 5 minutes is allotted for the additional transport leg to/from that remote LZ. The best-practice nationally, is about 10 minutes for an on-site pad. The American Heart Association has indicated that 20 minutes is a “standard” benchmark.

The preceding goals for cardiac care times are generally consistent with OSDH goals as outlined in a presentation (within a month of this report’s being submitted) by Dr. Tim Cathey at an OSDH-sponsored cardiac care network planning session. Dr. Cathey’s presentation included mention of a 15-minute scene time goal. He also discussed diversion to PCI hospital if within 30-40 minutes or if lysis-ineligible. Some of Dr. Cathey’s remarks were based upon a cardiac initiative in North Carolina; in that state there is a goal of less than 90 minutes, for the time interval between first medical contact and PCI.

Regional study of outcomes and times performance for Oklahoma cardiac transports

Since this report does not include specific statewide data for cardiac transports, detailed analyses for these transports are available only for a regional study entailing transports to one center in Tulsa (shown in the photo at right: Oklahoma Heart Institute at Hillcrest Medical Center, HMC).

In this study of 97 STEMI patients transported for PCI (a consecutive series running from January 2010 through June 2011), key findings supported the contention that HEMS extends the PCI center’s reach. Some of the principal results from that study are presented here.

The HMC study included patients from 18 referring hospitals (66 AMT patients). Of the 31 cases in which ground EMS was utilized, weather-related HEMS unavailability dictated surface transport in 6 (6.2% of 97 overall cases; 19.4% of all ground EMS cases). None of those 6 patients made it to PCI within 120 minutes; if HEMS had been available the goal would have been met in 4 of 6 cases. HEMS patients were transported from significantly further away than ground EMS patients, and time savings associated with the average HEMS transport (as compared to



ArcGIS-calculated ground times) were over 40 minutes.

In every case in which HEMS was used, at least 15 minutes was saved (meeting the *a priori* evidence-based definition for “significant time savings improving outcome”). In 80% of cases, at least a half-hour was saved by using HEMS instead of ground transport. Using the 45-225 minute time range (see previous *BMJ* figure) as the range in which expedited transport improves outcome, the preliminary calculations yielded a figure of 1 life saved for every 59 HEMS cardiac transports. Put another way, there were 1.7 lives saved for every 100 HEMS cardiac transports in the dataset. (These data have been submitted for publication, but have not been peer-reviewed, presented, or published as of this report’s submission.)

The HMC study demonstrated the critical role of HEMS in the still-evolving northeast Oklahoma cardiac care system. Had HEMS been unavailable, the absolute percentage reduction in those patients reaching PCI within 120 minutes was calculated to exceed 21%.

One interesting finding from the HMC study was the suggestion of HEMS undertriage. If HEMS had been deployed for all of the 31 cases in which ground EMS was actually used, all patients would have received PCI significantly faster, and there was a statistically and clinically significant doubling of the proportion of patients who would have achieved PCI within 120 minutes of initial presentation.

The HMC study included some results that can be compared to the general benchmarks outlined in the previous section. Some relevant results are reproduced in the following table. In the table, RH is “Referring Hospital” (the non-PCI center), “transfer activation” is the call to arrange transport (by ground or air), and “leave RH” is the time that the transport vehicle departed the referring facility. These times do not precisely match the time intervals for which national-level benchmarks were provided previously, but they do give a sense of the general performance of some parts of the Oklahoma system.

RH door to transfer activation	Median, range (IQR)	24, 1-137 (14-35)
	Ground EMS	29, 1-117 (17-48)
	HEMS	22, 1-137 (14-33)
	<i>p</i> , Ground v. HEMS	0.41
Transfer activation to leave RH	Median, range (IQR)	35, 5-120 (26-50)
	Ground EMS	30, 5-120 (22-44)
	HEMS	40, 10-113 (30-54)
	<i>p</i> , Ground v. HEMS	0.025
RH arrival to departure	Median, range (IQR)	61, 24-185 (48-80)
	Ground EMS	53, 24-185 (41-77)
	HEMS	64, 32-169 (50-80)
	<i>p</i> , Ground v. HEMS	0.12

The data above are a starting point. Further analyses will need to match the measured times to those for which national-level benchmarks have been established. Other data (for instance, the distance from which transporting vehicles responded to the RH) will be needed, before any conclusions can be drawn about system performance.

Cardiac air transport in Oklahoma: Conclusions

At this point, it would be premature to draw any major conclusions about cardiac AMT in Oklahoma. The HMC data, if and when they are presented/published after peer review, suggest that current performance has both favorable and unfavorable aspects. While other data are being pursued, some additional topics should be added to the conversation.

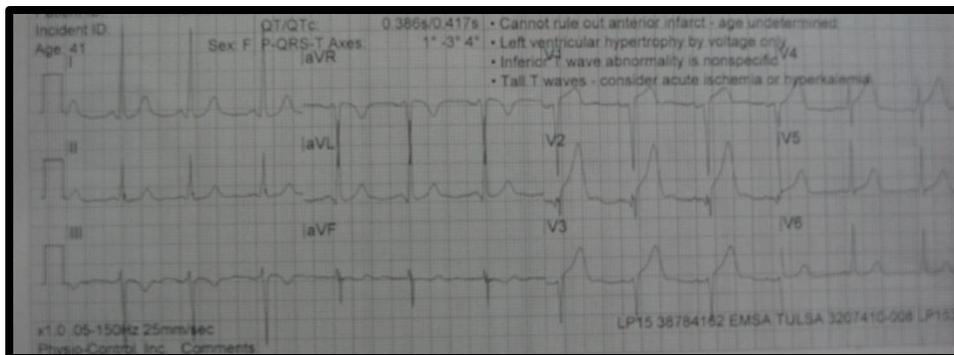
First, this report's interviews identified a set of economic problems. These issues were also mentioned by Dr. Cathey in his OSDH presentation, and in fact are discussed nationwide. Rural hospital administrators tend to not wish patients to bypass their facilities (by ground or air), and thus have those facilities lose the lucrative billing associated with initial stabilization of these patients (even if they are subsequently transported). Furthermore, there are concerns about losing the cardiac rehab revenues from patients who bypass the local facility to get PCI; once at a major facility for PCI, patients tend to stay in that system for (lucrative) rehab. All of these issues were mentioned throughout Oklahoma, but everywhere in Oklahoma those hospital personnel indicated they want what's best for their patients...thus rendering this problem potentially surmountable.

A second set of problems had to do with HEMS dispatch and availability. In a refrain heard all too often during interviews for this report, the byzantine nature of HEMS dispatch was lamented by an ED physician in a facility lacking on-site PCI. This physician, in reporting frustrations spent during an hour of trying to find AMT for his patient, was "positive" on HEMS' ability to streamline PCI, but "negative" on the reliability of the Oklahoma dispatch and asset-availability picture, to rapidly get HEMS to his patients when they need it.

Others with whom we spoke, were also positive about AMT's ability to reduce time-to-PCI, but nearly all had stories about times helicopters were not available or had delayed ETAs due to being busy on other missions. Interestingly, most rural-site individuals with whom we spoke, accepted the inevitability of missed AMT due to weather but handled other HEMS availability issues with less aplomb: "Unavailability due to weather, I'm OK with that. It's a part of living in Oklahoma. But having a helicopter not available because it's busy, and therefore having a terrible time getting a patient quickly to the cath lab, doesn't have to be part of living in Oklahoma."

The near-future should bring statewide assessment of what AMT does, and does not, bring to the cardiac table. One important decision that should be made by the state, is whether the goal is to get patients to PCI, or whether lysis is an acceptable alternative. It is known that HEMS contributes to the cost-effectiveness of primary PCI; even when patients were transported from longer distances (by air), the cost-effectiveness of primary PCI over time is maintained.¹¹⁰

As to the question of thrombolytic therapy or PCI, this report's authors do admit to a (pro-PCI) leaning. However, this report's opinions pale in importance, when compared to the views of OSDH and the state as a whole. It is noteworthy, that in the recent OSDH-sponsored cardiac network planning session attended by numerous cardiologists, the (unscientific) after-meeting polling of those cardiologists strongly favored PCI over lysis. This finding is consistent with the opinion of most (if not virtually all) cardiologists with whom the authors have discussed the subject over many years: if it is possible to get PCI within 120 minutes (and certainly if it's possible to get PCI within 90 minutes), then PCI rather than lysis should be the system goal. Whatever the "right" answer to the lysis-versus-PCI question is, the "Oklahoma" answer needs to be defined before any AMT system planning can proceed.



At left is an EKG of a cardiac patient whose STEMI was diagnosed by ground EMS; the ED Attending reviewed the transmitted EKG, agreed with the ground EMS assessment, and arranged for the patient to bypass the ED and instead go straight to the cath lab.

HEMS and stroke care in Oklahoma

As outlined in the initial section of this report, stroke (CVA) is evolving into a major source of patients for both scene and interfacility transports. In a state like Oklahoma, where scenes are remote and neurovascular services are often unavailable in community hospitals, HEMS offers the chance for stroke patients to get to definitive care in timely fashion. While expedited care for hemorrhagic CVA is important, most of the current data and conversations address ischemic CVA and its time-windowed therapies (e.g. thrombolytic therapy).

Stroke possibilities for AMT in Oklahoma

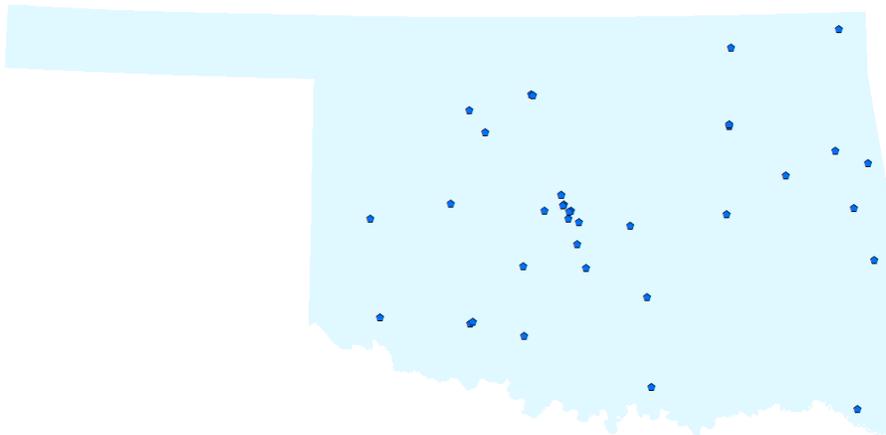
To the understandable surprise of many observers, existing data demonstrate that training of prehospital providers can allow them to identify major stroke syndromes with high accuracy.⁶ As is the case with cardiac transports, the idea is to identify those patients with substantial acute disease. Prehospital providers considering expedited transport have been trained to recognize major strokes for which lysis may be needed. There is no attempt to activate HEMS for cases that are borderline or not easily diagnosable. A corollary in cardiac transports is prehospital providers' being asked to learn STEMI recognition, while leaving out other less acute or obvious cardiac conditions.

The scene stroke transport idea is one that is very well suited to Oklahoma – if the correct training can be executed. With training, a rural area (north Florida and southern Georgia) was able to achieve stroke diagnosis accuracy of 76%; the 24% overtriage rate compares quite favorably with that usually seen for trauma (see previous discussion). In the Florida/Georgia study, half of the strokes were ischemic and thrombolytic therapy was administered in 38% of those ischemic CVA cases. Potential flooding of the AMT system with stroke patients was a concern that was broadly shared, but which never materialized. Stroke comprised only 4% of the HEMS service's volume, but HEMS scene stroke patients accounted for nearly a quarter of lysis cases at the receiving center.⁶

From the perspective of AMT, one of the most attractive characteristics of CVA patients is that they usually don't require a lot of pretransport medical stabilization and care.¹⁴⁹ The stroke population undergoing AMT is truly a group for which speed is usually the primary transport goal. HEMS is often in a position to provide that speed for either scene or interfacility transports.^{115,150}

Stroke system planning in Oklahoma

As is the case with acute cardiac disease, OSDH has already realized the importance of building a system of care for CVA. The authors of this report have worked with teams that have established systems of stroke care elsewhere,^{115,150,151} and the experience-based interpretation is that Oklahoma's trajectory heralds a good future.



(Left) Oklahoma stroke centers (primary and secondary) are depicted here, for comparison against HEMS asset locations as shown on similar maps earlier in this report. A more detailed OSDH stroke system map identifies particular centers (see next page).

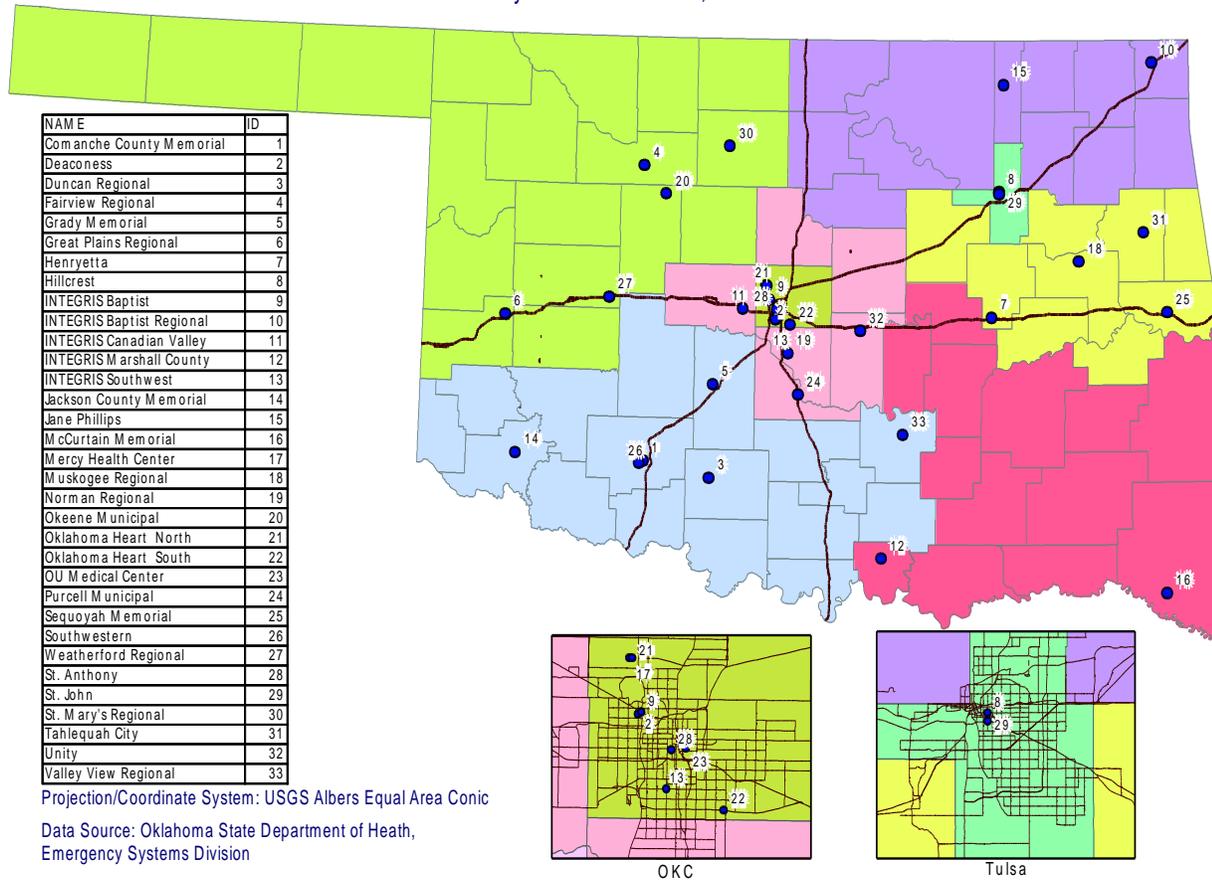
Perhaps one of the most important contributors to Oklahoma's success in establishing a stroke care system, is the fact that it's being driven from the ground-level providers rather than dictated from the top. Inter-

views for this report consistently identified “on-the-street” and “in-the-ED” providers who were interested in a statewide stroke system. Stroke appeared to be an area for which community hospitals are perceived as lacking the ability to provide definitive care. For example, prehospital providers in southeastern Oklahoma summarized their views: “Of all diagnostic areas in prehospital care, stroke patients seem to be the main area for increased helicopter use to get our patients where they need to be, in a timely way.”

