

# Relative Survivability of Cardiopulmonary Arrest in Rural Emergency Departments Utilizing Telemedicine

Kristi Henderson, DNP, NP-BC,  
FAEN; Kristen C. Isom, RN;  
Richard L. Summers, MD

*Institutional Affiliations:*  
*Department of Emergency*  
*Medicine University of Mississippi*  
*Medical Center*  
*2500 North State Street,*  
*Jackson, MS 39216*

**Keywords:** rural,  
telemedicine,  
cardiopulmonary arrest

## Introduction

In 2008 the Agency for Healthcare Research and Quality reported that as many as 20% of the population in the United States (U.S.) lives in what would be considered rural communities while only 9% of all physician's practice in these same designated areas.<sup>1</sup> There is even a greater scarcity of medical specialists within these underserved areas.<sup>1</sup> This intrinsic disparity along with geographic isolation and socioeconomic conditions has resulted in a significant gap in access to healthcare and often requires citizens of rural areas to commute long distances to receive medical attention. The situation is particularly problematic when the medical condition demands emergent attention. Access to timely emergency medical care is critical in the face of common health conditions such as myocardial infarctions, trauma, and acute ischemic strokes. However, regional disparities in access to emergency care have been noted to exist mostly in rural areas.<sup>2</sup>

Additionally, rural emergency departments (ED) are limited by the inability to recruit and retain board certified emergency physicians secondary to a national workforce shortage of these emergency specialists.<sup>3</sup> In their analysis, Peterson et al. found that 60 to 90 percent of counties, with a population of less than 20,000 people, did not have a board certified emergency physician. Limited resources and differentials in pay for ED physicians in these rural hospitals were cited as major causal factors resulting in the disparity.<sup>2,3</sup> In another report from the Institute of Medicine entitled *Hospital-Based Emergency Care: At the Breaking Point*, it is noted that the lack of qualified emergency care personnel in rural areas has a significant negative impact on health.<sup>4</sup> Because of these limitations, the outcomes in rural areas can be worse than those in urban areas. Telemedicine has been considered as a potential solution for providing access to advanced and specialized emergency medical care in these rural communities.

A major goal of telemedicine is to bring the same level of healthcare available in urban areas to the rural communities. In fact, the use of telemedicine in emergency care began in 1996 as an alternative method of solving health care access issues for patients in underserved areas and rural communities.<sup>5,6</sup> Advances in telecommunications technology allows for many elements of medical practice to be accomplished when the patient and health care provider are geographically separated. One unique form of telemedicine

called "teleemergency" was developed to specifically address the lack of access to emergency care in rural areas.<sup>7</sup> This program combines nurse practitioners, board certified emergency physicians, and telemedicine technology to provide coordinated quality emergency care to rural hospitals.<sup>8</sup> The program began in October 2003 as a pilot study to determine whether telemedicine teleconferencing technology could be utilized by nurse practitioners and collaborating physicians to improve the quality of emergency care in geographically isolated areas and alleviate difficulties in staffing rural EDs. Over the next three years, the number of participating hospitals has reached eleven sites with approximately 2,000 patients being treated each month. To date, the program has provided emergency care to over 400,000 citizens in Mississippi.<sup>9</sup>

One of the potential benefits identified early in the implementation of the teleemergency program was the impression amongst providers of a more expeditious and efficient management of cardiac arrest and resuscitation efforts in these rural hospitals when they were guided by the consulting telemedicine emergency specialist. This was thought to be of particular significance in light of the known negative impact of ineffectual or delayed advanced cardiac life support (ACLS) interventional efforts on survival in patients experiencing a cardiac arrest.<sup>10</sup> Survival from cardiac arrest has also been shown to significantly reflect regional disparities in care. Cummins et al. reported overall survival rates from cardiac arrest in the U.S. ranging from 16% to 29%.<sup>11</sup> This

experience was further supported by a collective review prepared by Sissell, Eslinger and Zimmerman who also examined the efficacy of advanced life support.<sup>12</sup> However, this level of survivability is generally not the case for many rural areas. Population density has in general been strongly associated with survival in out-of-hospital cardiac arrest.<sup>13</sup> In another study assessing the comparative influence of geographical locale on survival from cardiac arrest, it was noted that the average survival rate in rural areas was the lowest at 9% as compared to the 23% survival rate in urban areas.<sup>14</sup>

