Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®
Learn and Live℠

Science of Emergency Medical Dispatch

Joseph P. Ornato

Circulation 2009;119;2023-2025
DOI: 10.1161/CIRCULATIONAHA.109.855130
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 0009-7322. Online ISSN: 1524-4539

Editorial

Science of Emergency Medical Dispatch

Joseph P. Ornato, MD

Out-of-hospital cardiac arrest (OOH-CA) claims the lives of almost 300 000 Americans each year,[1] a loss of life equivalent to that caused by a September 11 World Trade Center attack on the United States every 3 days! Despite advances in public education on recognition of cardiac arrest, early notification of emergency medical services (EMS) 9-1-1 centers, lay bystander cardiopulmonary resuscitation, automated external defibrillator use, and improvements in EMS service delivery, fewer than 8% of adult OOH-CA victims survive to hospital discharge.[1]

Article p 2096

Most neurologically intact survivors come from the 20% to 38% of OOH-CA patients who have ventricular fibrillation as their first recorded rhythm, and the percentage of cases with a first recorded rhythm of ventricular fibrillation is decreasing nationally despite a near-constant incidence of OOH-CA.[1] A sudden cardiac arrest victim's chances of survival decrease 7% to 10% for every minute of delay until defibrillation.[2] The "chain of survival" paradigm of the American Heart Association lists the community "links" necessary (early access, early cardiopulmonary resuscitation, early defibrillation, early advanced life support) to optimize survival from OOH-CA. The first link, early access, includes public education on recognition of cardiac arrest and notification of the EMS system ("call 9-1-1") by anyone witnessing the event, as well as rapid dispatch of trained and properly equipped emergency rescuers to the scene.

An emergency medical dispatcher must have the training, protocols, experience, and poise to interrogate callers quickly and accurately to determine whether a life-threatening emergency has occurred and, if so, to send the appropriate public safety resources to the scene promptly. In the United States, most 9-1-1 center "public safety answering point" (PSAP) call takers are not medically trained personnel but individuals who must handle police, fire, and medical emergency calls. In a minority of high-performance EMS systems, a PSAP operator answers the 9-1-1 calls and hands the caller off to a medically trained "secondary PSAP" dispatcher if the caller indicates the existence of a medical emergency. Because cardiac arrest only accounts for ≈3% to 5% of all 9-1-1 medical calls (which only represent about 10% of all calls to 9-1-1 in most communities), dispatchers send multiple responding units (such as first responders on a fire truck and paramedics in an ambulance) to the scene with "lights and sirens" only when they have a high degree of suspicion that a life-or-death emergency is occurring. Sending "the marines" liberally without adequate medical justification risks depleting the EMS system of vital resources and endangering the lives of emergency responders as well as the public. Each year, several hundred public safety (ie, police, fire, and EMS) workers lose their lives in the line of duty in the United States. It has been estimated that ≈12.7 fatalities occur per 100 000 EMS workers annually because of ambulance crashes.[3]

Unfortunately, most 9-1-1 callers are laypersons who have little or no medical knowledge or training. They are often distraught emotionally after witnessing another person (who may be a friend, coworker, or relative) slump to the ground lifelessly. Laypersons (and dispatchers) are easily tricked into concluding falsely that an unconscious individual is not in cardiac arrest because a short burst of grand mal seizure activity occurs commonly as brain perfusion plummets, followed by several minutes of irregular agonal respirations. It is easy to understand how an unwary dispatcher could conclude that the call represents a "simple seizure" or non–life threatening syncope when the caller reports that the victim is "shaking all over" and subsequently "the patient is breathing."

In this issue of *Circulation*, Berdowski et al[4] analyzed emergency dispatch voice recordings on 285 consecutive cardiac arrest calls received by the Greater Amsterdam Dispatch Unit serving the City of Amsterdam, the Netherlands, during the first 8 months of 2004. Dispatchers failed to recognize cardiac arrest from their interrogation of the caller in 29% of cases, and survival was significantly lower (5% versus 14%, $P=0.04$) when a cardiac arrest was not recognized compared with when it was recognized. The most common reason for the dispatcher's failure to recognize cardiac arrest was the failure to ask the caller whether the patient was breathing and, if not, to describe the breathing. Normal breathing was never mentioned by callers reporting true cardiac arrest cases.

These are important findings, but they are not without precedent in the evolving new science of emergency medical dispatch. In an increasing number of countries in which English is the primary language (including the United States, Canada, the United Kingdom, and Singapore), the most structured, state-of-the-art, popular proprietary system is known as Medical Priority Dispatch (MPD), which is now in software version 12.0 (http://www.prioritydispatch.net). MPD is refined constantly by an expert panel at the National Academies of Emergency Dispatch using an ever-increasing

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

From the Department of Emergency Medicine, Virginia Commonwealth University, Richmond, Va.