The work for stroke systems development in Oklahoma is being coordinated from OSDH, with personnel including Vonnie Meritt RN MPH (whose assistance in providing Oklahoma stroke information is appreciated). In a report to OSDH, it is not necessary to replicate the details of that network. Some geographic highlights of the system are provided.

As of this writing, there are nearly 90 secondary stroke centers, and about 40 primary stroke centers (either self-designated or OSDH-inspected). Eight centers have undergone the rigorous Joint Commission accreditation process.

Primary Stroke Centers, Oklahoma 2011



Projection/Coordinate System: USGS Albers Equal Area Conic
 Data Source: Oklahoma State Department of Health, Emergency Systems Division

Created 03-21-2011



Disclaimer: This map is a compilation of records, information and data from various city, county and State offices and other sources, affecting the area shown, and is the best representation of the data available at the time. The map and data are to be used for reference purposes only. The user acknowledges and accepts all inherent limitations of the map, including the fact that the data are dynamic and in a constant state of maintenance.



Stroke care regionalization is well underway in Oklahoma. The time seems ripe to consider what role AMT may play as the system continues to mature.

Every ED in the state has access to a program (EMSystem) that gives real-time availability for stroke and other care. OSDH is working to assure the accuracy of this information, and to get stroke center level and availability onto the EMSystem.

There are definitely some “big holes” in the state’s stroke care network, according to OSDH personnel. There appears to be a real need for some hospitals in the uncovered areas of Oklahoma, to consider how they may be able to become stroke centers and thus complete the geographic care network.

The characteristics of the geographic care network for stroke will drive some triage decisions. A major goal of care in Oklahoma is for ambulances to drive some patients by secondary stroke centers, to get to primary centers. There are some potential speed bumps related to hospitals’ loss of revenue from lost patients (including rehab loss, as for cardiac patients). That said, conversations with OSDH have indicated admirable levels of overall cooperation from Oklahoma hospitals.

One critical step in development of a system that can be monitored (and therefore improved), is development of a statewide registry. The lack of registry data prevents execution of stroke-centered times analysis for this report. Unlike the case for the cardiac patients, there was no regional study in place that allowed reporting of a partial sample. Registry data take time to enter, and resources would need to be committed to cover the associated costs.

Targets for stroke patient care in Oklahoma

As is the case with other diagnoses, the first goal will be to get the right patients to the right level of stroke care, via the right vehicle. Field triage can, and has, allowed prehospital providers to correctly identify patients with major stroke syndromes. More sophisticated triage of potential stroke patients will be necessary to ascertain which “borderline” cases have sufficient chance of benefit, to warrant ground or air transport to a stroke center. A part of this process, is to determine which patients should be transferred to facilities with more limited therapeutic options (*i.e.* intravenous thrombolysis), and which patients warrant direct transport – by air or ground – to major stroke centers.

For stroke patients, the time imperative applies only for those cases in which there is reasonable possibility for eligibility for time-critical therapy. The situation is more complex for stroke than cardiac patients. There are multiple therapeutic options for CVA (*e.g.* intravenous lysis, intra-arterial lysis, mechanical interventions). Furthermore, eligibility for these options may vary depending on factors other than strict definition of symptom onset time. For patients with unstable posterior circulation strokes, for instance, therapeutic windows may be extended beyond the traditional time frames often quoted in the literature. For stroke-related decision making, the system may need to incorporate assistance (via telemedicine or other mechanisms) for those in rural areas. Such assistance comes with a price, but consultation may also obviate the need for expensive AMT and thus “pay for itself” from a systems basis.

Times for stroke patients who are determined to warrant transfer, should be subject to aggressive attempts at optimization. As previously stated, these patients are generally not medically complicated from an acute-care perspective. The rule for most stroke patients is, “move fast to get the patient to definitive care.” Time-consuming pre-flight interventions such as medication infusions or careful immobilization, that may be needed for medical or trauma patients, are not such a problem with the stroke population. Therefore, the goal is to have scene times (including times at referring hospitals) that are very short.

Existing data do not allow for fine parsing of incremental outcomes benefits associated with savings of certain amounts of time, but the aphorism “time is brain” is promulgated with sound factual basis. In the U.S., the on-scene target times for stroke are the same as for cardiac patients. These times (presented previously) are optimally 20 minutes or less for hospitals with on-site LZs (5 minutes added for remote LZs). The best-practice nationally, is about 10 minutes for an on-site pad; 20 minutes is the preferred benchmark as promulgated by the American Heart Association. Ongoing research will need to ascertain how Oklahoma is doing with respect to these times, and identify areas for improvement as the system moves forward.

Introduction to AMT finances

This part of the discussion will attempt to provide the briefest overview of some (not all) of the financial components of AMT. While hard “costs” or “charges” data are not available for this report, there are some general areas of discussion that warrant mention. The primary goal of presenting this information herein, is to highlight points that deserve deeper consideration, follow-up investigation, and further analysis. It is emphasized up front, that the information in this part of the discussion is not claimed as definitive or all-inclusive. Special disclaimer is necessary, to highlight the fact that the dollar figures quoted in this section are simply those that are publicly available or were offered by private services; these figures are reported without commentary as to the precision of their definition, or even their accuracy.

Information sources

Most of the information contained in this section, comes from interviews of Oklahomans. Since much of the information is sensitive, the interviews were conducted with the promise of anonymity. The information is presented with the *caveat* as above, regarding precision and accuracy.

Officials from Air Evac (Tim Pickering, Director of Government Affairs), Air Methods (Craig Yale, Vice President), and EagleMed (Mike Simmons, Director of Medical Affairs) contributed information for this report – for this section and for other sections – and their assistance is acknowledged and appreciated. No specific detailed pricing information was given by the HEMS services. It is worth specifically noting, that asking for such detailed information would require specifics and ancillary data that would render the question difficult to cover in a report that wasn’t wholly focused on finance.

Costs versus charges

It is important to note that, throughout this part of the discussion, the “costs” are actually referring to charges. Actual transport cost calculations, which are critical to performance of precise cost-effectiveness or cost-benefit analysis, are complex in their elucidation and are not available for this report. There is an industry worksheet that is available to interested parties (and which can be shared with OSDH if desired), that outlines all costs associated with HEMS operations. Personnel, equipment, supplies, insurance, and of course aviation-related costs must be taken into account in order to render the true resources required to run AMT programs.

As a second overarching note, the cost information provided in this section is most relevant to helicopter transport. FW transport costs are grossly similar, although this is dependent on the particular transport’s aircraft (*e.g.* jet versus turboprop) and logistics (*e.g.* short- versus long-distance). In Oklahoma, FW costs are certainly important, but FW transport is much less frequent than RW transport in our state. Partially because of this, and partially because FW tends to respond when RW is not an option (*e.g.* weather, distance/availability of HEMS), there was little angst over FW costs (or charges) encountered during this report’s interviews.

Since this report intends to concentrate on air medical services, there are few data herein, addressing the costs of ground transport. It is fair to point out, as one person experienced with air transport in Oklahoma remarked, that “people don’t want to consider the costs of ground ambulances. Every air transport is appropriately scrutinized, but no one is reviewing appropriateness of ground vehicle use for transports of 2, 3, or even 4 hours.” As compared to (warranted) scrutiny of transport appropriateness for HEMS cases, there seems less attention paid to cases undergoing multi-hour ground EMS transport (*i.e.* for whom HEMS undertriage is risked).

Costs of air medical transport in Oklahoma

There’s no requirement for disclosure of costs of air transport, and estimates have varied widely for the cost of a helicopter flight in the U.S. One report from a major news outlet (www.MSNBC.com, Health writer JoNel Aleccia, 12/17/09), notes that charges range up to \$25,000 per flight. The data from about 10 years ago, from one of the best cost-effectiveness studies in the literature (at a non-profit HEMS program based at Univer-

city of Michigan), provides an estimate of costs per transport at about \$4000.¹²⁶

Much has happened in the past decade, to drive HEMS operating costs higher. An EMS provider in north central Oklahoma reported, based upon personal experience with two separate transports a few years apart, stated: “Five years ago it was \$10,000 to fly from my town to Oklahoma City; this year the bill is \$25,000.” This report’s authors are personally familiar with a \$16,000 bill for air transport of a patient from one hospital in an Oklahoma metropolitan area, to another hospital *in the same metro area* (in fact, within 10 miles’ distance).

The cost escalation is not one that should be ascribed solely to profit motives. One of the largest not-for-profit operations in the U.S. is CalStar – a service with a fine reputation for both medical and operational excellence. *The Union* (of Western Nevada County, California; 9/20/2011) newspaper reported that, for northern California, the non-profit HEMS operator charges were right at \$20,000 per transport. The article pointed out that the costs of a helicopter were high (\$6 million for their aircraft), and that even a non-profit operation needed to stay afloat – experienced flight crews are not cheap. In California, even the presence of a membership (which is about the same as the cost in Oklahoma) doesn’t insulate against a big bill. Members who fly with REACH (a for-profit HEMS operator) who have no other healthcare insurance at the time of a flight, are billed half the cost of the transport.

Based upon the best available information, including confidentially conveyed information from one of the state’s air medical providers, the average gross charges for an Oklahoma HEMS flight come to about \$22,000. In individual cases, adjustments are occasionally made depending on parameters such as hardship discounts. Further details of this estimate cannot be provided without revealing confidential information. It is the opinion of this report’s authors, that the figure is generally in line with “truth” for HEMS charges for all of the state’s HEMS services. Of course, the average is just that – an average; individual flights would be potentially more expensive, or occasionally cheaper.

While the \$22,000 estimate may be off, it’s likely more accurate than the financial information found in the only publicly available source this report’s authors found. In the Oklahoma State Department of Health 2010 Ambulance Registry, charges appear to err on the low side; dollar amounts in this self-reporting registry are lower than those that were quoted by all of those who were interviewed for this report. The charges for Air Evac are listed as \$4,250-4,500 for transport, plus \$45/mile. Thus, a HEMS transport of 100 miles’ distance would cost well under \$10,000. EagleMed’s rotor-wing charges are listed as \$6,800 plus \$76/mile. An Air Methods program in OKC, MediFlight, lists charges as \$11,121 plus \$84/mile; the Tulsa Air Methods program charges are listed as \$10,921 plus \$115/mile. The pediatric Air Kids One lists charges as \$10,921 plus \$114/mile. CareFlite in Dallas (listed in the OSDH registry due to its being licensed in OK) provided a charge structure of \$11,000 plus \$100/mile. It’s conceivable that these charges as listed are correct, but it seems far more likely that they define charges differently or are otherwise in error. If the true charges are really as low as registry-listed, then there are widespread misconceptions about HEMS charges in our state.

Comparator ground EMS costs are not always easy to find. *The Union* (in California) pointed out that comparable-to-AMT trips by ground ALS would cost >\$2000 (due to per-mile charges that add ≥\$1000 to ground EMS base-rates). OSDH 2010 Ambulance Registry charges for critical care and other ambulance transfers, range broadly. Generalizations of ground EMS costs, which in Oklahoma ranged from “free” to a nearly \$2000 plus mileage, is thus difficult.

Intubation in a ground ambulance care space



Payment strategies for AMT

For every person interviewed during this project, who said “the helicopters are too expensive,” there was at least one other who said “you just have to join the service.” These individuals were referring to the membership or subscription model, which is used by two of the three services operating in Oklahoma. Since membership is so frequently mentioned in our state, it will be addressed first.

To “join” a service is an option open to those wishing to become members of either EagleMed or Air Evac. Air Methods does not offer a membership. Instead, they are preparing an air transport insurance policy that would cover any air transport costs; this policy is not on the market as of the preparation of this report but will be available soon according to Air Methods officials.

Membership is not the same as insurance. Air transport costs are only covered if they are provided by a member of the consortium that owns EagleMed and Air Evac (*i.e.* Air Methods transports aren’t covered).

Annual membership fees are similar for EagleMed and Air Evac, at \$50 for an individual and \$55 for a couple or \$60 per family. As previously noted, since EagleMed and Air Evac are owned by the same parent company (they are members of AirMedCare Network), there is reciprocity for members of these two services. Non-members are balance-billed for any transport costs not covered by insurance.

The balance-billing issue brings the cost discussion to its next point: insurance. The unfortunate fact of the matter is that the charges associated with AMT simply aren’t completely covered by insurance companies. Even those with “good” healthcare insurance cannot count on that insurance paying the full charges of an air medical transport. The potential impact of balance-billing is pointed out by the air medical providers themselves, as part of their marketing of memberships. For example, one of the websites for a provider of air medical helicopter services in Oklahoma (www.flyeaglemed.com/membership.html, accessed 31 Oct 2011) states that “insured patients sometimes pay \$800 to \$3500 dollars in out of pocket expenses for critical care air ambulance service.” The website goes on to point out that charges are zero dollars for patients who are members of the service, who are transported by that service.

In fact, the estimate that out-of-pocket (balance-billing) charges to the patient can be “\$800 to \$3500” seems conservative. Discussions with individuals in hospital administration and billing, as well as consultation of available information (*e.g.* from the MSNBC report cited earlier), leads to estimates that insurance companies tend to cover about a third of the costs of air transport. For a \$21,000 transport, this leaves the patient with a bill of \$14,000. The example is not hypothetical, but rather arises from conversations with an Oklahoma hospital administrator who voiced concerns about the balance-billing of patients for whom his hospital physicians called helicopters. He summed the problem as follows: “I know of a case where a patient had a bill of over \$20,000, and insurance covered less than \$8,000. In small-town Oklahoma, these patients are our neighbors, and hitting them with a \$12,000 bill hits them hard.”

In conversations with that hospital administrator, perhaps the most concerning point in terms of the considering the time-related cost/benefit of air transport, is his statement that “if the helicopter only saves 20-30 minutes, it’s not going to be worth a \$12,000 balance-bill for the patient.” Of course, for most patients, that 20-30 minutes *won’t* make a difference...but in some cases it will significantly improve outcome or even save a life. It seems less than ideal to have trepidation over balance-billing create situations in which HEMS isn’t called, and risks of poor outcome are accepted. The determination of need for air transport can be difficult enough, without a requirement for the triaging personnel to weigh the probability of benefit against the probability of a balance-bill that patients can’t afford.

