FINAL CONTRACT REPORT

REAL-TIME EMS HELICOPTER VIDEO FEASIBILITY STUDY

Dr. Debra Perina
Medical Director, Pegasus Aeromedical Program

Project Monitor
Cheryl Lynn,, Virginia Transportation Research Council

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INTRODUCTION

Deteriorating traffic conditions and resulting safety problems on I-81 have long been a topic of concern for the people living along the I-81 corridor, their elected representatives, and local government administrators. Increasing congestion along the largely four-lane highway has resulted in increases in crash rates. A higher percentage of tractor-trailer traffic in the vehicle mix on I-81 has increased the vulnerability to injury of passenger car occupants involved in those crashes. Fatal crashes on I-81 have remained relatively constant, in the twenties and low thirties, but the number of injury and property damage crashes have steadily increased in recent years.

A significant number of motor vehicle crash victims along the I-81 corridor are eventually transferred to UVA hospital, which is the closest level 1 trauma center. Although the EMS teams that are summoned to motor vehicle crashes are trained volunteers with experience in dealing with motor vehicle crashes, they are not doctors or nurses, and there are times when additional expertise is needed to prevent disability or death. In these situations, the advice of a more highly trained professional is needed at the crash scene. Multiple previous research studies have shown that the single most important factor affecting disability and death rates from crashes is the length of time between injury and access to critical care. The ideal situation would be if experienced medical providers could remotely see the crash site and be able to give advice to EMS providers at the scene.

The medical personnel staffing the Pegasus emergency evacuation helicopter have extensive experience in treating critically injured crash victims and are formally trained medical professionals with additional certifications in critical care. They can provide advice to local rescue squads while in transit to pick up the crash victim. To do this, they need as much information about the crash and its resulting injuries as possible. High resolution, mobile video transmissions would allow the Pegasus staff direct audio and visual access to the crash scene, the patient, and the care being provided, without requiring a detailed verbal description from EMS personnel. This effectively would allow critical care capabilities to reach crash victims sooner than is now possible, potentially reducing morbidity and mortality of the crash victim. This feasibility study was designed to determine whether the technology exists to connect the helicopter with ground EMS personnel.

PURPOSE AND SCOPE

The purpose of this project was to determine whether the use of ground-based video imaging by local rescue squad personnel and Pegasus medical staff is technically and organizationally feasible as a tool to improve pre-hospital care provided to crash victims. The available technology was rated against three criteria: (1) the video feed must be delayed by less than 60 seconds, (2) the picture quality must be adequate for remote evaluation of trauma, and (3) the signal must be secure to protect patient privacy.

METHODOLOGY

Companies with technology that could potentially work for this proposed project were identified through a literature search, web searches, attendance at conferences where technology was being demonstrated, and word of mouth among manufacturers, medical researchers, and EMS agencies or organizations. Each of these companies was contacted and each provided information and /or demonstrations of their product. In cases where similar research was being conducted, the principal investigator was contacted for information on the scope of their project, the technology being employed, and any problems encountered to date.

In the search for acceptable equipment, each "lead" identified through the above process, was followed up through direct contact by the principal investigator along with the assistance of the telemedicine department at the University of Virginia. Each company contacted was also queried as to any knowledge they might have of other companies who could potentially provide the desired technology if they could not. The principal investigator then made a determination as to whether the equipment was technically acceptable for the implementation phase of this project.

The following is a list of companies and contacts investigated during this phase of the project. Information obtained and the contact outcome are noted for each identified company.

1. Meridian Company, Noah Rifkin
2. NavTec Systems, Geoff Leighton
3. ARNAV Systems, Frank Williams
4. University of Texas, Houston, Dreams project, Doug Tindell
5. University of Maryland, Marian LaMonte, M.D
6. CISCO Project, Southwest Research, Tucson, Arizona
7. ARINC – David Miller
8. New York State EMS Authority, Carol Phielman

9. U.S. Coast Guard, Commander Art French, M.D

10. American Airlines, Kendall Greene, M.D

11. Uniformed University Casualty Research Center, Joe Heck, M.D.

12. WESCAM and subsidiary Broadcast Sports Technology, Norm Boese, Mark Merrill

In addition to identifying equipment necessary to perform the project, it was also necessary to determine other entities that would need to partner with the study team for project completion. Identified partners included ground EMS providers, other hospitals in the proposed study area, and other state or governmental agencies that might be impacted and/or were necessary for project completion. For the project to be successful, participation and cooperation was necessary from the parties listed below. The principal investigator, along with other members of the study team met with each identified group.

