

# Ambulance Response Times

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## **1 Introduction**

*Ambulance Response Time* or ART is time between making an emergency call and the arrival of the ambulance. We review the various variations in the definition which we will review below, together with the problems involved in measuring ART. We will also review ART standards, in particular in California and in the counties surrounding Kern. Finally we discuss the proposed ordinance in Kern County.

For a non-expert it is difficult to penetrate the medical literature, which

consists largely of case studies, and which is often quite deficient in statistical methodology. Finding the important contributions from a never-ending series of papers with very long lists of authors is not a trivial undertaking. Fortunately we now have *Emergency Medical Services at the Crossroads* [Institute of Medicine of the National Academies, 2006], which gives a very good overview of the state of EMS, the ways to measure quality and enforce accountability, and the possibilities of scientific research in the area.

## **2 Medical Importance of ART**

### **2.1 Cardiac Arrest**

Especially for urban areas ART can be very important in cases of cardiac arrest. Three quarters of all deaths from myocardial infarction occur after cardiac arrest in the community. Two out of three deaths occur before the victim reaches a hospital. More than 95% of cardiac arrest victims die, and every minute that passes before returning the heart to spontaneous circulation (ROSC) decreases the chance of survival by 10%.

Ambulances (or other early responders such as police and firemen) are critical, because they typically carry defibrillators, and defibrillation improves survival rates considerably (up to a factor six). The "chain-of-life" described by the American Heart Association depends on early access, early CPR, early defibrillation, and early acute cardiac life support. In most cases, without an ambulance on the scene quickly, there is no chain-of-life.

There are literally thousands of studies of out-of-hospital cardiac arrest survival rates. In general it is good to be rich, white, urban and married

and it is bad to be poor, black, rural, and single. If you must have a cardiac arrest, it is good to have it in a public place, especially if the bystanders know CPR [Layon et al., 2003; Vukmir, 2006]. There are, of course, fewer public places and generally fewer bystanders and passers-by in rural areas.

There are far fewer studies that directly focus on the effect of ART on survival. Pell et al. [2001] did a large-scale study in Scotland between 1991 and 1998. Of more than 10,000 arrests not witnessed by the ambulance crew but attended by them within 15 minutes about 6% survived to hospital discharge (the required ART in the UK is 14 minutes). A logistic regression model with several predictors, among them ART, was fitted to the survival data. We can use the regression coefficients to predict survival under different conditions. Reducing the 90th percentile for response time to 8 minutes gave a predicted survival of 8% and reducing the 90th percentile to 5 minutes increased predicted survival to 10-11%.

For rural areas, ART becomes less relevant, unfortunately. Clearly CPR training and availability of local defibrillators, along with other-than-ambulance-based first responders, are more important in the rural than in the urban situation. There are only a few places in rural areas that can expect ART to be less than ten minutes. After cardiac arrest brain damage due to prolonged anoxia is possible between 4 to 6 minutes, likely between 6 and 10 minutes, and certain after 10 minutes. In rural areas people will have to depend on non-health professionals, not even paramedics, for defibrillation and basic life support [Pell et al., 2001].

Jennings et al. [2006] studied 1790 bystander-witnessed cardiac arrests in Victoria in 2002 and 2003. Survival rate (to hospital discharge) of urban patients was 7.4%, of rural patients 1.9%. Distance from the nearest ambulance branch was an important factor determining survival. Rural

response times averaged 14 minutes and urban response times 8 minutes. Because of the importance of early defibrillation and early CPR it is clearly desirable to also have firefighter or police first responders, especially in rural areas.

## **2.2 Major Trauma**

Major trauma can have various causes, but traffic accidents are an important contributor. The experience of trauma centers in Korea and Vietnam led to the notion of the “Golden Hour”, which means patients have a much better chance of survival if they are brought to trauma specialists within 60 minutes. Rural ART can easily lead to longer delays.

The Traffic Safety Center at UC Berkeley devoted its Summer 2004 newsletter to rural road safety [Transportation Safety Center, 2004]. We summarize some of the main results discussed in that newsletter. In the U.S. 60% of fatal crashes occur on rural roads. There are many reasons for this. There are more miles of rural road and rural roads are inherently more dangerous. Studies by the National Highway Traffic Safety Administration show that fatal rural road crashes most involve people who live in the rural areas, not people passing through. Rural road users tend to use seat belts less, tend to speed more and drive more under the influence of alcohol. Seat belt use in pickup trucks is only 69%, compared to 81% for passenger cars. Also in rural areas older people are forced to drive, even when their health does not really permit it. In rural areas road users travel at very different speeds, because of the presence of agricultural equipment and heavy trucks on the same road. This causes accidents.