There is a related note with respect to time savings, that deals with *which* air transport service to call. As previously noted, if patients are members of EagleMed or Air Evac, then a transport by either of those services will cost them nothing – but the same transport by MediFlight or Tulsa Life Flight will cost them (and cost them significantly).

Financially based “triage to HEMS service” questions arise in both the interfacility and scene transport realms. There were multiple cases in preparation of this report, when prehospital personnel recollected patients asking for a particular HEMS service to be called because that was the service with which the patient had a

membership. Again, triage is already one of the most challenging jobs faced by healthcare providers; it's made even more difficult if it's impacted by financial issues and patient lobbying.

It seems very important to point out, that none of the air medical services in Oklahoma (and we corresponded with all) endorse the idea of having financial issues impact the selection of transport mode or transport service. All of the AMT providers operating in Oklahoma, have endorsed the position that the closest, most medically appropriate transport vehicle and service, is the right transport.

Air transport companies in Oklahoma: Financial stability and size

The news for years has included reports of HEMS programs' financial straits and closures, but upon close examination most of these programs have been university- or hospital-based. Costs of hospital-based AMT can be high, and hospitals have been more than willing to shed the ownership of HEMS in favor of "community-based" models wherein helicopters function independently from any hospital or university. For example, MediFlight is now a community-based program (no longer affiliated with OU); Tulsa Life Flight has taken the same path (it's no longer administered by Saint Francis/St. John in Tulsa). The move from hospital-based to community-based helicopter services in Oklahoma, mirrors what's happening in many areas of the U.S., and the reasons are mostly financial.

One of the authors of this report recently moved to Oklahoma from Massachusetts, where a not-for-profit university-affiliated (consortium) HEMS program charged about \$9,000 for lift-off and then \$84 per patient-loaded mile. This particular program (New England Life Flight, d/b/a Boston MedFlight) tends to come up roughly \$1 million "in the red" each year. The operating deficit of this type of university/hospital-based program is the subject of intense debate (*e.g.* questioning as to whether "doing things right" always means having higher expenses), and is outside the scope of this report since no such services are extant in Oklahoma. What is the case in Oklahoma, is that the companies providing HEMS transport have no such luxury as the capability to be "made whole" by supporting hospitals if they end the fiscal year in the red. They must be financially viable, or they will cease operations. This is particularly challenging with air medicine in a rural region, due to the very high fixed costs (albeit with correspondingly low variable costs) associated with operating HEMS.

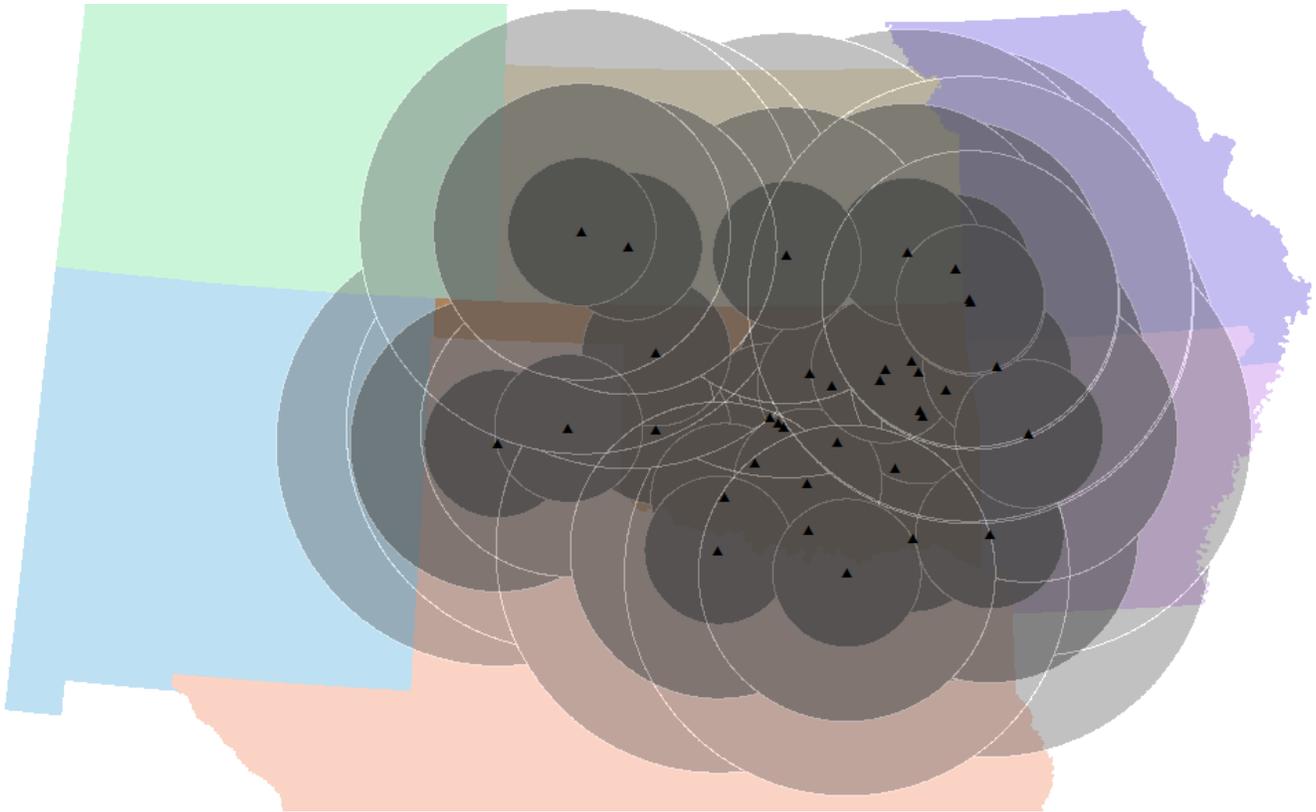
Reference to one source (www.marketwatch.com, 4th August 2011) provides information on Air Methods, the company that runs MediFlight and Tulsa Life Flight. Air Methods is the largest air medical transportation company in the world, with quarterly revenue (for the three-month period ending 30th June 2011) of \$150 million; this was up from the previous year's same-quarter results of \$139 million. Air Methods has just recently completed acquisition of one of the other major historical providers of air transport: Omniflight. Issues related to that acquisition, as well as higher-than-expected maintenance costs and mission cancellation rates, contributed to a decrement in company profitability for the quarter. The "take-home" point, though, is that Air Methods is a very large company, with enormous resource investment in (and significant profit from) AMT. The same can be said of the holding group that controls both Air Evac and EagleMed.

Without getting into the accounting details, the three services providing HEMS in Oklahoma appear to be in very solid financial shape. Their success renders it quite likely they'll all be here in the state, for the foreseeable future. It appears wise, therefore, to incorporate into planning for HEMS operations in our state, the presence of Air Evac, Air Methods, and EagleMed.

Financial conclusions

Angst surrounding HEMS costs is significant. For most, the financial impact of a balance-bill is nontrivial. It's understandable that a common *motif* from many with whom we spoke, was "you have to join a service." For those who do join, the price is reasonable, at least when compared to what the few pertinent data describe as the citizen-perceived reasonable cost for HEMS.¹²³ The problem lies with patients who didn't think to join, or who are transported by another (non-subscription) service for whatever reason (*e.g.* they had their car wreck in an area covered by MediFlight, or their service was not able to respond and they were flown by Tulsa Life Flight). Exploration of these questions will be a major part of ongoing HEMS systems planning in our state.

SECTION IV: RECOMMENDATIONS FOR AMT IN OKLAHOMA



Oklahoma’s future should involve optimization of AMT resource allocation. In some areas of the U.S., Oklahoma and the surrounding states have a reputation for being “overcovered” by HEMS. Future work should attempt to test the true AMT needs for Oklahoma, and determine whether the state is actually over- (or under-) covered.

Rationale and introduction to this section

It is hoped by the authors that the report's previous sections could stand alone as a useful tool for OSDH. By one view, the most important items to convey have already been conveyed. The authors have some concerns that the recommendations in this part of the discussion, could garner disproportionate attention. In fact, we believe that most of the answers to "next steps" questions are fairly easily identified through careful consideration of this report's preceding portions. That said, we do acknowledge that different individuals' read of the same information, may result in more than one possible "next step."

In spite of the risks attendant to attempts at synthesizing the preceding sections' findings into specific recommendations, we believe the exercise worthwhile for at least four reasons. First, and perhaps most importantly, inclusion of recommendations was part of the initial project deliverables requested from OSDH. Second, it is understood that some may not have time to read this entire report; the synthesis and recommendation section may help direct readers to parts of the monograph that are of particular interest or relevance. Third, the sheer time and exposure of this report's authors, to the AMT picture in Oklahoma, warrants some presentation of the *gestalt* we sense from around the state; we believe we are well-positioned to report (while not necessarily endorsing) what we're hearing from stakeholders. Finally, we in OUDEM would like this report to be a first step, rather than a terminal part, in the process of our working with the state to improve AMT for our citizens. As part of our making a case for OUDEM's continued involvement in Oklahoma transport systems study and improvement, it's only fair that we give an idea of directions for future efforts.

The information in this section is not presented in any particular order. Recommendations in this section are divided into categories, with the understanding that there is inevitably some overlap. Attempts to determine a method to present categories chronologically or in some other hierarchy, were not successful. Therefore we emphasize that the order of the "next steps" as presented below, is not intended to convey information about relative importance, timeline, ease, or even practicality.

After much consideration, we chose to include any recommendations that we thought might be useful for OSDH's review. This translated into inclusion of some recommendations that seem far-fetched – or downright nonfeasible. The authors understand that some of the items in this section aren't likely to be achieved any time soon, but we were uneasy about deciding where to draw the line on including something that we didn't think was likely to work. Thus, the section leans towards being all-inclusive, and judgments as to feasibility can be left to OSDH or discussed if a specific recommendation seems promising but difficult.



OUDEM is interested in continuing collaborations with OSDH, as we work toward a common goal of creating an AMT system that serves as a model for excellence in patient care, operational efficiency, and judicious resource utilization.

Triage and utilization review (UR)

Triage and UR issues remain the hot-button topics in AMT nationwide. While the entire country wrestles with improving precision of HEMS use, there are some directions we believe Oklahoma can take.

1. Determine state preferences for lysis versus primary PCI for STEMI.

Even papers that study prehospital lysis concede that PCI is the preferred technique when medical contact-to-balloon is achievable within 90 minutes.¹⁵² Things may be less straightforward when the window becomes 120 minutes. Regardless of what the state preferences (of cardiologists or OSDH) might be, we believe it's important to generate a logistics (time/distance) matrix that guides whether patients should go to rural hospitals or to receiving cardiac centers. The impact on AMT need is substantial. A decision to provide more care (*i.e.* lysis) at rural hospitals lessens the time-criticality of ultimate transport to receiving cardiac centers.

2. Determine state preferences for lysis versus expedited transport for stroke.

Similar to the case with PCI, the literature supports administration of lytics at rural hospitals, with subsequent transfer (by ground or air) to referral centers...but there is also evidence in favor of direct-to-stroke-center transport from the scene. As is the case with STEMI, the action item suggested, is that a decision support tool be developed, that allows prehospital providers to incorporate logistics (and clinical parameters) into judgments as to whether to transport to rural facilities or call for HEMS to take patients to high-level stroke centers. As is the case with PCI, the more that the state wishes rural hospitals to do, the less urgent the need for AMT and time-critical transportation.

(Below) This patient with a left MCA stroke received lytic therapy, administered intra-arterially at a tertiary stroke center. Helicopter transport had been activated from a lower-level stroke center. Transport decision-making should incorporate planned therapy since HEMS is often unnecessary after thrombolytic therapy.



3. Adopt CDC Trauma Triage Guidelines and HEMS Trauma Scene Dispatch Guidelines (when available).

The Oklahoma Trauma Education Project (OTEP) is already based upon the CDC Trauma Triage Guidelines. The CDC has convened an expert panel, comprising a subset of the panel that generated the Trauma Triage guidelines, to generate HEMS-specific guidelines.

One of this report's authors serves on the CDC panel, and we are thus optimistic that those guidelines

will include considerations relevant to large rural states such as Oklahoma. It is recommended that Oklahoma plans to review, modify as needed, and adopt the CDC’s HEMS trauma scene dispatch guidelines when they are disseminated in mid-2012.

The panel for the CDC includes individuals (including one of this report’s authors) who served on a combined NHTSA/CDC panel that used GRADE evidence-rating methodology to generate preliminary recommendations (not yet published) for HEMS trauma scene dispatch. Those initial recommendations are depicted at right. It is likely that the final CDC HEMS triage guidelines will have much in common with the pathway at right.

4. Generate listing of cases in which direct HEMS scene-to-referral center transport should be considered.

Trauma, STEMI, and stroke are diagnoses for which there may be some benefit to direct transport of patients from scenes to referral centers. Those may be the only such diagnoses, but there may also be other instances (e.g. pediatrics) in which the system should encourage direct transports. A listing of these types of cases would necessarily be partial, but even a partial listing could be useful to prehospital care providers.

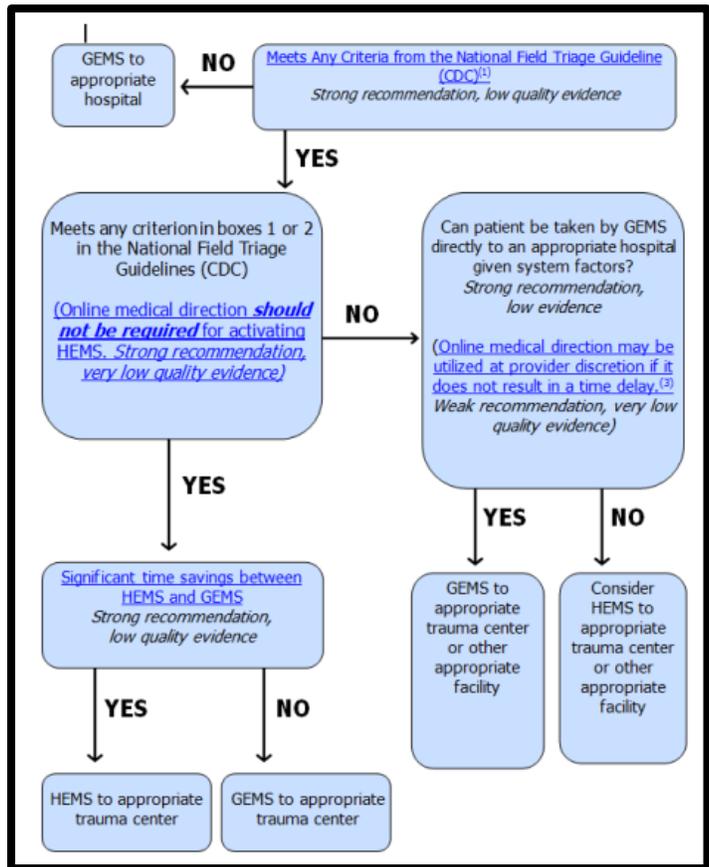
We understand this to be a challenging task. In considering injured patients, issues with respect to “inclusive” versus “exclusive” trauma systems are far too complex to address in detail here. STEMI and stroke cases could turn out to be just as tricky. Alternatively, these diagnoses could pose lesser problems since their therapies are discretely time-windowed (and AMT benefit is commensurately easier to estimate).