RESULTS

Literature review

The use of real-time remote audiovisual links have been employed in the care of patients by telemedicine since the early 1980's This technology was totally dependent on connections with T1 data transmission lines that required hard-wired connections between sites. Real-time video links without hard wire connections have only been possible in the last few years, with ground to ground linkages accomplished through the use of microwave or cellular technology. Currently there are four ongoing ground-based projects investigating the feasibility of this technology to enhance patient care in EMS vehicles. These studies are located at the University of Maryland, and in Houston Texas (Dreams Project), Las Vegas, Nevada, and New York State. To date there has been no successful real-time video imaging connecting aircraft with ground unit by non-military personnel.

Within the past three years, two clinical trials have been preformed by military personnel with variable results. These trials were performed by the U.S. Coast Guard and the U.S. Navy and produced mixed results. Problems noted in both these trials included grainy, suboptimal resolution of the video and unacceptable delay in transmission time between connected sites. As a result, all further testing by these two entities was suspended pending further technological advances.

Company and Partner Interviews

The following is a list of companies and contacts investigated during this phase of the project. Information obtained and the contact outcome are noted for each identified company.

1. Meridian Company, Noah Rifkin - This company represents clients that are looking for specific cutting edge technology and puts appropriate manufacturers in contact with potential

customers. Mr. Rifkin had no direct knowledge of manufacturers or companies with real-time video technology as proposed for this project, but did note the use of "some communication linkages" beyond normal radio transmissions between New York EMS systems and receiving hospitals. He referred the principal investigator to Carol Phielman who was spear-heading the project. Additionally, Mr. Rifkin offered to investigate other potential sources of equipment that might be useful in this video project, but subsequently could not identify other companies beyond those already identified by the project director.

2. NavTec Systems, Geoff Leighton -This is a British based company that specializes in microwave real-time video connections between two ground points. The company is currently working on achieving aircraft transmissions from air to ground through satellite up-link connections. The signal is analog and thus cannot be secured against other users accessing the signal.

3. ARNAV Systems, Frank Williams – This system employs computerized real-time flight following techniques using aircraft identifiers and microwave and radar transmissions. Point-to-point movement of aircraft is accomplished through this mechanism. This company does not employ video feed nor have a platform that would support video equipment in addition to what currently exists. They were unaware of companies with such technology.

4. University of Texas, Houston, Dreams project, Doug Tindell - This project is utilizing real-time audio and video to connect Houston EMS with the University of Texas in Houston. The transmission signal is compressed through microwave and analog techniques. The project has been complicated by lack of ability to transmit over distances, due to large buildings in downtown Houston blocking the microwave signals. The analog transmission also is problematic for security of the signal against other entities that might attempt to access the transmission. The equipment is first or second generation real-time video from WESCAM, and is a variant of that utilized in the military demonstrations.

5. University of Maryland, Brain Attack project, Marian LaMonte, M.D. This project is using real-time telemedicine video feed through microwave transmissions to connect ground EMS agencies in Baltimore City and the University of Maryland receiving hospital. This technology is only being employed in cases of suspected stroke patients to allow the neurologists to complete a neurological examination on the patient prior to arrival to the hospital, in order to shorten the interval between onset of systems and use of thrombolytic drugs. The equipment utilized was developed within the biomedical department at the University of Maryland by researcher Peter Wu. There is an assigned bandwidth for EMS in Maryland; however, the equipment used in this test could not use the normal EMS band, because it interfered with the band set aside for routine transmissions from aircraft. Interest was expressed in working to overcome this obstacle, but further research and development was projected to take 8-9 months.

6. CISCO Project, Southwest Research, Tucson, Arizona – This project is just beginning and is projected to connect ground EMS with receiving hospitals in a real-time video connection. This is projected to include aircraft linkages within a year after beginning the project. Equipment is expected to be obtained from Broadcast Sports Technologies.