And, of course, the ART is longer on rural roads. In a 1997 study by the National Transportation Safety Board the average ART for rural crashes

is 18 minutes, for urban crashes it is 10 minutes. Rural victims arrive at the hospital in 52 minutes, urban victims in 35 minutes. The TSC Newsletter reviews the situation on the Nor-Cal EMS area, which includes Butte, Colusa, Glenn, Lassen, Modoc, Plumas, Shasta, Sierra, Siskiyou, Tehama, and Trinity Counties (more than 20% of the state's territory with only 2% of the state's population). That is, of course, more rural than even the remotest areas in Kern County, but the problems are similar. ART can easily be an hour. Volunteers are often firefighter/paramedics, who are often more motivated to "put the wet stuff on the red stuff" than to provide medical assistance. Retirees, telecommuters, and X-commuters moving into the region from the Bay area still expect the same ART. EMS providers are reluctant to make huge investments in sparsely populated areas.

Data on rural ART's are more difficult to come by than data on urban ART's. We know, for example, that exceeding the usual 8 minute urban standard for ART does not significantly influence survival of trauma patients [Pons and Markovchick, 2002]. This study involved 3490 trauma patients in the Denver area in 1995. Of course this is all well within the "Golden Hour", so it has little implication for rural crashes.

### **3 Measurement Problems**

#### **3.1 Starting/Stopping the ART Clock**

Not all agencies use the same definition of ART. Although most often the clock starts at dispatch and ends at arrival, there are other possibilities that are sometimes used in the definition. We could start the clock when the 9-1-1 call comes in, or when the ambulance leaves. This will obvi-

ously lead to different measures of ART, comparisons between counties or states become difficult, and start/stop times may not be what seems most natural to patients.

In most cases the clock stops when ambulance personnel lets the dispatcher know they have arrived and the wheels of the ambulance have stopped rotating. This immediately raises the question about additional time that may be needed to make contact with the patient. Clearly this question will have different answers in different environments. In an urban environment ambulance personnel may have to go to the top of a high rise apartment building. This adds “vertical response time”.

For 454 high-priority calls in New York City [Silverman et al., 2005] the mean dispatch-scene time was 5.7 minutes and the mean scene-patient time was 2.3 minutes. The scene-patient time was 3.2 minutes for residential buildings, 2.9 minutes for office complexes, 1.7 minutes for private homes of less than 3 stories, and 0.6 minutes for outdoor calls.

In 216 emergency calls in a 440 miles area around Kansas City [Campbell et al., 1993] the median arrival-to-patient contact interval was 1.33 minutes. There were “barriers” (locked doors, stairways, police securing the scene, crowds) in 122 runs, with a median interval of 2.19 minutes, while the 94 runs without barriers had a median time interval of 0.82 minutes.

## **3.2 Conscious Errors**

In an interesting paper Moeller [2004] asked all 211 paramedic agencies within the State of Florida to fill in a survey. The most interesting questions concentrated on how ART was calculated from the point of view of the agency, of the parent, and of an elected official. So the agency is

asked to respond when they think a typical agency, parent, or politician think that the ART clock starts and stops. The purpose of the survey, which used vignettes to elicit responses, was to find out if agencies could use the definitional ambiguity in ART to look as good as possible.

The results are collected in Table 1 for start and Table 2 for stop.

[Table 1 about here.]

[Table 2 about here.]

It is clear from the results that the agency's perceived clocks start later and stop earlier than those of parents or politicians. This is not really a form of error, but of perception. In practice, it means that "the response time definition employed by agencies provided a more favorable image of agency performance than may otherwise be deserved" [Moeller, 2004, p. 14].