It may be worth pointing out, that the concept of “meeting the patient at the nearest community hospital” may not be as good an idea as hoped. The problem is that community hospitals around the U.S. are notorious for introducing significant delays – and charges – in processing patients that should really be immediately transferred out. These problems, also mentioned by many with whom we spoke during this report’s preparation, are not limited to trauma cases. Prehospital providers told us that STEMI and stroke patients are just as likely to suffer from unnecessary delays as are injured patients. When we spoke with these smaller hospitals’ administrative staff, they agreed. Said one CEO: “Every time a patient stops here, there is a 2-hour gridlock before they are transferred out. With so many ER docs we have coming through, we just can’t get things sped up.”

At least some rural providers reported to this report’s authors, that their medical oversight authorities require transport to the nearest hospital (i.e. non-dispatch of HEMS), for all non-trauma cases. This is a sufficiently important point, that the state should consider the evidence and promulgate an appropriate position statement (or protocol modification).

5. Document, at the time AMT is requested, the reasons for air medical dispatch.

A recent publication from OSDH’s Dr. Kenneth Stewart¹⁴⁵ included a recommendation that “identifying factors influencing the field transport decision will help develop transport guidelines that optimize efficiency” in AMT utilization. We agree, and would extend this to interfacility transports as well.



We understand that some of this is already occurring, but what we propose is generation of a data element set that is completed, in real time, for every single case in which AMT is requested. In our opinion, the dollars involved in AMT warrant such attention. The action items would include discussion as to how to generate the “standard data form,” how to train individuals to complete it, how to collect/collate the data, etc.

We believe the data gained by such an intervention would be extremely useful. We also think that most care providers, and even AMT providers, would endorse the process. Prehospital providers have indicated to us that they’d appreciate the opportunity to convey real reasons for HEMS calls.

The AMT services are also likely to endorse a process requiring indications for HEMS dispatch. As a matter of fact, officials from one of the state’s AMT providers (Air Evac) actually suggested completion of such a data sheet. They indicated that they often get called to rural areas for flights that fall outside of normal parameters dictating AMT, and they’d appreciate being able to have this information recorded. (For example, a provider in southeast Oklahoma told us that “we only have one paramedic on scene and if it gets hairy, we absolutely need the helicopter crew there for additional skills and backup.”)

Our discussions with rural-area hospital providers suggested they’d welcome more information on why HEMS is being called. Reported a physician hospital administrator in north central Oklahoma, “we understand the helicopter is a scarce resource. We want it to be there when we need it, so we certainly don’t call it unless we have a good reason.” A prehospital provider in northeastern Oklahoma agreed with that concept, adding “we understand that these folks who are being transported, are our neighbors, friends, and maybe family – we’re not going to stick them with an expensive helicopter bill unless we really think they need it.” In another corner of the state, an EMS chief highlighted the fact that HEMS appropriateness in rural Oklahoma is not the same as it is in some other places: “Bryan Bledsoe [a prominent critic of HEMS overuse] used to be my medical director in Texas,” stated the paramedic. “What he says about HEMS use may be right for metro Dallas, but it doesn’t fit here in rural Oklahoma.”

As part of the process of documenting reasons for calling AMT, we’d need to assure rural providers that there is no intent to be punitive. If ground EMS crews are calling helicopters to avoid 5-hour loss of ALS coverage, that fact needs to be known. We may even identify some previously underappreciated reasons for AMT use. Those reasons may even be amenable to correction (*i.e.* to reduce need for HEMS without compromising patients or EMS regions).

A component of “reason for dispatch” that has never been explicitly addressed in the prehospital literature, is the use of HEMS for solely logistical purposes rather than crew expertise. With the understanding that there is bias built into these judgments, it does appear to be worthy of asking ground EMS to indicate whether they are calling HEMS for advanced care beyond that available at the scene. As stated in a group interview with prehospital providers from both rural and urban regions: “In the metropolitan areas, HEMS is a taxi. They don’t bring anything to the scene in terms of expertise. In more rural areas, the HEMS crew may have more experience and expertise, and bring something to the clinical care table.”

One thing we might learn from a complete and honest indication of reasons for HEMS call, is that ground EMS providers are thinking of patient comfort (not just mortality). An EMT in southeast Oklahoma reported that “in an ambulance, it can take way over an hour to cross the county. There’s no way you want to be riding in that bumpy ambulance with a femur fracture – it’s just torture. Plus, the HEMS people can give a lot more pain medicine than we can.” The same topic of long-distance transport arose on the other side of the state, in a conversation with an ED physician with prehospital experience: “It’s best for us to call Air Evac for painful orthopedic injuries, because the 2-hour ride up the turnpike is cruel and unusual punishment for these patients.” Whether or not a helicopter should be called for an isolated femur fracture is a question for debate – but the debate on this triage criterion or others, will be best informed when we know the frequency with which these reasons for AMT dispatch occur.

6. Perform UR on every AMT request.

The implications of the preceding recommendation run directly into UR. We suggest that every single

AMT transport request in Oklahoma undergo UR. It is not likely that Oklahoma can get a firm handle on UR, by only looking at the cases that generate complaint or discussion. Assessing all cases would provide a population-based view of exactly why HEMS is getting called. This would have research implications as well as practical value. If the reasons for AMT call were documented up front (as suggested in the previous point), UR would be facilitated; UR would be limited only by willingness of those calling HEMS, to be truthful about their reasons.

The mechanics of 100% UR would need to be arranged. For many regions, UR may already be occurring at 100% (this was reported by some prehospital chiefs). For others, UR may be more sporadic. Ascertainment of the level of UR in each region would need to be followed by a process to standardize UR, on the part of both the requestor and the transporting service. Work with the AMT services as well as ground EMS and referring hospitals, would help assure this process works as intended.

Review of flights should not be limited to trauma, nor should it be limited to non-physician requestors for HEMS. There are no data proving that scene trauma HEMS utilization is any less likely to be “appropriate,” as compared to nontrauma or interfacility flights.

Any HEMS outcomes advantage is not solely predicated on time, but time is nevertheless a critical component of helicopter operations. UR must therefore incorporate accurate times information.

UR can be very informative, especially if there are resources available to review details on selected cases. For instance, it would be useful for UR to focus on whether there were cases of interfacility transport, in which HEMS should have been called from the scene. It would also be informative to follow cases for which AMT was requested, but not able to be provided (either by the initially requested service, or not provided at all). Optimally, the plan would include assessment of all cases for which ground EMS *wished* to call HEMS, even if a call was never made (because of situations such as obvious weather issues).

The UR process needs to have participation from individuals who are perceived as being objective. A plan to rely on AMT services or receiving centers is neither fair nor likely to succeed. Transport services and hospitals are susceptible to understandable competition and marketing forces, that render them poor choices to give referring providers what may be perceived as adverse feedback. Additionally, objective UR could ameliorate the problems associated with trying to find hospital-based physicians at referring institutions to perform UR on their own staff partners. As one OSDH source stated: “It’s hard to expect good peer review when there are only a few physicians at a given facility.”

All-case UR would have benefits of focusing on some physician-driven overutilization. We heard about high-risk obstetrics cases that went by air, but which could have been transported by ground if the transport decision would have been made a few hours earlier. Physician education may help reduce these types of utilizations, and may also help reduce premature HEMS dispatches such as were described by one south Oklahoma EMS chief: “Our local hospital often doesn’t have orthopedics, so they fly all of the patients from there if there are bone injuries. What’s amazing, is that the hospital listens in on the radio, and they’ll call EMS and instruct them to call the helicopter even before EMS gets there, if the hospital thinks it’s something they don’t have capability to care for. The hospital will say to EMS, ‘don’t take them here, we can’t care for them.’ That may be reasonable in some cases, but I’ve seen isolated tib-fib fractures flown under those circumstances.”

7. Provide feedback based on UR results

Some of the advantages of every-case UR pointed out in the previous recommendation, require feedback be given to whomever called for AMT. We believe that feedback should occur on each case, even if that feedback is limited to a quick “good call” notice. Monthly reviews and feedback sessions could be prepared for individual users of AMT, depending on the mechanics of how the UR feedback system would be designed. This report’s authors have participated in statewide UR feedback efforts elsewhere, and we’d be interested in working with OSDH and others to create processes that work well for Oklahoma. Regardless of the details, what happens all too often, is UR without feedback – which is incomplete UR.

Dispatch process

If triage and utilization review were the main sources of dissatisfaction we encountered during work on this report, the often-byzantine nature of HEMS dispatch ran a close second. We regularly encountered EMS providers and ED physicians who bemoaned the fact that they often have to make multiple calls before they can decide on appropriate dispatch. From the HEMS program viewpoint, there are different concerns. One service's officials claim they regularly have to move their helicopter from its base helipad at a southwestern Oklahoma hospital, to make landing room on that helipad for another service's helicopter – a helicopter dispatched from 90 miles away to come and execute an interfacility transport.

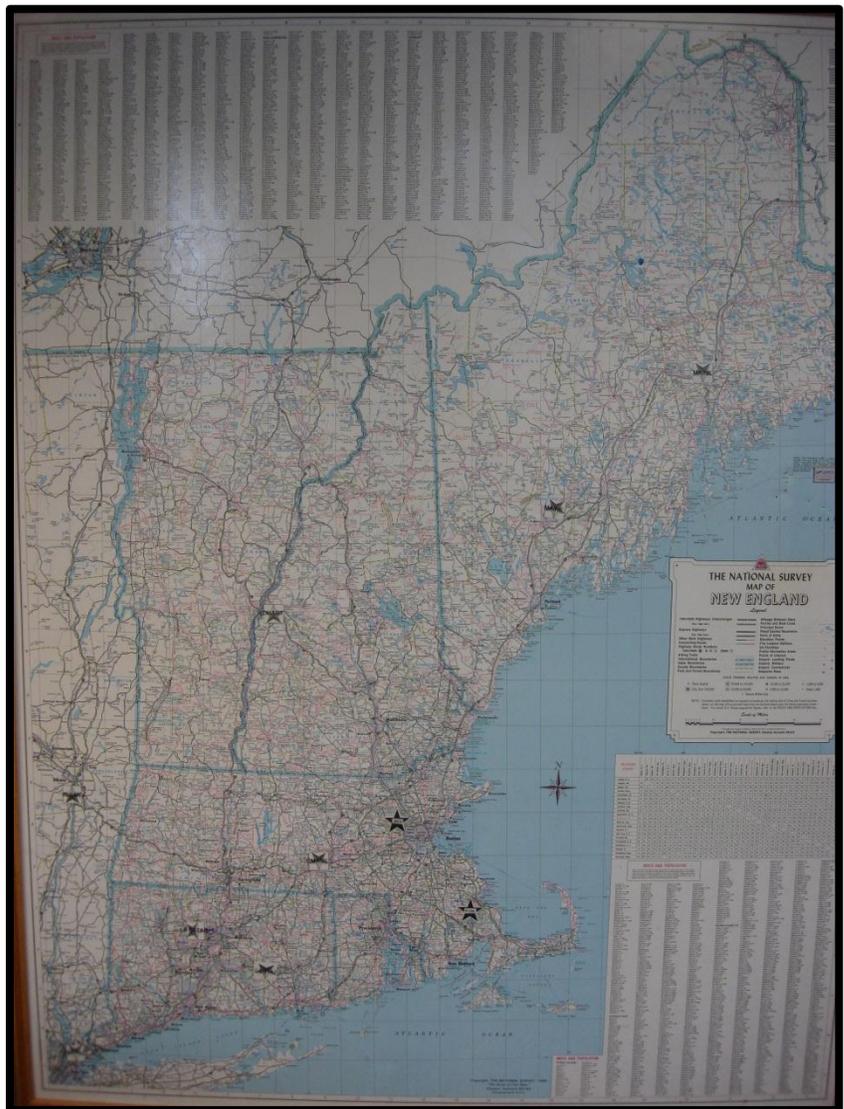
Although there is work to be done, correction of dispatch issues seems a more tractable problem than triage. Some recommendations will be made, but first we outline some issues illustrating the need for change. Following a brief introduction to dispatch issues, we offer specific recommendations.

At right is a map depicting HEMS assets for a given region. Many states' assets must be considered in order for most regional plans to be complete; this is also the case in Oklahoma. Static maps such as this are a necessary starting point, but true situational awareness is only enabled by real-time tracking of HEMS assets with dynamic, constantly updated mapping technology.

Dispatch problems & current resources

The current system does not work as well as Oklahomans deserve. There are delays incurred in calling multiple HEMS services, and there is frequent mistrust of ETAs and related information such as source location of responding helicopters. Furthermore, most individuals with whom we spoke, indicated that it was neither reasonable nor practical to expect HEMS services to call competing services' aircraft when this course was appropriate. A closer look at these issues follows.

HEMS services do report they call other programs when they are called for transport and are unable to provide the service. Ground EMS providers – correctly or incorrectly – are consistent in their disagreement with this proposition. One Fire/EMS Chief stated, "They don't tell us where the aircraft is coming from. They say 'we'll be there in 10 minutes' and then call back 10 minutes later and say the same thing. We have recurring 40-minute actual response times, for patients who had quoted response times



of 10 minutes and who were 20 minutes' ground transport from the trauma center."

Another example of a commonly occurring theme was heard in north-central Oklahoma: "When Eagle-Med is called, we have no idea whether they're coming from Baptist or Stillwater – which is much further away and the time makes a big difference." Help with cross-service dispatch is spotty. Says one EMS chief, "We call the helicopter service based in our county first. If they're not available here in the county, they may call and help us find a helicopter, but only if we specifically ask them and even then they're not consistent with being willing to help. They usually would rather we just use another one of their aircraft from further away."

What often occurs, is that the most appropriate helicopter – the closest one – is not the one that responds. As one prehospital provider remarked, "it's just too cumbersome to expect people to always call multiple services to see who's really closest. Sometimes they call one number and if that service says 'yes' they quit asking questions." Historical ties with certain HEMS services are also potentially problematic. Such loyalties can be responsible for inappropriate preferential use of one service, even when there is another service's aircraft in preferable position to execute a transport (*e.g.* as mentioned at the top paragraph of this page).

Interviews identified broad skepticism about HEMS services' ever being able to be expected to perform well on passing flights to other services. One group of EMS providers agreed that "No HEMS service really ever passes flights off to any other service, if they have any aircraft anywhere that can do the flight. MediFlight is the best of the services in our area, but even they will send their helicopter all the way from Seminole rather than pass the call off to a closer aircraft from another service."

Even though the system sometimes works, there is undeniable inconsistency. An appreciative prehospital provider related a story of calling Air Evac, which service was unavailable but whom then called a second program's aircraft. Unfortunately, this individual reported that there had been instances in which Air Evac had not executed those other-service calls when maybe they should have. This EMS director was strongly appreciative of the help provided by Air Evac on at least one occasion, but he was equally strong in the sentiment that consistent allocation of calls to the right aircraft would be best enabled by central dispatch.