While there are numerous studies assessing the use of telemedicine for facilitating specialty care, only limited information can be found about the implications of telemedicine for rural emergency care. Most of the research that does exist regarding the use of telemedicine in emergency care relates to avoiding unnecessary patient transfers, trauma care and critical care needs in the EDs.<sup>15</sup> We could find no studies that examine the relative outcomes of patients at rural hospitals suffering from cardiopulmonary arrest and requiring emergent resuscitation directed by telemedicine consultation. In this study, we examine the survival rates of cardiopulmonary arrest patients in a consortium of rural EDs that utilize telemergency to guide ACLS resuscitation protocols and compare these rates to a similar population in a large urban tertiary healthcare center.

## Methods

The study utilized a retrospective chart review methodology to assess the records of all adult patients age 18 years or greater that presented to a participating telemergency ED of a rural based hospital with a community population of less than 30,000. The chart review methods followed were those that are considered standard for this type of medical record review (MMR).<sup>16</sup> A MMR study design was chosen because it was an analysis of practice and outcomes and did not involve a prospective intervention. It is possible that if the rural EDs knew this data was being collected prospectively it might bias their reporting or result in a Hawthorne effect. A standardization of the sampling methods, data extraction and quality was assured by using a consistent search methodology within the electronic medical record database as described below. Data reliability was considered to be satisfactory since only a small group of three extractors were employed and the extraction criteria was very explicit. Potential missing or conflicting data was clarified by examination of written nursing records.

The study data included those patients presenting to the ED over the five years of the program after 2005 when the Mississippi Board of Medical Licensure and the Mississippi Board of Nursing approved regulations pertaining to emergency telemedicine within the state. Each ED within the

telemergency program is staffed with a nurse practitioner at the rural hospital who is able to consult with a board certified emergency specialist at the tertiary hospital.<sup>7,8</sup> There are many critical access hospitals in rural communities that encompass a county of around 10,000 residents that see only a few patients each day in their ED. This limited volume makes it financially impossible for these hospitals to staff their hospitals with a physician. Additionally, it is rare that these communities even have an emergency medicine trained physician available or anyone of that training that can respond to emergencies. This has led to a condition where many of these rural hospitals are faced with the option of staffing with a nurse practitioner or closing their ED. Most patients with chronic conditions can drive the hours needed to see a specialist in a clinic. That is not a viable option for individuals with acute conditions like cardiac arrest. This situation is what led to the development of the telemergency program as described in more detail in the cited references.<sup>7,8,9</sup> The consultation process provides the emergency specialist with audio and visual access to the remote patient in order to actively direct management in real time. When a patient arrives to the rural hospital that requires an ACLS intervention, the emergency physician can provide guidance on patient treatment, procedures and medical decision-making. The emergency specialist is able to view the patient's vital signs and responses to treatment across the telemedicine system. The process allows rural EDs to remain open and provide the only immediate access to emergency care available to the community.

For comparison, the data from the records of the urban academic ED that provided the telemedicine consultation services were also analyzed. This specific urban hospital services a large metro area with a population of approximately 400,000. Both the rural telemergency hospital EDs and the urban ED utilize electronic medical records that allowed for direct record retrieval by a database search. Patient records with a diagnosis of cardiac arrest, ventricular tachycardia/fibrillation, asystole, pulseless electrical activity, or any records describing procedures that included ACLS/CPR were extracted for further review. Those patients found to have suffered a cardiac arrest or other medical conditions resulting in a loss of vital signs either prior to presentation or after presentation to the ED in whom a standard ACLS protocol was initiated or a "code" status was declared due to a loss of vital signs were included in the study. The survival outcomes for those patients were recorded for each group. Survival is defined as ROSC (return of spontaneous circulation) in the ED and survival to hospital admission. That definition is now clarified in the in the methods section and further clarified in the limitations section. Exclusion criteria included any patient with traumatic arrest, pediatric patients (less than 18 years of age), patients with atrial fibrillation or atrial flutter and patients who did not receive some form of ACLS or cardiopulmonary resuscitation (CPR).

The survival outcomes of those patients meeting study criteria were compared between the rural EDs utilizing telemedicine and the urban hospital using the Fisher Exact test with a level of significance of  $< 0.05$ . The total volumes in each categorical group were also recorded and are reported. The protocol for this study was approved by the Institutional Review Board of the University of Mississippi Medical Center and HIPPA confidentiality was maintained as the data was promptly de-identified after abstraction.