7. ARINC – David Miller – ARNIC is based in Annapolis Maryland and works with clients to put together specific system needs by identifying equipment or equipment components necessary to build the desired system. This company was contacted following the meeting with the Virginia Department of Aviation on the referral of its director, Ken Weigand. Mr. Miller indicated that he was not aware of any system capable of providing real-time video/audio feed

8. New York State EMS Authority, Carol Phielman – This project uses photos taken at the incident scene and then transmitted to the receiving hospital. These photos are used by medical personnel to aid in determining the potential extent of a patient's injuries based on the mechanism of injury. This project uses static displays and no video or audio transmissions. The information is also not real time, with the photo's reaching the hospital at or about the same time as the patient.

9. U.S. Coast Guard, Commander Art French, M.D. – The Coast Guard in conjunction with other branches of the military has an interest in this type of technology from two perspectives: (1) to be able to provide surveillance of other craft remotely by officers on land through a video stream from a Coast Guard vessel, and (2) to be able to offer instructions to Coast Guard personnel to provide medical care to patients encountered on the high seas. The Coast Guard conducted limited tests off the U.S. coast approximately two years ago with variable success. Equipment was provided from WESCAM, and was similar to that supplied to other branches of the military for demonstration purposes(see below). Problems encountered included an analog signal that did not protect against others intercepting the signal. Video quality was grainy with such poor resolution that individuals on land could not make out sufficient detail to be able to perform the required mission. The mode of data transmission was by satellite up-link.

10. American Airlines, Kendall Greene, M.D. – American Airlines along with it's partner, British Airways, has investigated ways to provide real-time flight data from cockpit video for Trans-Atlantic Flights. To date, no equipment has been tested which performed in a manner desired by the companies. Video feed was grainy, choppy, and had up to a minute delay in feedback to video feed. The equipment tested used satellite up-link technology for transmission. This was very costly, but did allow for appropriate security of video feed. Presently, the video quality precludes use for the level of routine cockpit monitoring presently desired by these commercial airlines. ARNAV systems has been used in the past for flight-following of commercial aircraft, but recent advances in satellite tracking have resulted in this method being preferred.

11. Uniformed University Casualty Research Center, Joe Heck, M.D. The U.S. Military has had an interest in this type of technology specifically as it relates to enhancing the survival of battlefield casualties. In theory, if physicians could provide remote assessments through video linkages and instructions to field medics, the survival rate of casualties would be higher. The military conducted two field demonstrations of state-of –the-art technology roughly two years ago before putting further efforts on hold. WESCAM was the company that provided the technology utilized in the demonstrations. There were several problems

encountered with the technology. Poor video resolution resulted in physicians not being able to provide direction at times. A delay of up to one minute in video feed resulted in delays in direction of care that would have negatively impacted survival. Finally, the transmission signal was analog resulting in inability to appropriately secure the transmission from interference and interception by other entities.

12. WESCAM and subsidiary Broadcast Sports Technology, Norm Boese, Mark Merrill – WESCAM and it's subsidiary, Broadcast Sports Technology, have been the major supplier of real-time video equipment for several of the projects identified in the course of this feasibility study. This company was contacted early on in the study, and the equipment available at that time was capable of analog only transmission and had delayed transmission time due to satellite up-link transmission requirements when used in aircraft. The limitations of this type of technology were well demonstrated by previous projects identified in other portions of this text. In March 2001, the company was again contacted for an update. At this time, further modifications had just been implemented in their equipment making digital transmission possible and augmented microwave transmission feasible between an aircraft and the ground. This had not been technically feasible prior to this time. Break-though technology occurred largely due to funding by the FOX Network sports channel primarily for NASCAR transmissions. The new product debuted at the Indianapolis 500 in March and exceeded expectations. The product was then shown at the Paris air show in June 2001. The third demonstration of this technology occurred in Charlottesville in July 2001 (see results section of this document).

Necessary partners in this endeavor included ground EMS providers, other hospitals in the proposed study area, and other state or governmental agencies that might be impacted and/or were necessary for project completion. For the project to be successful, participation and cooperation was necessary from each potential partner, and the Principal Investigator and other members of the research team met with each. The outcome from these meetings is detailed below.