There are some resources that are already in place, that seem quite well positioned to aid in improving AMT dispatch. The main two resources are the Trauma Referral Center (TReC) and EMResource.

TReC was set up for trauma, but seems well-positioned to extend its focus to other time-urgent situations. Currently, TReC has little if anything to do with HEMS. TReC leaders report they "very rarely speak with HEMS. In fact, it may be 'never.'" TReC's unfamiliarity with HEMS real-time logistics (which is not TReC's "fault") was a common refrain heard from many, during preparation of this report.

Despite not interacting much with HEMS, TReC has identified problems with HEMS dispatch. The most common issue TReC encounters is improper execution of HEMS dispatch (*e.g.* failure of a HEMS service to triage a call to another service's better-positioned aircraft). TReC personnel aren't able to do anything about this. Nor are TReC workers able to do much about some other problems they encounter – problems that could be solved with the recommendations we present later on. These problems include lack of ability to have a physician on hand to deal with challenging cases, or to assist handling non-trauma calls (which do come in to TReC). TReC personnel reported to us that "it would be very advantageous to us to have physicians here with us for quick consultations or when someone really wants to talk to a doc."

TReC could, with adjustment of duties and allocation of some additional resources, be well-suited to assist in dispatch. TReC leadership points out that "TReC would benefit from having one person on line discussing a case, with a second TReC person arranging dispatch. But this is not done." TReC does have a roster of available hospitals for provision of a given type of care; the roster rotates on a daily (not per-patient) basis.

TReC has access to EMResource, which has substantial capabilities for following asset availability in Oklahoma. With thanks to Bill Henrion for providing the information, EMResource's capabilities include: monitoring healthcare assets, tracking ED capacity, HAVBED reporting, biosurveillance, mass casualty resource tracking, and more. In terms of HEMS and regional transport issues, EMResource offerings include tracking of HEMS assets and monitoring of hospital capabilities to receive patients in each of nine diagnostic categories.

TReC personnel report that, through no fault of EMResource, the program's HEMS component is not

very reliable. “We don’t really trust the ‘HEMS Available’ on-line indicators; often things are indicated as available, when they really aren’t.”

It may be true that EMResource can be improved, and it may also be the case that TReC could stand some modification. However, it is quite clear that EMResource and TReC were well-conceived projects, the planning and building of which required a substantial amount of hard work – hard work that continues to pay off. It certainly seems that these tools are among the strengths of Oklahoma’s system, and TReC and EMResource represent a basis upon which to build solutions to the dispatch problem.

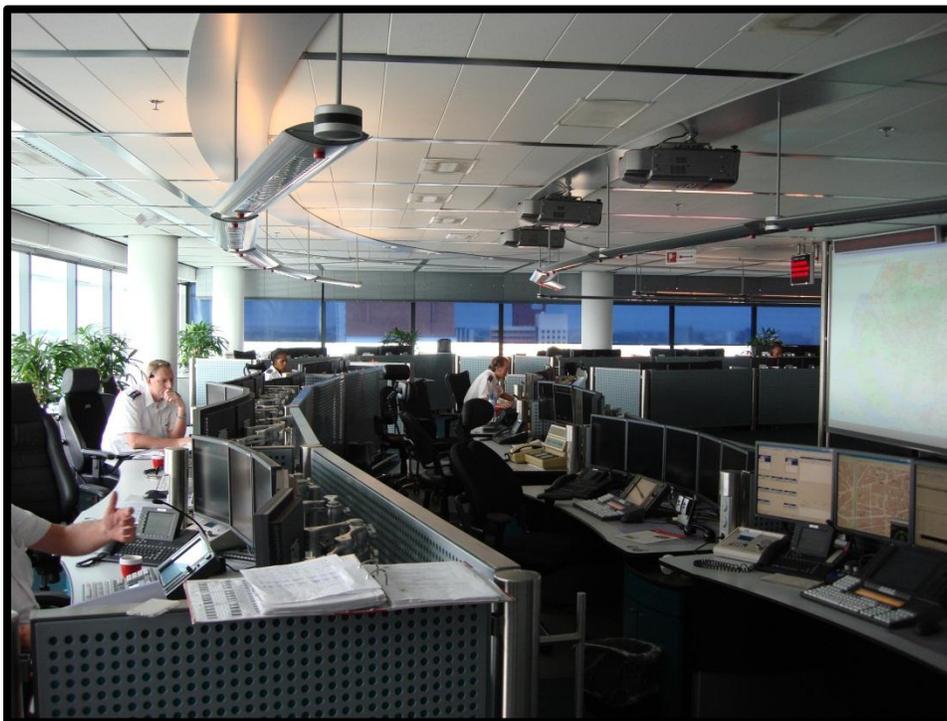
1. Establish centralized asset following, vehicle triage decision support, and AMT dispatch.

Caregivers throughout Oklahoma consistently expressed frustration with the inability to call a single number for AMT. With only a few dozen total RW assets responding in our state, modern asset tracking technology easily allows for a firm handle on the system. Centralized answering of calls by a state-sponsored entity, that could quickly assign the closest appropriate vehicle, would be a significant step towards an ideal system.

The state-sponsored center would use GPS tracking provided by the HEMS services (which have agreed to provide this information, during interviews for this report). The call center would have indications of which aircraft are in-service, which are out of service, and which are in-service with response delays.

A call for HEMS transport would be made to the center, and the first step would be to determine whether the caller had questions regarding necessity of AMT. In a case where there was a question about vehicle triage, the central dispatch center would have access to (previously agreed-upon) protocols, and for borderline or unusual cases the center would have ready access to experienced physicians to aid with decision making.

Centralized decision support could help in the uncommon instances in which public service officers arrive at patients long before ground EMS. A law enforcement officer, from OHP, remarked that in his area he’s often the first on-scene and spends a long time waiting on help. He said a state-sponsored central triage and dispatch (with decision support) would be “wonderful.” He pointed out that in some cases, OHP follows the preferences to wait on EMS before calling HEMS but that this costs “an awful lot of time sometimes.”



Shown left, is the centralized HEMS tracking and dispatch center for The Netherlands (a country with a quarter of Oklahoma’s area). A large display at the room’s front depicts real-time asset location and availability. Medical personnel workstation capabilities include communications, dispatch, and tracking software.

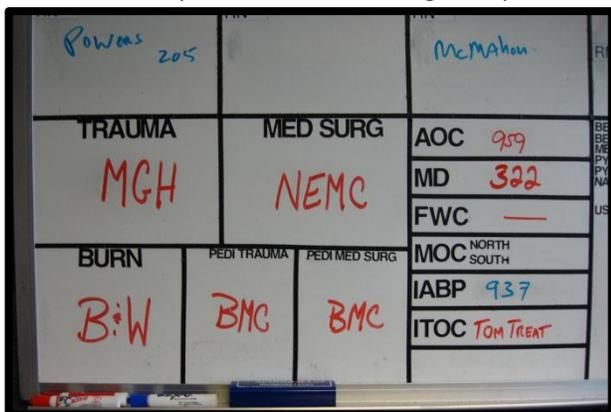
Centralized dispatch decision making must consider out-of-state assets. Transport of Oklahoma-sited patients may respond from (or take patients to) Kansas, Missouri, Arkansas, or Texas. In some areas, such as northeastern Oklahoma, the nearest HEMS providers are *usually* coming from out-of-state. Providers in this area call and check availability of multiple helicopters. As one chief of EMS explained: “We call EagleMed in Missouri, and hopefully they’re available. If they aren’t available we call MedFlight (ARCH) from Missouri. If neither of those are available we may just transport by ground to Joplin – it’s only half-hour away. Sometimes, we call a helicopter service from Joplin, thinking that aircraft is coming, and instead they send a helicopter from Bentonville (Arkansas)...but if we find out the aircraft is really coming from Bentonville we’ll just cancel the helicopter and go by ground as that’s faster.” In addition to illustrating the importance of considering out-of-state assets, the story demonstrates yet again the dispatch quagmire with which Oklahoma’s prehospital providers deal on a daily basis.

It is worth mentioning, that “on-site” helipads really means that there is no ground EMS leg that has to occur, and that some hospitals that reported “on-site” pads actually have a ground transport leg. The Deaconess Hospital uses Baptist’s helipad, and there is an EMSA ground leg required for all such transports; Baptist itself uses a ground ambulance to get patients from the helipad to the ED. This issue may not be critical, but it should be clarified when HEMS is being considered. Centralized dispatch would go far towards having HEMS being dispatched by personnel with knowledge of exactly which additional transport legs might be entailed, with use of the helicopter. Without intending any criticism of the centers with “on-site” pads requiring ground transfers, the literature (as previously discussed) clearly outlines the importance of understanding and considering in triage, *all* parts of a potential transport.

Dispatch centers costing substantial dollars (and other resources) exist for the air medical service providers of Oklahoma. Rather than replace (or worse, replicate) these centers in Oklahoma, the plan should be to investigate mechanisms for centralized call evaluation and HEMS dispatch, with the latter actually still occurring with a quick phone call to HEMS service dispatch centers. There would be little barrier to this for interfacility transports; this may be a first-step maneuver to assess the feasibility of centralized dispatch. It is acknowledged that in this area, much work and planning would need to occur. It’s important to note that the concept of centralized dispatch was discussed in detail with both Air Evac and Air Methods. Both services’ senior officials supported the concept and indeed embraced the idea that a nonpartisan (state) center could improve system efficiency while optimizing resource utilization.

2. Offer assistance with destination determination: Establish a multidisciplinary roster system.

In many cases, referring providers know exactly where they wish their patient to go. In those cases, the centralized dispatch center’s role is limited to vehicle assignment and dispatch, with facilitation of contact with personnel at the receiving hospitals. In some cases, though, prehospital or hospital personnel may not know where their patients need to go. These cases are not rare in Oklahoma, and this report’s authors encountered quite a few cases in which rural ED practitioners had to do some telephoning around to find an accepting hospital. For these patients, the “unassigned” patients, time can be wasted in trying to find a receiving hospital. Fortunately, there is a clear way out of this problem: establishment of a roster system and assignment of receiving hospitals by the centralized dispatch center.



At left is the “roster” at Boston MedFlight Communications. Competition is an issue with rosters, but Oklahoma competition is no more intense than that in Boston’s centers (Brigham & Women’s Hospital, Massachusetts General Hospital, Boston Medical Center, New England Medical Center, Children’s Hospital, and Beth Israel Deaconess).

This recommendation is part of centralized dispatch, but it's listed separately from the initial recommendation because of its different political hurdles. The fact of the matter is, in areas characterized by even more inter-hospital competition than is seen in Oklahoma, centralized assignment of receiving centers for "unassigned" patients (*i.e.* those cases for which the provider calling for AMT already has an intended receiving facility) works quite well.¹⁵³

The authors of this report have considerable experience with this system, as operated by a single call center (at a nonprofit AMT service) that tracks which hospital is next on a rotating roster, for a variety of patient types (*e.g.* trauma, cardiac, stroke, pediatric). The advantage for those calling the centralized dispatch number, is that they make a single call and 1) get an aircraft dispatched, and/or get advice on vehicle triage if there is a question, 2) are assigned a receiving facility based upon the roster, and 3) are transferred to the receiving facility's ED (or other personnel) by phone, to discuss patients with receiving facilities. Hospitals' agreement to participate in the roster system means they agree to accept all unassigned patients when they are "up next" unless they have taken themselves out of the rotation. This system has worked extremely well for decades in Boston, partially because it respects referring physicians' wishes to select the receiving hospital when there are preferences. Other contributors to system success is the maintenance of very strict confidentiality with regard to referral patterns; even the 6-hospital "owners" of the nonprofit AMT service in Boston, could not see the referral information for the other hospitals in the network.

AIR TRANSPORT OF PATIENTS WITH UNSTABLE AORTIC ANEURYSMS DIRECTLY INTO OPERATING ROOMS

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ABSTRACT

Objective. The purpose of this study was to describe an air transport service's protocol for direct transport of patients with abdominal aortic aneurysm leak (AAAL) into receiving hospital operating rooms (ORs). **Methods.** This retrospective consecutive-case analysis examined AAAL patients undergoing nurse-paramedic Boston MedFlight (BMF) transport during 1999–2004, who were taken directly into ORs at four academic centers. BMF uses a rotating roster system to assign receiving hospitals when referring physicians have no preidentified receiving facility, but this practice may prolong patient transport or be associated with less diagnostic certainty, and thus more delay, at receiving hospitals. Thus, the study compared "Roster" versus "Non-roster" patients' time and outcome end points. Continuous nonpara-

INTRODUCTION

In recent years, use of helicopter EMS (HEMS) to facilitate rapid provision of specialized care has taken myriad forms. In most cases, HEMS interfacility transport is used to get patients to a receiving hospital's emergency department (ED) or to a medical or surgical ward. In some instances, however, an urgent need for intervention prompts HEMS delivery of patients directly to a specialized hospital unit.

The most obvious example of "direct-to-therapy" transport is the trauma patient taken directly to the operating room (OR); indeed, literature has addressed use of HEMS in combination with immediate operation as long ago as 1982.¹ More recently, authors have noted

Roster systems work, not only for trauma patients but for a variety of those cases in which outcomes are threatened by extensive time spent searching for a receiving facility. The literature from an area using a roster system (combined with a direct-to-OR protocol, bypassing the ED) demonstrates clear advantages – with very few risks or disadvantages – in "pre-designation" of receiving centers. Roster systems are characterized by potential for all sorts of competition-based hurdles, but these hurdles have been overcome elsewhere in the country. Oklahomans can similarly work together to achieve the best healthcare system for time-critical patients.

Centralized dispatch would also be able to track those patients for whom AMT was requested, but for whom it was unavailable. Patterns of non-available that recur, could be identified and potentially drive efforts to improve HEMS asset placement statewide. An example case, provided by an ED physician in southwestern Oklahoma, is illustrative: "Our ground EMS called for Air Evac, but they got an hour for ETA due to shift change. So instead of sending the patient to the Level I center in Oklahoma City, where they really needed to go, they

came by ground here and then were transported by air to OU. The patient had a head bleed and a pelvic fracture, and we didn't do much for him here but run up a lot of bills and X-rays before shipping him where he needed to go in the first place." This may be an isolated story, but if centralized dispatch tracked these sorts of occurrences, analysis of these types of calls could lead to better systems design and better understanding of the true cost-benefit calculus.

One idea (heard from OSDH personnel), is to get the Oklahoma Hospital Association involved in a pilot project to categorize facilities and their capabilities, and track their readiness at any given time. This sort of asset tracking would be an important complement to, and just as important as, the tracking of aviation assets.