### **3.3 Fraud**

It is not clear how often other less subtle types of "conscious errors" occur. It is obviously in the interest of the ambulance companies to look as good as possible. The federal government, in particular the Office of the Inspector General,



## **4 Regulatory Frameworks**

### **4.1 Federal**

### **4.2 California**

### **4.3 County and City**

## **5 EMS in Surrounding Counties**

An Emergency Medical Services Authority (EMSA) staff survey from 2001 shows ART standards in different California counties. Results are in the table below, and at

<http://www.emsaac.com/Survey/ResponseTimes.htm>

Observe that the table has two pairs of columns. The first pair refers to standards for first response time, the second refers to ART properly. The two different standards reflect the fact that in some counties first responders (firemen, police) can arrive before the ambulance arrives.

[Table 3 about here.]

Another 2002 EMSA staff survey gives information about the different ways the ART clock is started by local EMS ordinances in California. It illustrates the ambiguity in defining ART. The survey can be found in the table below and at

<http://www.emsaac.com/Survey/ResponseTimeClockStart.htm>

[Table 4 about here.]

## **5.1 Kern**

The Kern County EMS website is at

<http://www.co.kern.ca.us/ems/>

## **5.2 Ventura**

The Ventura County EMS website is at

<http://www.vchca.org/ph/ems/index.htm>

In the EMS plan [Ventura County EMS Department], found at

[http://www.vchca.org/ph/ems/pdf/EMS\\_PLAN.pdf](http://www.vchca.org/ph/ems/pdf/EMS_PLAN.pdf),

we find that ART for metro/urban is 8 minutes, for suburban/rural is 20 minutes, and for wilderness is 30 minutes. Area's are defined by population density of the corresponding census tract: wilderness has 5 or fewer people per square mile, remore has 5 to 9 people, rural has 10 to 99 people, and urban has 100 or more people per square mile.

<http://www.vchca.org/ph/ems/aed/index.htm>

<http://www.vchca.org/ph/ems/aed/PAD.htm>

## **5.3 Santa Barbara**

The Santa Barbara County EMS website is at

<http://www.sbcphd.org/ems/default.html>.

In 1998 there was an interesting study done on EMS response to cardiac arrests in Santa Barbara County [Luna]. You can find it at

<http://www.sbcphd.org/documents/ems/cardiacstudy.pdf>

Of 307 confirmed cardiac arrests 15 had non-cardiac etiology, in 103 cases no attempts were made to resuscitate. Of the remaining 188 cases 103 (55%) arrests were witnessed and 68 (36%) had an initial shockable rhythm. Return of spontaneous circulation (ROSC) occurred in the field for 33 (18%) and in the emergency room for 4 (2%) patients. In total 23 (12%) were admitted to IC unit of the hospital and eventually only 10 (5%) survived.

Despite the gloomy outcome, which is just in the nature of the disease, it was ruled that Santa Barbara EMS was doing a great job. Average ART was 5 minutes, and average fire department response time was 4 minutes. For the 10 survivors those average response times were 3 minutes for ambulances and 1 minute for the fire department. It should be mentioned that in Santa Barbara the fire department is an official ALS provider, and carries and uses defibrillators.

#### **5.4 San Luis Obispo**

The San Luis Obispo County EMS website is at

<http://www.sloemsa.org/>.

#### **5.5 Central California EMS**

Central California EMS services Fresno, Madera, Tulare, and Kings Counties. It's website is at

<http://www.co.fresno.ca.us/5600/communityhealth/EmergencyMedicalServices/default.htm>.

## **5.6 Los Angeles**

ART is regulated in the Los Angeles County Code. For urban (all census tracts with population density for 100 persons or more per square mile) ART is 8 minutes, for rural (between 10 and 99 persons) it is 20 minutes, and for wilderness (less than 10 persons) it is asap.

[http://www.bpcnet.com/codes/lacounty/\\_DATA/TITLE07/Chapter\\_7\\_16\\_AMBULANCES\\_.htm](http://www.bpcnet.com/codes/lacounty/_DATA/TITLE07/Chapter_7_16_AMBULANCES_.htm)

In March 2006 supervisors voted to basically break the monopoly of American Medical Response (AMR) for ambulance services in the county, and to split the contracts with three other providers. See

<http://www.jems.com/products/articles/18252/>

The main motivation given by the board is in terms of ART, and it is stated that AMR refused to abide by the ART standard in the contracts.