Correspondence to Joseph P. Ornato, MD, FACP, FACC, FACEP, Professor and Chair, Department of Emergency Medicine, Virginia Commonwealth University Health Center, 401 N 12th St, Room G248, Richmond, VA 23298-0401. E-mail ornato@aol.com

(*Circulation*. 2009;119:2023-2025.)

Circulation is available at http://circ.ahajournals.org
DOI: 10.1161/CIRCULATIONAHA.109.855130

database of emergency calls from high-performance EMS systems throughout the world. Countries whose primary language is not English or where a significant percentage of the population is multilingual have a special challenge because they must develop their own system of emergency medical dispatch, learning the universal lessons of dispatch science step by step just as others before them have done in other countries, disadvantaged by having a smaller database of calls initially on which to identify protocol weaknesses and opportunities for improvement.

Dutch emergency dispatchers receive training and perform their duties using general protocols, asking the caller to 1) verify the exact location of the incident and his or her callback phone number, 2) describe the emergency, and 3) indicate whether the patient is conscious and breathing. In contrast, MPD dispatchers interrogate callers, send emergency units, and provide life-saving cardiopulmonary resuscitation and first aid "pre-arrival" instructions to callers using scripted protocols. High-performance MPD centers in the United States have 2 dispatchers online on each emergency call, one to ask questions and give the caller prearrival instructions, the other to dispatch emergency units. Instead of taking 1 to 2 minutes to dispatch EMS and first response units, high-performance MPD systems will typically have vehicles rolling in ≤30 seconds from call receipt.

A shared element of all successful emergency medical dispatch programs is a strong quality-improvement process that provides feedback to dispatchers, drives protocol change, and identifies topics that need to be covered in dispatcher continuing education. All emergency calls are recorded and undergo intense quality improvement scrutiny at MPD dispatch centers just as in Amsterdam. Data derived from analysis of millions of 9-1-1 calls drive refinements in MPD protocols, allowing the system to get more accurate and efficient over time. By "scripting" the exact wording and sequence of the questions and prearrival instructions, MPD speeds call processing time dramatically and virtually eliminates variability in performance that is inevitable when call centers allow dispatch personnel to ask questions "ad libitum." Regardless of time of day, day of week, or which dispatcher is on duty, the public can be assured of receiving the exact same high-quality efficient questioning and prearrival instructions, as well as a consistent EMS system response that has been preapproved by the system's medical director for a given type of call. Automated protocol-based call taking with MPD is more accurate and consistent than the subjective or experience-based determinations made by individual emergency medical dispatchers.[5]

One of MPD's important goals has been to improve the accuracy of detection of cardiac arrest, which is termed the "cardiac arrest quotient." As cited by Berdowski et al,[4] early reports from individual sites were unable to identify major differences in cardiac arrest detection using MPD versus the standard unstructured caller interrogation by dispatcher.[6–8] Significant progress has been made by the National Academies of Emergency Dispatch in the last 3 to 5 years, keying off the 2 physiological confounders, seizures and agonal (gasping) breathing, that can confuse callers and dispatchers. For example, when a caller reports that a patient is "having a seizure," the MPD protocol now prompts the dispatcher to ask whether the patient has a history of epilepsy or prior seizures. A negative response significantly increases the probability that the "seizure" is actually due to a cardiac arrest, prompting a maximal "lights and sirens"–tiered (first responder units and ambulance) EMS system response.[9] MPD has also long recognized the importance of differentiating normal versus agonal respiration by asking the caller whether the victim is "breathing normally." If the caller can't decide, the dispatcher asks the caller to say "breathe" into the phone every time the victim makes a respiratory effort, allowing the trained dispatcher to make the differentiation between normal and agonal respirations. This approach can increase the accuracy of dispatcher cardiac arrest detection significantly.[10]