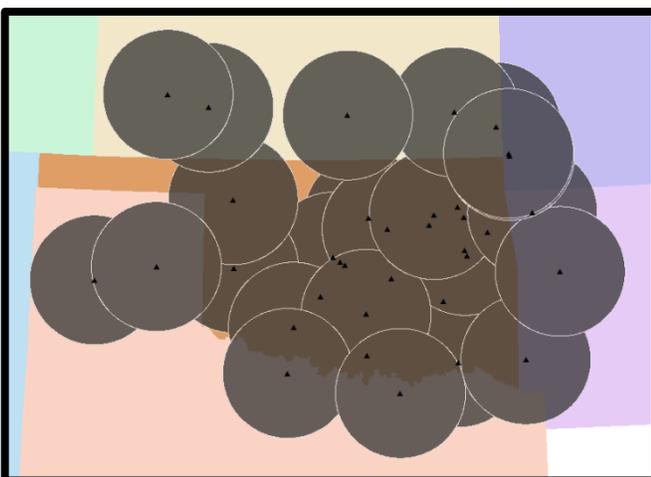
3. Require AMT services to notify a coordinating center (e.g. central dispatch) of response plans.

When any AMT service is responding to a scene in Oklahoma, that service should notify the other services operating in the same area, that they are on the way to the scene. This notification, which could occur via a centralized dispatch and asset management system (as previously recommended), has advantages in both aviation safety and asset preservation (for other calls).

One refrain heard around the state, was the problem of multiple helicopters responding to the same trauma scene. In nearly every region of the state in which it was logistically possible to have more than one air medical unit respond to the same scene, this scenario appears to have occurred at least a few times. In north central Oklahoma, an OHP trooper told of seeing three different helicopters arriving at the same scene, when he wasn't even sure one was needed. Similar stories, usually with two aircraft but sometimes with three, were heard in other areas of the state. A central Oklahoma hospital administrator with EMS experience reported that at a lake fire (in which there were no serious injuries), he witnessed three helicopters responding. He said, "HEMS is essential, but overused. We have to have statewide triage and dispatch to get this under control."

The "cost" of this inefficiency goes beyond fuel, and includes such issues as resource thinning. Helicopters that are superfluous at a scene represent assets that have been removed from their bases (and base coverage areas), risking prolonged response times to any legitimate calls back in their base areas.

Notification of plans to respond is a common-sense move, and one that should be able to be implemented. Some issues will of course need to be discussed (e.g. autolaunch, which is dispatch of an aircraft based upon pre-EMS information, on the contingency that HEMS will be needed.) Autolaunch has its advantages, most notably streamlined response times to remote scenes (to which launch is activated based upon radio traffic from police officers arriving at trauma sites well in advance of EMS). Autolaunch disadvantages include increased risk of multiple aircraft arriving at the same scene, if communications are suboptimal. Centralized dispatch that takes autolaunch into account, through GPS-based tracking as well as communications, would eliminate this problem. The AMT program that practices autolaunch most frequently in Oklahoma (Air Evac) has indicated they are enthusiastic to participate in a centralized GPS-based dispatching system.



The map at left depicts the 30-minute flying radii from HEMS bases serving Oklahoma. When all aircraft are at their bases, most of the state seems reasonably well covered. However, if multiple aircraft leave their bases for the same (one-patient) scene, HEMS response times for subsequent (truly needy) patients in the "home base area" could be needlessly prolonged.

Logistics: Timing and geography

Many of this report's recommendations are in some way linked to geography or timing/logistics. This part of the recommendations section will address some logistics ideas that are not discussed in detail elsewhere.

1. *Execute hospital-by-hospital analysis of LZ location.*

Through no ill intent or purposeful deception, some of the hospitals that reported on-site helipads in a recent survey by OUDEM, actually require a ground transport from their "on-site" pad. These extra transfers (and times) must be considered in terms of logistics "costs" since the extra time periods and patient movements can reduce or even negate benefits of air medical transport.^{48,55-57} To the extent that finances and other barriers can be overcome, the desired solution for Oklahoma is for all hospitals/facilities that use HEMS, to have true on-site helipads. We will not know how we are progressing towards that goal, until we know the current status.

The action item for this intervention is to generate a listing of every acute care hospital, with data on transport length (and need for ground ambulance leg) between the helipad and the hospital's usual receiving areas. Some details would need to be arranged (*e.g.* determination of which part of the hospital from which distances are measured), but these are solvable problems. A statewide database of information (easily obtained from a variety of sources) would be useful for systems planning and well-informed vehicle triage decisions.

2. *Generate a statewide resource for pre-established landing zones.*

This has largely been done, at least in many areas of Oklahoma. In LeFlore County, for instance, there are about 30 such LZs. Pre-designation of LZs has potential benefits that include both safety and time savings; rather than trying to explain where a pick-up point is, prehospital providers simply request "HEMS to LZ14."

In some areas, pre-established LZs have already been established, but are not used due to the fact that response times are so long (due to long distances) that it's easier to get patients to the hospital or the airport. As hospital and airport LZs tend to be safer, there's no reason to require ambulances stay at the scene with patients just because there is a predesignated LZ.

For those areas where pre-established LZs have been established, OSDH may be able to help with system performance by assuring everyone has the same information. Communications and efficiency would be optimized by having ground EMS and AMT services operating from the same reference.

3. *Investigate whether air medical assets should be added, subtracted, or moved.*

In Oklahoma, air medical resource placement is critical. Often, the news is good: a hospital administrator in one western OK town remarked that "having a helicopter move to our area has been a godsend." Interestingly, the chief of the regional EMS system, in a separate interview, stated in reference to the exact same helicopter: "About half the time we call HEMS, they are not available within any reasonable time frame so we have to transport to the local facility which is nowhere near suitable to take care of the patient. The ETAs for other air medical services are 30-40 minutes, so we have no choice and have to go to the Level 4 facility."

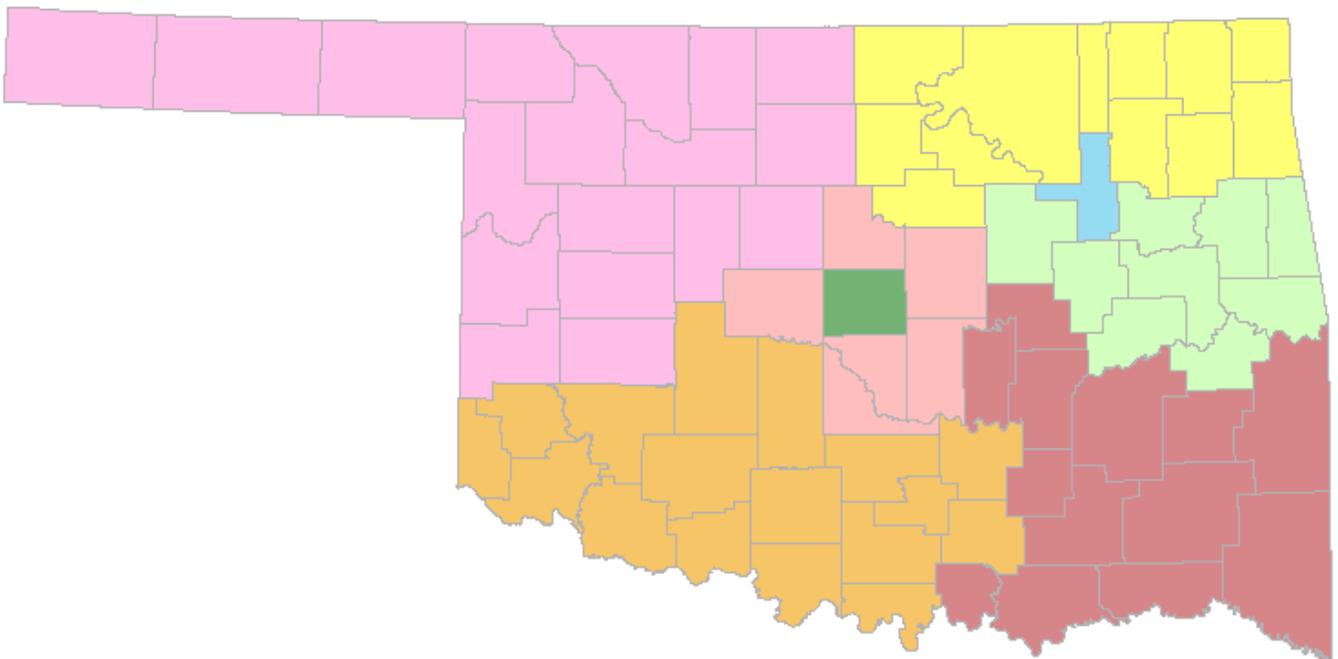
The issue mentioned above, may be one of depth of resources. If a HEMS unit is busy a lot, and a lot of flights are missed, then that unit's profitability is good but patients don't get the expedited AMT access they need. Some geographic data-gathering (and cross-referencing to missed calls as collected from a centralized dispatch operation) would inform consideration of this issue.

In Oklahoma, distances can be great. "Oklahoma City seems a million miles away," remarked one law enforcement official in the panhandle. "We sure need a helicopter placed here." Other public safety officers nearby, stated they were often on-scene for a long time before EMS arrival. Said one OHP trooper, "When we lost the Guymon helicopter, it got real tough. With no helicopter available – which is often the case – we have to go over 2 hours by ground to Amarillo, which is where 99% of our transports go." The same official noted Oklahoma-based helicopter unavailability often resulted in calling air medical services from Amarillo.

No one encountered during preparation of this report criticized the air medical service that ran the

Guymon aircraft, for removing that aircraft. All understood the economics...but the characterization of the helicopter loss as “a major blow” (as quoted by an area OHP trooper) was the common theme. A prehospital provider familiar with the panhandle situation noted that the helicopter removal “crippled our ability to move people quickly. We really need some state-subsidized helicopter service.” Another regional EMS provider pointed out that, even if there is availability of the now-closest air medical asset, the response times for the panhandle “usually run 40 minutes or so to get a helicopter here, so we often go to the hospital for a modified scene run.”

Investigation of the costs and benefits of air medical asset placement may reveal recommendations for placement of new aircraft. No one expects the AMT services to just move aircraft around or add new assets that will lose money, but the first step is to determine where (if anywhere) asset location changes/additions are needed. If any such asset location changes are identified as necessary, then conversations can begin as to how those resources may need to be supported. As is the case with many of the recommendations in this section, collection of data will drive the ultimate decision making process.



Oklahoma’s prehospital regions constitute an excellent geographic basis from which to execute area-level planning related to AMT. The geographic regions’ current advisory board system could potentially be modified to include all aspects of prehospital care and interfacility transport within state systems of care.

4. Document response times for quality assurance and mapping purposes (to identify “holes” in the system).

The following comes from a physician in a mid-sized town in Oklahoma: “The medical flight crews are not always based with the helicopter, and that often adds a half-hour or so to the time they can lift off. I remember on more than one occasion, where the aircraft ETA to our hospital was an hour – and it really shouldn’t be more than half that if crews are there.”

Documentation of these types of data should not be problematic. Oklahoma agencies already submit NEMSIS-compliant data – with addition of some Oklahoma-specific data – and the “catch” rate is about 99% of all transports. It should not be difficult to execute minor adjustments to the data, to allow for capture of data elements that are deemed critical to ongoing quality assurance efforts.

Response time documentation is also important to track and demonstrate response times when they

are good. OKC hospital administrators are worried that lack of timely response could be causing loss of patients (and revenue) to Texas hospitals. Data can help test the hypothesis of these administrators – and if the hypothesis is proved then perhaps the administrators would consider funding subsidized helicopter asset placement.

5. *Characterize the role of FW transport in Oklahoma.*

The larger the area, the more likely FW becomes a viable option, and Oklahoma is a very large state. Some realize this. At OSDH, personnel discussing this report made sure to recommend FW's being mentioned as an underutilized asset. A rural hospital CEO agreed: "Fixed-wing is very undersold, undermarketed, and underused in Oklahoma."

In addition to Oklahoma's distance factors, which are substantial, our state has weather patterns that can seem unusually harsh. The skies are usually, but not always, blue in Oklahoma. Bad weather can certainly be sufficiently severe to stop even airplanes from flying, but as a general rule when weather stops helicopters from flying it is worth at least checking whether FW assets can be used for AMT.

The action item would start with generating a map of Oklahoma, with flight-radius circles for FW (like the maps previously drawn for RW). Institution of a centralized dispatch center (see previous recommendation) could include an information matrix (time, distance, acuity, etc.) that could inform decisions as to whether triage to FW were sensible.

6. *Centralize aviation asset tracking.*

This recommendation is closely linked to the centralized dispatch and related recommendations presented earlier. Some aspects are strictly geographic/logistic, and thus the recommendation is repeated here.

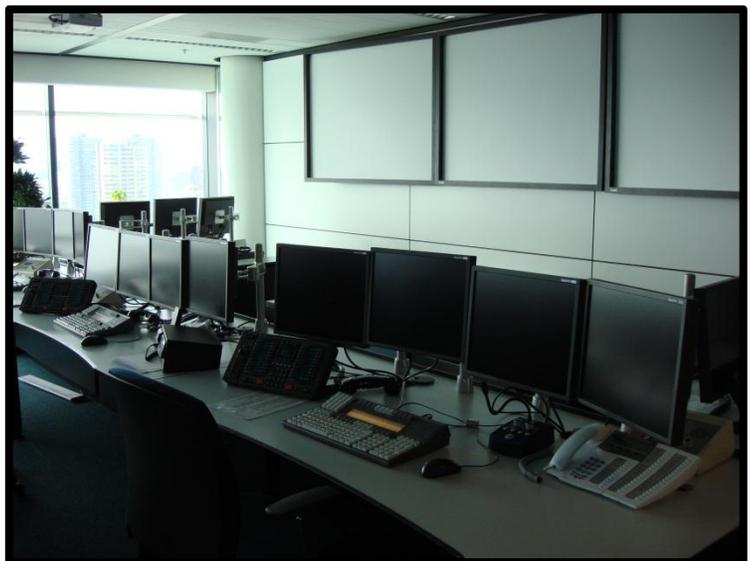
One of the most frustrating issues for the prehospital providers with whom we spoke, was the lack of a single resource for triage to, and dispatch of, the most appropriate air medical provider. The same issue was raised by hospital providers. Whether or not centralized dispatch decision-making can be effected in Oklahoma remains to be seen, but the first step is an *accurate* up-to-date awareness of air medical resource positioning and availability. Tracking at the level that's needed, is relatively easily provided using computer technology and dynamic displays such as the monitoring center depicted at right (from Rotterdam).

State-level tracking is provided, according to Air Methods officials, in at least one state (Arizona). Officials at both Air Methods and Air Evac have indicated they would be comfortable sharing GPS-based helicopter asset tracking information with the State. Presumably, since EagleMed has the same parent company as Air Evac, such asset tracking would not be a problem from the perspective of that service.

In the opinion of the authors of this report, centralized asset tracking would be ineffectual in the absence of centralized dispatch. However, centralized tracking could be an intermediate point in working toward a unified system for asset tracking, triage, and dispatch.

EMResource, an excellent idea arising from within OSDH, is used by many, but is often reported to be problematic in terms of its being updated with minute-by-minute asset availability. OSDH personnel report they could use assistance in improving the accuracy and overall performance of EMResource.

EMResource isn't helping trauma centers in some cases. In one semi-rural area, the EMS chief reported that the trauma center handles helicopter dispatch. "If we need a trauma center, we just call them. They then



call the helicopter, maybe depending on which helicopter is closest, but it's pretty obvious sometimes that the trauma center doesn't really know where the nearest helicopter is. They're also more likely to call their preferred helicopter group to do the transport."