## Results

The inclusion criteria were met by 459 of the patients presenting to the urban tertiary care center and by 39 patients seen at the rural telemergency hospitals. Of this 459 urban patients, 114 patients survived (24.8 %) as compared to the 8 of 39 total rural patients (20.5%). An analysis by Fisher Exact test indicated that there was no significant difference in the proportion of survivors between the two groups ( $p = 0.695$ ).

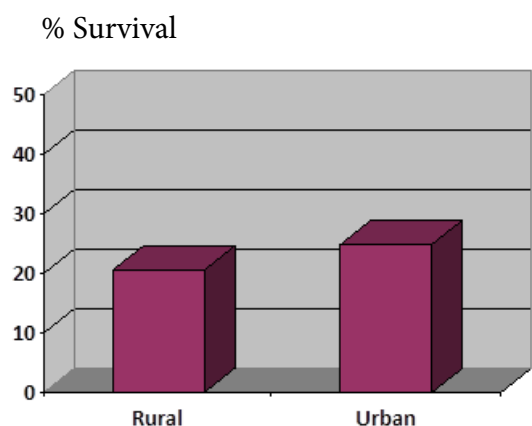


Figure 1: Comparison of percent survival of urban and telemergency rural patients with cardiopulmonary arrest (NS = not significantly different  $p > 0.05$ ).

## Discussion

Despite the universal need for access to timely emergency medical care, the availability of these services is declining. According to a report by the American College of Emergency Physicians, the number of EDs available to serve the population has decreased over recent years.<sup>17</sup> At the same time, the number of ED visits has risen to more than 120 million visits. The problems associated with access to emergency care are further magnified in rural areas where this shortage tends to be more severe.

Mississippi, like many other predominantly rural states, is also challenged with inadequate access to quality emergency medical care with non-board certified emergency physicians

servicing smaller hospitals. Peterson et al. suggest that non-emergency physicians are “essential components of the emergency department workforce, especially in suburban and rural settings”.<sup>3</sup> Telemedicine support for these non-specialist providers has been considered as a potential means to improve the quality of emergency care in the rural setting.<sup>7,8</sup> However, very little is known about the impact such interactions might have on ED operations and patient outcomes. The current study examines patient survival related to cardiopulmonary arrest and the impact of concurrent telemedicine guided ACLS intervention in rural EDs. The results of this study are promising and serve as a first step in understanding how the use of telemedicine in rural emergency care might influence patient outcomes. Narrowing the gap between the level of care found in rural and urban hospitals is a major goal of the telemergency program. This study suggests that resuscitation guided by telemedicine consultation with emergency specialists could increase the survival rate of patients with cardiopulmonary arrest to equate with that of urban hospitals.

## Limitations

There are several limitations to this study. ACLS survivability in cardiopulmonary arrest is dependent on multiple variables. While our study revealed no significance difference in the proportion of survivors, it is important to note that the rural areas have varying levels of prehospital responders with some of this service being provided by fire station personnel and EMT-Basic trained responders. In addition, the challenges associated with locating rural homesteads along back roads in sparsely populated areas are self-evident. In our database, the total length of time the patient was in cardiac arrest prior to ED treatment was not available for examination. In rural states, the “communities” can encompass an entire county or several adjacent counties and populations are frequently dispersed over large land areas rather than concentrated in a single city or town. Sometimes a single hospital and ambulance system is tasked to service this entire low-density community. Most of the rural EDs in this study have only one or two ambulances to support the entire county and have varying levels of paramedics and emergency medical technicians. The patient population, resuscitation skills of first responders and EMS personnel, and transport times could each significantly influence the potential for survival from cardiac arrest.<sup>18</sup>

There is also a likely difference between the survival rates of pre-hospital and in-hospital arrest patients with an expected worse outcome for those with an out-of-hospital cardiopulmonary arrest. The available database that was used in this study was unable to accurately differentiate

the two groups so a distinction was not made in our analysis. It is difficult to know how this limitation would influence the study results since pre-hospital arrest may likely be more prevalent in the urban condition.