As pointed out by Berdowski et al,[4] agonal respiration can be a critical confounder for the science of EMS dispatch, but its presence is also of prognostic importance. Clark et al[11] were the first to document the importance of noting agonal respiration, which was identified by EMS rescuers in 40% of 445 OOH-CA cases in King County, Wash, in 1991. The presence of agonal respiration suggests very recent onset of cardiac arrest, because they are observed more frequently in witnessed than with unwitnessed cases (55% versus 16%, $P<0.001$) and when the initial rhythm is ventricular fibrillation rather than asystole or pulseless electrical activity (56% versus 34%, $P<0.001$). A higher percentage of patients with versus without agonal respiration survive to hospital discharge (27% versus 9%, $P<0.001$).[11] However, the relationship between agonal respiration and a more favorable outcome may not be due entirely to its frequent association with a short cardiac arrest downtime interval. Agonal or gasping respiration is a terminal respiratory pattern originating in the medulla which appears and lasts several minutes after profound anoxia or ischemia in virtually all mammalian experimental cardiac arrest models and the majority of sudden infant death syndrome cases.[12] It has been described as an autoresuscitative physiological phenomenon because it improves pulmonary gas exchange, increases venous return, and increases cardiac output and coronary perfusion.[12]

Regardless of the language spoken, rapid identification of potential cardiac arrest cases by emergency medical dispatchers is a critical element for improving survival from OOH-CA. Berdowski et al[4] are to be applauded for their important contribution to the science of emergency medical dispatch and for confirming the need for emergency dispatchers to ascertain whether an unconscious person has abnormal breathing. Their approach to balancing the need to improve detection of cardiac arrest (sensitivity) with minimizing the number of false alarms (specificity) will serve as a model for all emergency medical dispatch systems being developed throughout the world.

Disclosures

Dr Ornato is cardiac vice-chair of the National Institutes of Health–sponsored Resuscitation Outcomes Consortium, a member of the science advisory board of Zoll Medical and *Circulation*, and medical director of the Richmond Ambulance Authority.

References

1. Lloyd-Jones D, Adams R, Carnethon M, De Simone G, Ferguson TB, Flegal K, Ford E, Furie K, Go A, Greenlund K, Haase N, Hailpern S, Ho M, Howard V, Kissela B, Kittner S, Lackland D, Lisabeth L, Marelli A, McDermott M, Meigs J, Mozaffarian D, Nichol G, O'Donnell C, Roger V, Rosamond W, Sacco R, Sorlie P, Stafford R, Steinberger J, Thom T, Wasserthiel-Smoller S, Wong N, Wylie-Rosett J, Hong Y. Heart disease and stroke statistics – 2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation.* 2009;119:480–486.
2. 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;83:1832–1847.
3. Maguire BJ, Hunting KL, Smith GS, Levick NR. Occupational fatalities in emergency medical services: a hidden crisis. *Ann Emerg Med.* 2002; 40:625–632.
4. Berdowski J, Beekhuis F, Zwinderman AH, Tijssen JGP, Koster RW. Importance of the first link: description and recognition of an out-of-hospital cardiac arrest in an emergency call. *Circulation.* 2009;119: 2096–2102.
5. Clawson J, Olola CH, Heward A, Scott G, Patterson B. Accuracy of emergency medical dispatchers' subjective ability to identify when higher dispatch levels are warranted over a Medical Priority Dispatch System automated protocol's recommended coding based on paramedic outcome data. *Emerg Med J.* 2007;24:560–563.
6. Flynn J, Archer F, Morgans A. Sensitivity and specificity of the medical priority dispatch system in detecting cardiac arrest emergency calls in Melbourne. *Prehosp Disaster Med.* 2006;21(suppl):72–76.
7. Garza AG, Gratton MC, Chen JJ, Carlson B. The accuracy of predicting cardiac arrest by emergency medical services dispatchers: the calling party effect. *Acad Emerg Med.* 2003;10:955–960.
8. Heward A, Damiani M, Hartley-Sharpe C. Does the use of the Advanced Medical Priority Dispatch System affect cardiac arrest detection? *Emerg Med J.* 2004;21:115–118.
9. Clawson J, Olola C, Heward A, Patterson B. Cardiac arrest predictability in seizure patients based on emergency medical dispatcher identification of previous seizure or epilepsy history. *Resuscitation.* 2007;75:298–304.
10. Clawson J, Olola C, Scott G, Heward A, Patterson B. Effect of a Medical Priority Dispatch System key question addition in the seizure/convulsion/fitting protocol to improve recognition of ineffective (agonal) breathing. *Resuscitation.* 2008;79:257–264.
11. Clark JJ, Larsen MP, Culley LL, Graves JR, Eisenberg MS. Incidence of agonal respirations in sudden cardiac arrest. *Ann Emerg Med.* 1992;21: 1464–1467.
12. Manole MD, Hickey RW. Preterminal gasping and effects on the cardiac function. *Crit Care Med.* 2006;34(suppl):S438–S441.

KEY WORDS: Editorials ■ cardiopulmonary arrest ■ cardiopulmonary resuscitation ■ emergency medical service communication systems