One issue with respect to asset tracking, is to avoid situations where a helicopter accepts a mission while still on another mission. Prehospital providers in central Oklahoma stated, "EagleMed does all of the interfacility transports within the INTEGRIS system, even if there are other helicopters closer-by. That may be okay, but what's not okay is that they'll accept a scene mission if they're 'almost done' with an interfacility transport – and they will give an inaccurate ETA."

Asset tracking has to rely on data provided by AMT services, and those services have to provide accurate data. Air Methods and Air Evac officials both pointed out that centralized dispatch decision-making is already underway in some regions. Part of the system, is that assets that are reported as "available" must really be available, within the time frame reflected in the central asset tracker. For example, if a helicopter is labeled as "available with 20-minute launch delay", the aircraft has to actually meet that timeline. Air medical assets that are reported as available, and found to be unavailable due to either spot-checks or actual calls, result in removal of the service provider from the "rotation" (for those areas served by more than one service). This seems a poor solution to Oklahoma's problem of accurate recording of asset availability – patients could be triaged to a further-out aircraft if a HEMS unit is taken out of the rotation. However, it appears likely that OSDH could work with the air medical service providers to generate a consensus set of guidelines governing behavior in this arena.

7. Continue education regarding recommended destination centers for trauma.

There were instances in which EMS personnel seemed to have a misunderstanding of the state-promulgated trauma triage guidelines. As outlined in Oklahoma's regional trauma destination plans (which spell out destinations on a county-by-county basis), the current system for transfer of the injured takes into account patient status, logistics, and local resources. While not identified in a concrete pattern, interviews with pre-hospital personnel suggest a perception that some HEMS transports are occurring for patients that ought to be cared for locally (or at most, undergo short ground EMS transport to Level III centers).

The trauma destination plans that have already been generated by the efforts of many within Oklahoma, seem well-tailored to address the potential for confusion. While trauma destination (or trauma in general) is not the intended focus of this monograph, it must be acknowledged that the decisions surrounding transport mode are inextricably linked to those regarding destination. Further work along the lines of maximizing appropriate HEMS utilization should incorporate continuing education on the trauma destination plans applicable in given regions.



Oklahoma's trauma triage and destination plans have been carefully prepared, and education in this arena is ongoing. It is anticipated that continuing efforts to disseminate the tools that have already been developed, will result in improved system performance.

Medical care

Medical care is an area in which the state may wish to tread lightly. AMT services tend to know well, how to hire, train, and monitor their crews and the care they provide. This is especially the case, if the programs are all CAMTS-certified (as recommended earlier). Some fundamentals are provided herein, to serve as a basis for discussion. It is certainly the case, that CAMTS standards are a “baseline” goal, and that Oklahoma could easily become a nationwide example for coordinated care by surpassing the CAMTS-level standards. It would take far more cooperation than money, to reach this goal.

1. Investigate whether vehicle issues are a problem.

With the Oklahoma programs’ move to smaller aircraft, there has been some angst. Every crew member always wants a larger, faster aircraft...but this also means a more expensive aircraft. The very reason so many hospital-based HEMS programs have run into financial problems, is that the economics mathematics just doesn’t work well for most of the mid-size or larger twin-engine aircraft.

The transition to smaller aircraft, which is not necessarily inevitably a bad thing, does bring some issues. Weight-and-balance issues are more likely to come into play. One hospital administrator in a tertiary facility, noted that his hospital had to spend a large amount of money on a smaller isolette, and they had to move from a 3-person to a 2-person specialty crew (with attendant loss of care capabilities).

The action item for this recommendation, is to discuss whether the occasional need for a larger aircraft (*e.g.* to accommodate larger crew or equipment) is sufficient to try and determine if there’s an economically viable pathway to having such an asset. This would include discussions with air medical crews as well as referring and receiving physicians, to determine the resources required for such an asset – and the potential sources for those resources if they were determined to be desirable.

2. Characterize HEMS medical crews.

The opinions about HEMS crews ranged widely as we traveled the state. One opinion that was commonly encountered, was that “we don’t know what we’re getting.” HEMS crew qualifications, training, background, experience, and clinical care protocols are, in the words of some physicians with whom we spoke, a “black hole.” These opinions are important, as they drive the (sometimes logistically nonsensical) selection of some HEMS services over others.

Opinions about differential HEMS crews’ abilities may or may not be correct, but it would be nice to have some handle on the truth either way. A group of prehospital providers in central Oklahoma agreed that, on balance, there was a difference in quality among the services they used. “The new folks have far less training than the old-timers had when they started. It used to be very difficult to get hired on at MediFlight – now they’re hiring people with only a few years’ nursing experience.” Confidential information obtained from hospital administration at one site, also yielded some concerns about overall quality of a particular service’s crew.

If statements like the above are true, then there may need to be some additional training requested. If there are really substantial differences in crew qualities, the state should strongly consider working to assure that crews’ capabilities are at least roughly similar. Just as importantly, if the statements are unfair generalizations, that information should be collected and disseminated to reassure prehospital providers. If the state’s aim will be to have the closest RW asset defined as the appropriate one, then there shouldn’t be a lot of difference between crews. It is both unfair and unworkable, to ask those who have the difficult job of triage, to take into account differential capabilities of varying crews.

The action item is to consider having OSDH poll AMT services to get a cross-sectional report on medical crews’ basics: years’ healthcare experience, degree/certifications, years’ AMT experience. Other parameters could conceivably be added as well.

3. *Generate standard state-endorsed guidelines for some components of AMT care.*

A trauma patient who is injured in eastern Oklahoma may receive prehospital blood transfusions...*if* the responding service is Tulsa Life Flight. Other AMT services do not offer prehospital packed red blood cells (PRBCs). Transfusion capability for hemorrhagic shock has the theoretical potential (becoming less theoretical and more real, given the evolution of the evidence) to impact survival. If having PRBC transfusion capability is desirable in any part of Oklahoma, it's desirable regardless of which HEMS service responds, and transfusion capability should be available anywhere in the state. One reason to generate state protocols, is to have evidence-based evaluation of questions, considered in light of our regional and geographic needs, serve as a basis for state-promulgated recommendations.

No one with experience in HEMS is likely to believe that strict standardization of care is a good idea. However, on some major issues (e.g. PRBC transfusion) it seems wise to promote similar approaches for “big-picture items.” The bottom line is not homogenization of care; this goal seems unrealistic. Rather, the goal would be to promote calling appropriate aircraft based on logistics rather than medical care capabilities (it's not fair to ask prehospital providers to keep track of medical care differences). The PRBC issue is brought up because it's an example of a difficult arrangement to make, but one that is perceived as potentially being sufficiently important to offset longer ETAs. At least one prehospital provider gave PRBC transfusion capability as a major reason for calling TLF – even if the aircraft has a longer ETA to the scene than another service's RW asset.



HEMS care should be equally good regardless of the particular service providing transport.

Other medical care issues may be amenable to inter-service discussions, with generation of statewide protocols that reflect combination of evidence and Oklahoma specialist preferences. Similar protocols have been developed in other U.S. regions; protocols for pretransport stabilization of cardiac, trauma, and stroke patients in Boston ended up saving significant time. For example, a physician in central Oklahoma notes that the HEMS service spends about 20 minutes in changing IV pumps over to that service's equipment, and wonders if

this delay is really necessary. It may be necessary, but it may not be needed; review of protocols by all services has potential to tease out whether there's any "low-hanging fruit" in terms of generating common approaches.

In some cases, statewide "protocols" could have protective or justifying effect on AMT crew practices. During the work on this report, we frequently heard complaints that HEMS crews intubate too frequently. We have heard those complaints around the country for decades. They are usually equally well-intentioned and erroneous; the errors are based upon unfamiliarity with airway management in the AMT setting.

In many cases, preflight intubation is dictated by limitations of providing in-flight care.¹⁵⁴ Even those studies that have demonstrated high in-flight intubation success, have noted the retrospective nature of data collection and recommended judicious use of pre-flight airway control.¹³⁸ As prehospital providers, the authors of this report are concerned about pressures to delay definitive airway management in patients undergoing transport in a risky setting. Standardized protocols for airway management would allow for off-line discussion and determination as to the factors that should lead to pre-flight airway management. Overzealous intubations "just for flight" would be reduced, and (equally importantly), providers unfamiliar with helicopter EMS care would be reassured by state-endorsed protocols guiding performance of intubation.

Another pre-flight intervention, the requirement for placement of tube thoracostomy for all pneumothorax patients undergoing HEMS transport, is also erroneous and potentially more dangerous. In this arena, state-endorsed protocols could help explain why, in patients not on positive pressure ventilation, tiny pneumothoraces are unlikely to cause intratransport problems. In this case, AMT crews would be able to perform case-by-case as well as offline education, against placement of some unnecessary chest tubes.

One commonly encountered opinion within the tertiary hospitals, was that HEMS crews' practice is pretty much in a "black box." Said one neurologist, "We have no idea what the air medical crews are doing post-lysis, for instance. They've never shared their protocols, and we just never talk to them. We feel far more 'connected' to the ground EMS crews that transport us patients, than we do to any of the three helicopter services." This lack of connection would be addressed by working toward some common transport care guidelines.

Airway management may be an area in which common care guidelines could be generated. The action item for this recommendation, would be to work together to decide which – if any – areas of AMT stabilization and transport might be amenable to generation and promulgation of a "standard Oklahoma approach." The working group for these recommendations would include AMT service representatives as well as others from appropriate specialties (e.g. trauma, cardiology).

Prehospital Electrocardiogram and Early Helicopter Dispatch to Expedite Interfacility Transfer for Percutaneous Coronary Intervention

Stephen H. Thomas, MD, MPH,*† Christine Kociszewski, EMT,* Robert J. Hyde, MA, EMT,‡ Paul J. Brennan, EMT,‡ and Suzanne K. Wedel, MD*§

(Left) This study included streamlining care pathways for STEMI patients going directly from scenes to PCI. Six receiving PCI labs in Boston agreed upon a common protocol to streamline care. It seems likely that three AMT services can work with cardiologists in Oklahoma toward the same end.

4. Generate and teach an OSDH-sponsored course for streamlining pre-AMT stabilization and care.

AMT services in Oklahoma should be commended for their attention and resource investment in this educational arena. The services may have the best persons to teach whatever standard coursework is developed, but OSDH (in cooperation with AMT services) should be involved in coordination, development, vetting, and promulgation of the course and its material.

OSDH's interest in this matter is related to capability for system improvements. Improvement of on-scene times (including those for interfacility transports) is a high priority. It's difficult, if not impossible, to provide all instructions needed for stabilizing and "packaging" a given patient, while the HEMS unit is *en route*. The only answer to the challenge of streamlining "on-scene" times for these interfacility runs, is to provide standardized training directed at all hospitals from which HEMS flights originate.

System performance monitoring

Performance monitoring is a key to striving to improve any system. Whether it's benchmarks, dashboards, or other nomenclature, the tracking and trending of data are key elements to generating system excellence.

1. Work with AMT services to determine variables to be followed.

It seems likely that if AMT providers assembled in a neutral fashion, there would be little difficulty in reaching some consensus on issues that are important to be followed. Such a "summit" would be an initial step in the right direction, of establishing a truly statewide system. The efforts could start small: response times, on-scene times, etc.

2. Work towards a scorecard to monitor overall system performance.

A sample scorecard below, provided courtesy of Boston MedFlight, serves as an example of what a statewide scorecard (dashboard) may look like. This scorecard indicates for a single month (September 2011), how the program is doing with respect to a number of parameters. This information was shared by one of the authors' old AMT programs, for internal use by OSDH. Many of the actual "performance" numbers have been changed out of respect for Boston MedFlight's confidentiality.

One of this report's authors was involved in design of the scorecard below. However, it is quite clear to the authors that the items (or goals) on the scorecard below, are not necessarily right for Oklahoma. The scorecard is provided as a template and spur for further discussion.

	Indicator	Freq	Goal	Performance	Status	Performance Trend
Utilization and Performance	24 Hour Discharge – Scene	Q	< 15%	14.5	Green	↑
	24 Hour Discharge – All Interfacility RW	Q	<10%	5	Green	↑
	Meet Massachusetts Scene RW Criteria	Q	60%	48	Red	↓
	Meet Objective Criteria – Interfacility RW	M	90%	86	Yellow	↓
	Meet System Criteria – Interfacility RW	M	95%	98	Green	↑
	System Completion Ratio	M	77%	74	Yellow	↓
	BMF GR Completion Ratio	M	90%	91	Green	=
	RW Completion Ratio (Weather-adjusted)	M	90%	92	Green	=
	ICU – ICU < 60 min transport done by GR	M	89%	75	Red	↓
Operational Readiness	IFR RW Availability	M	95%		Blue	
	RW Vehicle Availability	M	95%		Blue	
	NVG RW Availability	M	95%		Blue	
	Night FW Pilot Availability	M	100%		Blue	
	RW Activation Time < 8 minutes	M	75%	62	Red	↑
	GR Activation Time < 8 minutes	M	75%	70	Yellow	↓
	Vehicle OOS staffing	M	< 1%	0.4	Green	↑
	Ops Sup OOS staffing	M	< 1%	0	Green	↑
Comms	Briefing Within targeted time	M	95%	96	Green	=
	ETA Accuracy	Q	100%		Blue	
	Post mission GR Debriefing	M	95%	80	Red	↑
	Received-Dispatch < 3 min	Q	95%	94	Yellow	↑
	Backups Completed/Documented	Q	100%	100	Yellow	█
	Network Uptime For Critical Applications	Q	99.5%	100	Yellow	█

Servers/Workstations Below Storage Capacity	Q	100%	100		=
Website Counter	Q		4689		↓
Disinfection audit	Q	85%			
RLS Use	M	< 10%	9.7		↑
Vehicle Contingency Plan Drill	Q	100%	100		=
Ground vehicle Road Safety Score	M	9			
STEMI/Ischemic stroke scene time target met	M	75%	42		↓
Ischemic stroke onset to transfer time met	M	75%	100		=
Targeted temperature mgmt. implemented	Q	90%	95		↓
ETI Success – Procedure Success	Q	95%	93		↓
ETI Success – No Desaturation	Q	95%	92		↓
Vent Used	M	95%	100		↑
Peak or Plateau Pressure < 31	M	95%	99		↑
ETT/CP Documented	Q	95%	97		=
Mean Trauma Scene Time	M	< 18.9	14.9		↓
Pain Scale Documented	Q	95%	100		=
Fetal heart monitoring documented	Q	95%	100		=
Sepsis MAP > 65 MmHg	M	95%	100		↑
Aortic Dissection Anti-Impulse Therapy	Q	100%	100		=
Brain Injury MAP > 80	M	95	100		=
Sedation adverse events	M	1	1.4		↓
Ridealong Customer Satisfaction	Q	100%	100		=
IHOP Requestor Customer Satisfaction	Q	100%	100		=
Patient Satisfaction	Q	100%	96		↓
Employee Retention	A	85%	85		↑



The scorecard “dashboard” above was provided courtesy of Boston MedFlight.

Cost-benefit and cost-effectiveness analysis

It has not been until the last 5-10 years that true cost-effectiveness studies have been enabled by existence of pertinent evidence. While there's still work to be done in terms of both costs and effectiveness, there is a sufficient evidence base at this time, upon which to base at least coarse calculations for cost-effectiveness.