Another possible limitation to the findings is the fact that the urban center represents a nearly consistent standard of care with highly experienced personnel and higher acuity patient volumes resulting in more frequent exposures to cardiac arrest. Therefore, the inherent diversity amongst the variety of rural hospitals and their patient types could also result in disparate outcomes. It is important to note that the survivals were not weighted heavily to any one of these rural hospitals and there was a scattering of data throughout the group. While the overall survival rate of approximately 25% reflects that seen at the national average, the study only look at immediate survival and did not capture the out-of-hospital or long-term survival of these patients.<sup>10,11,14</sup> However, all these noted distinctions would be expected to have resulted in a worsening of outcomes in the rural setting and thereby increase the difference between the groups.

The subsequent quality of life for the survivors was not determined in this study. The only available data at the time of the study was that for ROSC in the ED and survival to hospital admission. The extended data to include out-of-hospital, neurologically intact survival is often not available and can also be the result of many confounding extraneous factors that are difficult to control for in determining causality. Future research investigating similar outcomes should take all these factors into consideration.

It would have been best to determine the survival rate in the rural hospitals prior to the initiation of the telemergency program. However, these hospitals did not have an electronic medical record prior to this program and therefore that information was not readily available and probably could not be accurately determined.

## Conclusions

Survival of patients in cardiopulmonary arrest presenting to a ED in a rural hospital has historically been significantly lower than that in the urban ED setting.<sup>13,14</sup> In this study, rural EDs using ACLS resuscitation guided by telemedicine consultation with emergency specialists were found to have survival rates that were not significantly different from those in the consulting urban academic medical center. This finding suggests that telemedicine use may improve the quality of cardiac arrest emergency care delivery in the rural ED setting.

## References

1. Agency for Healthcare Research and Quality. National Healthcare Quality Report. 2008.

2. Carr B, Branas C, Metlay J, Sullivan A, Camargo C. Access to emergency care in the United States. *Ann Emerg Med* 2009; 54(2): 261-269.
3. Peterson L, Dodoo M, Bennett K, Bazemore A, Phillips R. Non-emergency medicine-trained physicians coverage in rural emergency departments. *J Rural Health* 2008; 24(2): 183-188.
4. Institute of Medicine. Hospital-based emergency care: At the breaking point, National Academies Press, 2007, Washington DC.
5. Roh C. (2008). Telemedicine: What it is, where it came from and where it will go. *Comparative Technology Transfer and Society* 2008; 6 (1): 35-55.
6. Craig J, Patterson V. Introduction to the practice of telemedicine. *J Telemed Telecare*. 2005;11(1):3-9.
7. Galli R, Keith J, McKenzie K, Hall GS, Henderson K. TelEmergency: A Novel System for Delivering Emergency Care to Rural Hospitals. *Ann Emerg Med* 2008; 51: 275-284.
8. Henderson K. TelEmergency: distance emergency care in rural emergency departments using nurse practitioners. *J Emerg Nurs*. 2006; 32(5): 388-393.
9. Summers RL, Henderson K, Isom KC, Galli RL. The Anniversary of TelEmergency. *J Miss State Med Assoc*. 2013; 54(12): 340-341.
10. Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation*. 2006; 69(2): 229-234.
11. Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. *Circulation*. 1991; 83(5): 1832-1847.
12. Bissell RA, Eslinger DG, Zimmerman L. The efficacy of advanced life support: a review of the literature. *Prehosp Disaster Med*. 1998; 13(1): 77-87.
13. Stapczynski JS, Svenson JE, Stone CK. Population density, automated external defibrillator use, and survival in rural cardiac arrest. *Acad Emerg Med*. 1997; 4(6): 552-558.
14. Vukmir RB. The influence of urban, suburban, or rural locale on survival from refractory prehospital cardiac arrest. *Am J Emerg Med*. 2004; 22(2): 90-93.
15. Lewis ER, Thomas CA, Wilson ML, Mbarika VW. Telemedicine in acute-phase injury management: a review of practice and advancements. *Telemed J E Health*. 2012; 18(6): 434-445.
16. Worster A, Haines T. Advanced statistics: understanding medical record review (MRR) studies. *Acad Emerg Med*. 2004; 11(2): 187-192.
17. America's emergency care environment, a state-by-state Report Card: 2014 edition. Report Card Task Force Members; ACEP Staff. *Ann Emerg Med*. 2014; 63(2): 97-242.
18. Fabbri A, Marchesini G, Spada M, Lervese T, Dente M, Galvani M, Vandelli A. Monitoring intervention programmes for out-of-hospital cardiac arrest in a mixed urban and rural setting. *Resuscitation*. 2006; 1(2): 180-187.