<http://grandjury.co.la.ca.us/gjury99/REPORTgj-16.htm>

## **5.7 Inland Counties**

Inland Counties Emergency Medical Agency (ICEMA) serves San Bernadino, Inyo, and Mono Counties. The website is at

<http://www.sbcounty.gov/icema/Default.htm>.

ICEMA has a truly excellent document [Inland Counties Emergency Medical Agency, 2006] on its website describing the 2005-2006 performance of its ambulance providers.

<http://www.sbcounty.gov/icema/WhatsNew/PBCann0506.pdf>.

**A History of EMS**

**B The Ambulance Wars**

**C Wedworth-Townsend and the Paramedics**

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## Notes

<sup>1</sup>1st Responder: from time call is dispatched by 911 to provider. Ambulance: time call is received at ambulance service.

<sup>2</sup>From time of dispatch notification /alert to responding unit.

<sup>3</sup>From dispatch

<sup>4</sup>From receipt of 911 call to wheels stopped

<sup>5</sup>10 minutes if no ALS 1st Response and 12 minutes if 1st response is ALS

<sup>6</sup>From dispatch to at scene time

<sup>7</sup>From time dispatched to arrival on scene as recorded by dispatch

<sup>8</sup>From dispatch to at scene time

<sup>9</sup>Tracking all times in dispatch

<sup>10</sup>Definition varies among provider agencies

<sup>11</sup>Wants to change to call rings in dispatch

<sup>12</sup>Dispatch has 60 sec., 90% of time. Unit has 7 min. 90% of time

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Table 1: Perspectives of When Response Time Starts

	Agency	Parent	Politician
Injury/Illness Occurs	1.7%	20.2%	0.0%
Dial 9-1-1	0.9%	57.1%	46.6%
9-1-1 Answered	47.9%	16.0%	31.9%
9-1-1 Call Completed	14.5%	6.7%	2.6%
Emergency Unit Dispatched	33.3%	0.0%	12.9%
Emergency Unit En-route	1.7%	0.0%	6.0%

Table 2: Perspectives of When Response Time Stops

	Agency	Parent	Politician
Arrival at Location	85.1%	29.3%	66.1%
Patient Contact	14.9%	70.7%	33.9%

Table 3: Response Time Standard for Metro/Urban Areas

County	ALS First Response		ALS Transport	
	Minutes	%	Minutes	%
Contra Costa	5	None	10	95
CVEMSA (Mendocino)	None		None	
CVEMSA (Napa) <sup>1</sup>	7	90	8	90
CVEMSA (Sonoma) <sup>2</sup>	8	90	8	90
Fresno, Madera	None		10	95
Imperial	None		10	95
Kern	None		8	90
Kings	None		8	90
Los Angeles	8	95	8	95
Marin <sup>3</sup>	10	90	10	90
Merced <sup>4</sup>	None		10	90
Mountain Valley	None		8	90
Monterey	8	90	None	
Nor-Cal (Shasta)	None		8	90
Riverside <sup>5</sup>	5	90-95	10 or 12	90
San Diego <sup>6</sup>	8	90	10	90
San Francisco	8	90	10	90
San Joaquin	None		8	90
San Luis Obispo	10	90	10	90
San Mateo	6:59	90	12:59	90
Santa Barbara <sup>7</sup>	5	90	7:59	90
Sierra Sacramento	None		8	90
Tuolumn	None		None	
Ventura <sup>8</sup>	6	None	8 $\frac{1}{2}$	90

Table 5: Survey for Response Time Clock Start Standards

Agency	Clock Starts at:
San Francisco <sup>9</sup>	First Phone ring in dispatch
Tulare	Call answered in dispatch
LA <sup>10</sup>	Unit notified
Santa Clara	First unit to a call notified of call
Merced	Call answered in dispatch
Solono	Call answered in dispatch
Ventura	Unit notified, Call answered in dispatch
Riverside	Call location obtained
Marin	Unit notified
San Mateo	Time unit dispatched to call (Unit notified)
Kern	Call location obtained
Santa Barbara <sup>11</sup>	Unit notified
San Luis Obispo	Unit notified
Fresno	Call answered in dispatch
Napa	Call answered in dispatch
Imperial	Unit notified
Sonoma <sup>12</sup>	Call answered in dispatch, Unit notified of call
Nor-Cal	Unit notified
SSV	Call answered in dispatch
Merced	Call answered in dispatch