1. Rockingham Memorial Hospital – Kent Folsum, MD, Emergency Department Director and Mary Ann Noland, the Emergency Department Nurse Manager attended the meeting. Dr. Folsum expressed interest in the project on behalf of Rockingham Memorial Hospital and was particularly interested in the potential for video connections to eventually exist between EMS units and receiving hospitals if the technology being tested proves useful. He pledged support of the current project and offered to train local EMS agencies and orient Rockingham Memorial ED physicians and staff on the nature of the project and our proposed protocols. We discussed the potential for accident victims on the I-81 corridor, who are currently taken to Rockingham Memorial before transfer to UVA, to be transported to UVA as a result of this project. Dr. Folsum did not feel this would create any negative impact on his census or operations. It was agreed by both parties that the accident victim would be taken to Rockingham Memorial Hospital first if the ground transport time to there was shorter than the air transport time to UVA.

2. Stonewall Jackson Hospital – Colleen Arnold, MD, is the director of the Emergency Department, as well as the local EMS Medical Director, so she could speak to involvement

of the area EMS squads as well as the ED. Dr. Arnold expressed great interest in this project, as her hospital is the recipient of all serious accident victims in the southern portion of the proposed project study area. Stonewall Jackson Hospital is a small community hospital that lacks many resources to effectively care for a major trauma patient. Dr. Arnold felt that this study might result in accident victims being transported to a trauma center sooner and that they might even bypass Stonewall Jackson altogether which in her opinion was totally appropriate. She further indicated that the local EMS agencies would be happy to participate in the study, and that she would help facilitate and train the squads as needed.

Dr. Folsum is also the Regional EMS Medical Director for this council, and thus was able to articulate the desire of the Council to participate in the implementation phase of this study. Issues discussed included ways to in-service the ground EMS providers of the equipment, recurrent training that would be necessary periodically during the study period, and the best ways to accomplish data collection regarding performance of the equipment being tested.

3. Virginia Department of Aviation – Ken Weigand, Director, represented the Department at this meeting. The Aviation Department expressed ongoing interest in the project and a desire to be kept informed as the project moves forward. The Department of Aviation is currently in a competitive bid process for grant monies from NASA and the FAA to be a test bed for new technologies that can be integrated in aircraft to enhance communication capabilities. The helicopter video project is in line with other proposals as emerging technology in aviation and could potentially dove-tail nicely with the efforts of this technology test-bed.

4. Virginia Department of State Police – Colonel Gerald Massengill, along with all District Sergeants and the State Police Chief Pilot, were present for the meeting. The State Police expressed interest in the project and a desire to be kept informed regarding equipment identified and employed in this regard. Equipment similar to that necessary for this project has significant appeal and application to the law enforcement mission. The State Police agreed to assist in this project by allowing the portable video equipment that is to be operated by EMS to be carried in the trunk of their vehicles. Since State Police are almost always the first responding unit to an accident scene, they would be responsible for giving the equipment to the first responding EMS unit at the scene of the accident and re-securing the equipment after it's use. Nothing further would be expected from the officers , leaving them free to perform their traffic control duties. There were also discussions that the State Police are constructing a network of microwave towers along I-64 and I-81. This microwave network is obviously envisioned as being totally secure and for law enforcement purposes only. Within these discussions the opportunity to potentially use this network as part of the communication system for the proposed project was offered and is potentially viable, depending on the in-aircraft equipment chosen.

Currently, there are 3 research projects attempting to use real-time video linkages between ground EMS units and hospitals to enhance patient care. There are no projects utilizing this technology in an aeromedical setting linking aircraft to ground based locations. This type of technology is constantly undergoing modifications, with advancements occurring in a rapid fashion.

Equipment Demonstration

A public demonstration of the WESTCAM equipment was held at Charlottesville-Albemarle Airport on July 17, 2001. The demonstration was attended by members of the news media, with subsequent coverage on local TV (See Table 1). During this demonstration the selected equipment performed according to expectations. It was easy for ground EMS personnel to use and the video quality was real-time and of sufficient resolution to permit treatment decisions to be made by providers. Thus, acceptable technology currently exists to allow the implementation portion of this study to proceed.