1. Assess costs of "loss of ground ALS coverage."

This explanation, as discussed earlier in this report, is a very common reason that's given for HEMS transports that would otherwise appear to be "overutilization." The practice of needing to retain ground EMS coverage in Oklahoma's rural areas came up again and again, during preparation of this report. It may or may not be the "right" thing, but the following comments from south central Oklahoma were emblematic: "It's a 5-hour loss of an ALS ambulance to transfer someone to OKC or Tulsa, and we just can't spare the ground crew for that length of time without stretching coverage in an unacceptable manner."

2. Assess costs of rural hospital service availability, that would be needed if there were no AMT.

AMT providers point out that it's cheaper to call HEMS occasionally, than to maintain a stable of on-call specialists every evening and weekend. In the opinion of the authors, this claim rings true. In some developing countries (and in some large ones, like China), AMT is used to prevent having to use sparse healthcare resources to provide rural coverage; sick patients are simply flown to the larger centers. Whether or not there is a significant impact on cost-benefit calculations in Oklahoma, the question appears worth some investigation.

3. Consider whether a statewide TRISS study is feasible or desirable.

OSDH experts (e.g. Kenneth Stewart) could consider whether TRISS-type analysis, on a statewide basis, would be useful. Such analysis would have inherent disadvantages related to TRISS methodology, but there would be potential utility to such a study as well. In the event a TRISS study would not be appropriate, there are possibilities for generation of other models that may allow best use of the statewide data in the trauma registry.

4. Execute the most rigorous cost-effectiveness study attainable given current information.

True cost-benefit analysis is very complex, and would probably require a year-long effort. The authors have identified potential qualified collaborators in the project, and would like to work with the state to generate all of the necessary parameters to model cost-effectiveness in Oklahoma.

Assessment of costs and benefits should include consideration of multiple issues; some are easy to remember and some are not. A few examples are provided here.

Once an asset is in place – as it must be for certain regions to have any reasonable time-sensitive care – there may be reasons to utilize that asset for less-acute patients. Loss of an air medical asset due to infrequent use (as occurred in the Oklahoma panhandle) may make economic sense, but there may also be an overall cost-benefit favorability to maintenance of the asset's viability with slightly lower acuity flights, rather than lose the asset altogether.

Cost-effectiveness analysis could also include (for the benefit of Oklahoma hospitals) tracking of patients who were lost to out-of-state hospitals due to AMT unavailability. It is possible that this number of patients is significant. A group of leaders at a major Oklahoma City hospital reported that "the main problem with HEMS, is that we don't have enough helicopters. Availability problems mean we are losing patients to Dallas." This may or may not be occurring on a significant basis, but statewide tracking (e.g. as would occur with centralized dispatch) would help answer the question.

This part of the discussion does not attempt to lay out the myriad variables which should be accounted for in cost-effectiveness analysis. We merely highlight a few items, to illustrate the complexity of these doable – but time-consuming – studies.

Business of AMT and interactions with AMT services

This section has been placed last, because its recommendations tend to follow from others already explained. All air transport in Oklahoma is currently provided by a few companies. Alteration in the ways that AMT is planned, delivered, or reimbursed should best occur through a collaborative process involving all of these companies. Even if the state could force changes – which is not the case for many if not most of our recommendations – the pathway to successful system-building involves teamwork rather than top-down regulation. As is the case with the other parts of this report, the recommendations are numbered but not necessarily in order of priority, cost, or feasibility.

1. Convene a meeting of AMT representatives to discuss OSDH-defined important aspects of this report.

Once OSDH has had the opportunity to internally digest and draw conclusions from this report, it seems wise to arrange a “*summit*” meeting of the AMT companies. OUDEM would be happy to host this meeting, and make all of the arrangements. The meeting goals would be defined by OSDH, but it’s likely the main “gain” would be promulgation of the message that we are aiming for a statewide system in which patients get the best care, and companies’ financial viability (and continued provision of a vital service) is preserved.

2. Define possible incentives for improved performance.

Whether financial or otherwise, change usually requires buy-in, and buy-in requires incentives. Interactions with Oklahoma’s (for-profit) AMT companies must therefore include conversations about incentives.

We don’t believe that expensive incentives will generally be needed for hospitals. Referring hospitals will usually be happy to have a system that expedites their ability to execute appropriate transfers in a streamlined fashion (especially if issues like back-end rehab can be resolved). Receiving centers will usually have specialists (e.g. trauma surgeons, cardiologists) who will invest in effecting necessary changes at the receiving end; history shows that specialists usually wish to improve patient outcomes in their field while generating robust, top-level clinical practices.

While our judgment is that hospitals will not require too much in the way of incentives to optimize AMT in Oklahoma, we also believe that those hospitals will not provide as much leverage for change as might be wished. In an era in which the hospitals in Oklahoma have basically divested themselves of resource allocation toward AMT, it seems unlikely they will be in a position to argue for (or fund) changes in the system. A typical hospital administrator with whom we spoke as part of this report, was interested in patient outcomes but said “We are in a great position. We get helicopter transport for essentially nothing. We aren’t going to be very interested in changing the system in a way that costs us money.”

Thus, the recommendation is for OSDH to define incentives that may be offered, to spur system improvements. We don’t think hospital incentives should be very difficult to define. The challenge seems to be incenting AMT providers themselves. Whether these incentives are monetary or other-form, some concrete rationale for change will need to be offered in order to obtain buy-in from AMT companies.

3. Require CAMTS certification as part of licensing.

In some states, restraint-of-trade issues have unfortunately caused problems with requiring CAMTS certification for air medical operators. This potential hurdle acknowledged, we believe that CAMTS certification should be required for AMT operations in Oklahoma. In fact, it appears that most if not all operators providing AMT in Oklahoma, are already CAMTS-certified. Making this the “rule” would be useful for our system.

The CAMTS requirements are the industry standard, and have truly become the “minimum acceptable” performance level. Any service that is not CAMTS certified, should go through a similar process using similar (non-aviation) inspections and reviews, before being eligible for transport (or perhaps reimbursement from the Trauma fund) in Oklahoma. If CAMTS certification is obtained, then the medical aspects of state certification are

met (the state can't require the aviation requirements of CAMTS due to non-ability to regulate aviation). This approach was not only acceptable to, but was recommended by, senior officials at one of the HEMS services operating in Oklahoma. They note that, as long as the aviation-related parts of certification are left to the federal government, courts have upheld the requirement for CAMTS certification.

4. *Have the state get a handle on AMT marketing.*

"The new HEMS program came in a few years ago, giving out cups and T-shirts, and now everyone's calling them." This quote or something similar, was heard from more than one prehospital and hospital provider, around the state. Some prehospital providers were genuinely upset with AMT providers' seemingly innocuous efforts such as offering of inexpensive continuing education-type courses. These providers stated that "the HEMS crews teach medical courses for free, so they can get their foot in the door with the prehospital providers who then are more likely to call them." A group of EMTs in one meeting in central Oklahoma passed along the message that "OU MediFlight used to do all the scene runs, and everything was fine. Then, EagleMed and Air Evac came in here. Marketing went crazy and triage went nuts."

Marketing has obvious potential to inappropriately influence service usage. Interestingly, in an era in which there is increasing scrutiny (and limitation) over healthcare providers receiving goods and services from pharmaceutical companies, there is no apparent limit to what HEMS operators are allowed to give away. Among the items that were identified by ground EMS providers were "dinners for the whole EMS service, ACLS for a quarter of what it really costs, and challenge coins for calling a particular service." These marketing maneuvers may or may not be actually occurring, but if they are they may not be in the best interests of appropriate HEMS use and asset management.

Marketing has been received with some suspicion, even by people who are, on balance, "pro-HEMS." A rural hospital CEO who averred that "there's no doubt HEMS saves lives," lamented that "when Air Evac and EagleMed moved in, they encouraged sheriffs to call HEMS without going through central dispatch. The list of items to call a helicopter for, included such things as syncope. We in the hospitals, had no idea what was going on with these 'education' programs, and there was no input by the EMS dispatch center."

It is not the intent – nor necessarily the place – of this report to pass judgment on the accuracy of the preceding paragraphs' statements. What is within our bailiwick, is to identify and highlight that there is, at minimum, a broadly held *perception* that AMT services' marketing efforts focus as much on profits as on following of appropriate triage and sensible asset utilization (*i.e.* use of the closest HEMS unit).

It's not necessarily the case that the state should try and assume a position of approving or disapproving, every marketing maneuver. However, the state should take on a role of reviewing any materials that are provided with respect to HEMS triage and utilization, to ensure that those materials' recommendations fall in line with OSDH preferences for HEMS use.

One marketing issue that will need to be addressed, is the arrangement of a particular hospital with a particular AMT service as a preferred provider. Given the (sometimes literal) life-or-death difference that even 15-20 minutes' time difference can make, it is not appropriate for a transfer – even within a single hospital system that has a preferred AMT service – to not have the "default" setting of being executed by the closest helicopter that can provide that service. It is understood that the marketing advantages of having a helicopter on-site at a hospital are potentially significant. It became clear during preparation of this report, that many Oklahoma hospital administrators view HEMS presence as a major marketing tool. One CEO described the HEMS group as a "turnkey operation" with minimal-to-no hospital expense, and substantial benefit to the system. We understand, that it's not feasible to simply mandate without discussion, that these hospitals have to ignore the aircraft sitting on their property, and instead use another aircraft that's closer...but if patient outcome is likely to benefit, it's worth the effort to see what can be worked out.

5. *Require financial disclosures as part of licensing.*

During this report, there was understandable reluctance on the part of commercial air medical services

providers, to report details of charges and related financial information. The AMT providers with whom we spoke were interested in cooperating, but there was understandable uncertainty about the nature of the data being requested, the group with whom the data would be shared, and the ultimate use of those data. One issue that was mentioned, is that some services may comply with information requests and not others, thus setting up the cooperating services for criticism based upon numbers they voluntarily submitted.

It should be specifically noted that one service did provide a summary of their billing practices (as outlined previously). For reasons of not penalizing that service for cooperation, the authors offered to not name that service in this report. The “average gross charge” of \$22,000 as mentioned earlier, does not include adjustments for hardship, etc.

The disadvantages, from the air medical services’ perspective, of submitting financial data, are largely mitigated by a “leveling of the playing field” – if all commercial operators are required to submit financial data, then those data could be assessed for all HEMS (and FW) transports rather than just for one or two services. In fact, the suggestion for this requirement for air medical services financial reporting came from a senior official at an air medical service. He noted that Arizona requires reporting to the state, the rates that are billed for transports, as a requirement for licensure in that state. He suggested that Oklahoma may consider the same thing. To the extent that such reporting would not be onerous to the air medical services companies, it’s hard to dispute the utility of having this information reported.

Just as this report was being finalized, a circular email was received by the authors, noting the fact that the Oregon state listing of charges for air medical services was out of date and therefore misleading. The point of mentioning this, is that many states are seeing scrutiny and uncertainty as to the real charges that are occurring for AMT. It seems likely (although not certain) that the current listing of AMT charges for Oklahoma are also out of date. The Oklahoma registry information should be either updated or deleted. (One of this report’s authors serves as Medical Director for the Oklahoma Medical Control Board; he reports that the Oklahoma Ambulance Registry’s data for EMSA are indeed accurate: \$1100 plus \$6-9 per mile.)

6. Study the functioning of the subscriber system for AMT membership.

The subscription system was universally recommended by nearly everyone with whom we spoke, in rural Oklahoma. When we dug deeper, what was really said was, “if you don’t get the subscription you’re really going to get hit hard if you need a helicopter.” It seemed that the universal truth was not necessarily that the current system is a good one, but rather that under the current system, getting a helicopter subscription was the best course to take.

Some of the questions about the subscription service are obvious, and deserve attention. How many times does a subscriber of one HEMS service, get transported by another HEMS service and thus has to pay the “full freight” charge? How often does a HEMS subscriber need AMT and get no transport at all (as due to weather or logistics)? What is the frequency with which a patient’s subscriber status impacts AMT decision-making? For instance, one CEO reported that “folks here pay the subscription, and think that means they get to call a helicopter whenever they want to. I think that’s how the services are marketing the subscriptions.” Besides the marketing issues, patients’ subscription status should not be a factor in the vehicle triage decision making process. As a nurse in a small rural Oklahoma ED wrote, “Helicopters are great but, if you’re not a subscriber, the costs are exorbitant! Unfortunately, as a nurse I feel like I shouldn’t exactly stop and look and see if the patient I have, is a subscriber.”

The questions mentioned in this section, and others, could be fairly easily addressed with prospective data collection. Assembly of the data would be useful, to assuage or confirm concerns about the subscription model. Particularly if centralized dispatch and data entry occurred, these data could be easily.

7. Determine whether, and how, the state may pay for AMT.

With two subscription services offering memberships for \$50-60 annually, and the third service (Air Methods) preparing to introduce a similarly priced AMT insurance plan, perhaps it’s time for the state to step in.

The authors of this report claim no expertise in the field of health insurance regulation, but if it's really worth \$50 or so per year to have HEMS coverage for Oklahomans, then perhaps OSDH can prepare a plan to assure that everyone is covered.

One idea that arose, was discussed with the authors by others in the AMT industry with appropriate expertise. Their ideas are presented next for consideration, without our really having the fund of knowledge to judge feasibility.

States could conceivably require "franchise areas." The Airline Deregulation Act makes it clear that states can't regulate routes, rates, and services, but the establishment of "preferred providers" doesn't run afoul of these rules. The Federal Communications Commission (FCC) allows states franchising authority, and this could be extended to naming of "preferred providers" who are called first. If the state is actually the paying agency, the state can be denoted the "consumer" and Medicare can "bill under arrangement." The hospital pays AMT services, and then the hospital bills the patient. This approach used to be done for Medicare and HEMS years ago. In essence, the hospital is using HEMS as a vendor.

Trauma fund monies appear to disproportionately go towards HEMS. In addition to the fact that HEMS services are facile at completing paperwork, there are also other reasons for the (apparent) disproportionate reimbursement. First and foremost, if a ground EMS service doesn't transport the patient, they don't get paid (by CMS rule). This may be the best mechanism for handling payment, but it certainly seems to risk biasing ground EMS against calling for HEMS in borderline cases. It is time to reassess this practice, and see if there is a way to be more equitable in reimbursing prehospital services.

Just as financial incentives to fly borderline patients could be spurring AMT practices, incentives to drive borderline patients could conceivably influence decisions to go by ground. A central Oklahoma prehospital group reported that "when ground EMS in western Oklahoma gets a patient with insurance, they'll transport them if it's anywhere near a borderline case, because they need the money to stay afloat. It's crazy, but if they don't transport a patient, they don't get a dime."



World headquarters of one of the AMT services that operates in Oklahoma. MediFlight and Tulsa Life Flight are both community-based programs owned and operated by Air Methods, based south of Denver, Colorado. Air Methods corporate officials, as well as officials from Air Evac (based in Missouri) and EagleMed (based in Kansas), provided useful information without which this report would have been incomplete. The cooperation of the AMT services (as well as ground EMS providers) is acknowledged and appreciated.

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