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**Abstract:**

Innovations in communications technology, computer systems and software, and medical as well as nonmedical devices occur rapidly, and it may be difficult for clinical practice modifications to keep pace. The goals of this review are to discuss emerging technologies in emergency medical services (EMS) and to highlight studies and resources supported by the EMS for Children program. We will describe applications of new technology in the areas of EMS processes, telemedicine, patient monitoring and treatment, disaster management, and provider education.

**Keywords:**

telemedicine; physiological monitoring; patient simulation

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# New Technologies in Emergency Medical Services for Children

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In an era of smartphones and even smarter technology, emergency medical services (EMS) are gaining access to innovations that make their job, saving lives, easier. Enhanced 9-1-1 technology and automatic crash notification systems provide faster EMS responses.<sup>1</sup> Global positioning system technology and advanced wireless video communication software enable ambulances and helicopters to reach injured persons sooner and minimize transport times.<sup>2,3</sup> Three-channel cardiac monitors have been replaced by integrated 12-lead electrocardiography (ECG)-monitor-defibrillators capable of transmitting ECGs to the hospital in advance of the patient's arrival. Ambulance onboard computer recorders have been shown to be effective in improving driver performance and lowering vehicle maintenance costs,<sup>4</sup> and motorized stretchers reduce on the job injuries.

## COMMUNICATION TECHNOLOGY

Advances in telecommunications and wireless networking include the use of mobile phones for voice and text communication, as well as connectivity to the Internet, all which have certain implications for the prehospital provider. Cellular and other wireless data networks have to be built to sustain the capacity of the number of wireless device users, and technologies continue to evolve. Next-generation Wi-Fi networks, called WiMAX *mesh networks*, can cover areas with a radius of 2 to 6 miles and make it possible for ambulances to communicate voice, vitals sign, and electronic patient care records (ePCRs) information.<sup>5</sup>

Mobile phones can be considered a link in the chain of survival for out-of-hospital cardiac arrest (OHCA). Smartphones can access educational materials, call for help without leaving the victim, and access a chest compression metronome.<sup>6,7</sup> Applications allow users to register and be notified of nearby OHCA events and will even direct the citizen rescuer to the nearest automated external defibrillator.<sup>8</sup> A study of such a network in Stockholm, Sweden, demonstrated that citizen rescuers arrived prior to EMS in 45% of cases.<sup>9</sup>

Additional smartphone reference applications exist for pharmacology, clinical decision rules, laboratory data, and ECG rhythms. PalmEM (palmER Worldwide, Wilmington, Delaware) contains a weight-based pediatric chart and is available for purchase in iPhone (Apple, Cupertino, California) and Android (Google, Mountain View, California) versions. Table 1 demonstrates some representative smartphone applications currently available on the market.<sup>10</sup> These applications are currently in use in the clinical setting; however, the role of these in prehospital care has yet to be explored.

## ADAPTION OF THE ELECTRONIC HEALTH RECORD

Emergency medical service providers historically have used paper charts to document prehospital care. These paper charts have certain disadvantages including illegibility and frequent misplacement when transferring the care of the patient to the receiving facility. Recently, computers and tablets that are smaller and more durable have been incorporated into prehospital care. Computer software programs that provide the basis for the electronic health record also have the capacity for computer decision support systems, which can combine an expert knowledge base with algorithms that inform decision making. The creation of Web-

based platforms allows large amounts of information to be stored in “clouds” and accessed from distant locations. Global positioning software is now nearly ubiquitous, present in mobile communication devices, computers, and automobiles.

One profound effect of computer and wireless information technology (IT) in health care is the creation of ePCRs. Electronic patient care records have the potential to improve the quality of EMS records and the timeliness of patient handoff information. Improving EMS information systems and integrating them with other electronic health records have been identified as a national priority several times: in the 1998 EMS Agenda for the Future, in the 2006 Institute of Medicine (IOM) report, and at the 2010 Academic Emergency Medicine Consensus Conference.

Most EMS providers now use some type of ePCR.<sup>11</sup> Some medical centers are able to receive ePCRs ahead of the ambulance's arrival. In San Diego, the Beacon Health Information Exchange allows patients' clinical outcomes to be distributed back to the EMS agencies.<sup>12</sup> The use of standardized ePCRs allows EMS operators to gather and analyze clinical data and participate in clinical research. Although barriers to ePCR system implementation exist, descriptions of success detail the use of grant funding and the benefits of training staff on health IT, as well as recommending the establishment of relationships with billing companies to pay for implementation.<sup>13</sup> These ePCR systems also have the potential to improve billing for EMS agencies. One metro EMS system documented a 47% revenue increase in 5 years after implementing a computerized patient data system.<sup>14</sup>

Computer decision support systems have also been used successfully to help prioritize the dispatch of ambulances.<sup>15</sup> Emergency medical service agencies are using software to predict incidence and location of emergency calls, allowing strategic positioning of ambulances. Computer decision support systems have immense potential to be integrated with patient monitoring and telemedicine in the future.

## TELEMEDICINE IN EMS

*Telemedicine* is defined by the Institute of Medicine as “the use of electronic information and communications technologies to provide and support health-care when distance separates participants.”<sup>16</sup> The purpose of telemedicine is to improve patient care by improving the medical communication processes between patients and health care providers using

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