Table 1
Attendance List
Westcam EMV Video Demonstration

	Organization	Email
Greg Cross	VDOT Rural ITS Planning	Its81@shentel.net
Michael D. Berg	Director, Thomas Jefferson EMS Council	TJEMS@cstone.net
Nick Saunders	Virginia State Police, Chief Pilot	barrelhouse@juno.com
Cathy Seigermom Wolz	Media Office, UVa health Systems	cds6v@virginia.edu
Lori Lichorobuc	NBC29	lichorobuc@nbc29.com
Lewis Jenkins	TJEMS council member	lpj@virginia.edu
Brett Henyon	Pegasus-flight crew member and project contact	bkh@virginia.edu
Jon DuFresne	VDOT-Intelligent Transportation Systems Division	Dufresne_jon@vdot.state.va.us
Gary Allen	Va. Transp. Research Council	allen_gr@vdot.state.vs.ua
Art French	Commander U.S. Coast Guard, assigned to NHTSA	afrench@nhtsa.dot.gov
Matt Mueda	NHTSA	mmueda@nhtsa.dot.gov
Gene Sullivan	Director, UVa Telemedicine Department	genes@virginia.edu
Kent R. Folsum M.D.	ED Director, Rockingham Memorial Hospital Regional EMS Medical Director	macdaddymd@aol.com
Steve Shergold	VDOT-Intelligent Transportation Systems Division	Shergold_s@vdot.state.va.us
Jim McGowan	UVA, Patient Care Services Administrator, Emergency Services	Jm4w@virginia.edu
Michael Patterson	UVa Telemedicine	mp8c@virginia.edu

DISCUSSION

During the course of this study many problems were encountered. This type of technology has only recently been available, and in some cases is still in research and development. This made identifying companies and other projects very difficult, as there was essentially no central clearinghouse of such technology. Additionally, this study sought to place the technology in an aviation environment, where limited experience existed and the equipment largely untested. Some companies that had the necessary technology and were close to meeting the project needs were not willing to share the information or provide technology for proprietary reasons.

Once the appropriate technology was identified as available through WESCAM and Broadcast Sports Technology, efforts to customize the equipment for this project were successful, culminating in the local demonstration of the technology. This demonstration showed that the video signal is of sufficient quality to allow medical personnel to make treatment decisions. There is virtually no delay in signal transmission resulting in true real-time receipt of information. The signal is digitized, and thus secure against other entities inadvertently accessing the signal. This protects patient confidentiality when treating accident victims and transmitting information between ground personnel and the helicopter crew. Finally, the ability to augment microwave transmission of the signal allows for air-to ground transmission over longer distances making aircraft connects between Charlottesville and I-81 possible.

In addition to the equipment necessary for completion of the project, significant cooperation and partnerships must be in place for successful implementation of the helicopter video project. Key partnerships have been developed between Rockingham Memorial Hospital, Stonewall Jackson Hospital, Central Shenandoah EMS Council, and the Virginia State Police. Each of these groups has a vested interest in the project and have agreed to participate in a multi-year pilot test of the equipment. In addition, the Virginia State Department of Aviation has indicated ongoing interest in this project.

Limitations of this study include the fact that technological advances are occurring so rapidly with the type of equipment necessary for this project, that it is possible the technology identified for this study may be outdated in a few months. Likewise, it is possible that other appropriate equipment exists that may not have been discovered by the investigators.

CONCLUSIONS

1. Real-time video imaging is technically feasible between ground-based units. This was clearly shown in the public demonstration of the identified equipment in July 2001.

2. Images produced by the video equipment are of sufficient signal quality to allow aeromedical crew to make patient care decisions remotely.

3. Digitalization of the transmission signals allows for encryption of information, thus insuring security of the signal and patient confidentiality

RECOMMENDATIONS

Real-time Video Connections are technically feasible between ground-based EMS agencies and helicopter medical crews. WESCAM and it's subsidiary, Broadcast Sports Technology, is the only company identified in the course of this feasibility study that can provide this video imaging in digital format**.** This type of transmission is necessary to maintain patient confidentiality and the security of transmission signals between sources. Accordingly, it is recommended that WESCAM be the sole-source company to provide the real-time video imaging technology for Phase II, the implementation phase, of this project.