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Emergency Medical Service (EMS)-Rotorcraft Technology Workshop

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Emergency Medical Service (EMS)-Rotorcraft Technology Workshop

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The contents of this document represent the consensus of participants in the Emergency Medical Service (EMS) -Rotorcraft Technology Workshop. Each specific recommendation is not necessarily accepted by each participant. The contents also do not necessarily reflect the official views or policies of any public or private organizations which participated in the Workshop.

Emergency Medical Service (EMS)-Rotorcraft Technology Workshop

EXECUTIVE SUMMARY

BACKGROUND

The National Aeronautics and Space Administration (NASA) sponsored a Public Service Helicopter User's Workshop at its Ames Research Center in July 1980. This Workshop examined the use and benefits of public service helicopters in Law Enforcement and Public Safety, Disaster Relief, Emergency Medical Services (EMS), Search and Rescue, and Fire Protection. The consensus of the Workshop's Working Group Chairmen was that continuing NASA/operator interchanges were critical to the establishment of research and technology programs responsive to Public Service Operator needs. The Emergency Medical Service (EMS) - Rotorcraft Technology Workshop was the first response to this call for NASA/operator interchange. The purpose of the workshop was to provide both an extensive and intensive overview of the increasing role of rotorcraft in EMS together with panel discussions of rotorcraft technology needs from the standpoint of manufacturers and users as well as national benefits and opportunities.

The Helicopter Role in EMS

Trauma kills 115,000 persons a year at an annual cost to society of $87 billion. Improved emergency medical services (EMS) can reduce this high mortality rate that results from injuries caused by traffic, occupational, residential, and recreational accidents. Prompt on scene treatment by medical personnel using modern emergency medical equipment and rapid transport of the victim from the injury scene to a shock trauma center can reduce the number of mortalities by 50%. Another form of EMS where time is vital is hospital to hospital transfer of critical patients requiring specialized treatment, and transport of organs/blood, medical supplies and equipment.

There is a growing support for regional state shock trauma centers based on helicopter transportation to and from the injury scene. It has been demonstrated by existing shock trauma centers that helicopters can reduce response time by as much as 80%. In recognition of the importance of helicopters to EMS, helicopters at hospitals have doubled over the last five years.

Helicopters also perform other EMS related public services such as Search and Rescue (SAR) and Disaster Relief. U.S. helicopters have airlifted approximately 800,000 persons from life threatening situations such as ship collisions, floods, fires and aircraft accidents in remote areas. In 1978 the U.S. Coast Guard flew 11,700 helicopter SAR missions, saving 1,953 lives.

OBJECTIVES OF WORKSHOP

- To provide an extensive and intensive overview of the increasing role of rotorcraft in EMS.
- To reach a consensus of present and future rotorcraft technology needs from the standpoint of manufacturers and users as well as national benefits and opportunities.
- To provide EMS planners an insight into the various concepts currently in operation as well as an opportunity to discuss current and proposed EMS equipment.
- To provide technologists (manufacturers, operators and researchers) an insight into rotorcraft technology needs as seen by EMS users.

MAJOR FINDINGS

- **A lead organization on the National level should be designated to establish concepts, locations and number of shock-trauma air medical services.**

- **The organizations listed below should be informed concerning the potential benefits of a National EMS program.**

  FEDERAL/STATE
  Federal Emergency Management Agency (FEMA)
  Office of Emergency Services (OES)
  Military Services
  Office of Civil Defense
  Department of Transportation/National Highway Traffic Safety Administration (DOT/NHTSA)
  Department of Health and Human Services (DH&HS)
  National Aeronautics and Space Administration (NASA)

  PRIVATE SECTOR
  Insurance Industry
  American Medical Association (AMA)
  Medical Life Support and Diagnostic Equipment Manufacturers
  Helicopter Manufacturers

- **NASA should assume the lead role in integrating Technology Requirements to define the potential market for Advanced Public Service Helicopters in the following areas:**
  - EMS
  - Law Enforcement
  - Disaster Relief
  - Fire Fighting
  - Military

- **Great opportunities exist for current vehicles, but medical specialists desire an advanced vehicle, particularly one which incorporates advances in medical technology trends in health care.**

- **Key technology needs for the EMS helicopter of the future are:**
  - Ride quality of fixed wing aircraft, i.e., reduced internal and external noise, reduced vibration
  - No tail rotor
  - Small rotor diameter
  - Improved visibility
  - Crashworthy vehicle
  - IFR capability
  - More affordable
  - High reliability
  - Fuel efficient
  - Specialized cabins for advanced medical/diagnostic and communications equipment

- **The outcome of the trauma patient (mortality/morbidity and costs) is improved by reducing time between accident/incident and definitive medical care.**
  - Cost to society is estimated by the U.S. Department of Transportation to be 87 billion dollars per year
  - DOT forecasts an increase in deaths/injury severity due to the large/small car mix on highways
  - Vehicle must enable patient to have rapid access to technology and surgical skills
  - Total system speed is essential

- **Spectrum of on-site approaches:**
  - Stabilization through intensive care unit
  - Number and type of hospitals is a function of geography, population density, medical care philosophy, use rate, etc.

OVERVIEW OF WORKSHOP

The EMS-Rotorcraft Technology Workshop was sponsored by the National Aeronautics and Space Administration's Ames Research Center. The Workshop was held on 14 and 15 October, 1981, in the Health and Human Services Auditorium, Washington, D.C.

The Workshop brought together representatives from all aspects of Emergency Medical Services, including public officials at all levels of government, EMS physicians, rotorcraft users, manufacturers and researchers.

The Workshop was interspersed with technology review sessions, overview sessions and panel discussions. Topics covered in these sessions and panel discussions ranged from accomplishments and future technology needs for EMS aircraft and medical requirements for future helicopters to costs/benefits of helicopter EMS.

The detailed workshop agenda is presented in Appendix A.

The list of workshop attendees is presented in Appendix B.

ABSTRACTS OF SELECTED WORKSHOP PRESENTATIONS

The Workshop was privileged to have among its speakers internationally recognized leaders in the field of the use of helicopters in EMS. An insight into two approaches to the National EMS system was provided by Dr. Christian Buhler, Chief Executive Officer of Swiss Air Rescue (SAR), and Dr. Gerhard Kugler of the German Automobile Club (ADAC). Dr. R Adams Cowley, Director of the Maryland Institute of Emergency Medical Services System (MIEMSS) and featured in the book and television drama, "Shock Trauma", presented an overview of the MIEMSS. Dr. Howard Champion, Director, Shock-Trauma Unit, Washington Hospital Center, provided an insight into a functioning EMS program. Brief biographical sketches of these individuals and abstracts of their presentations follow.

Dr. Christian Buhler

The keynote remarks were presented by Dr. Christian Buhler, Chief Executive Officer of Swiss Air-Rescue (SAR) and its subsidiary, Swiss Air-Ambulance Ltd. Prior to assuming his present position, Dr. Buhler had been a freelance pilot with SAR and beginning in 1971 became SAR's chief pilot and in charge of various other functions.

This world renowned authority on the use of helicopters in EMS set the tone for the workshop by his presentation which is abstracted below:

"Today's Accomplishments and Tommorrow's Requirements for EMS Aircraft"

The Swiss Air Rescue (SAR) was formed in 1952 as a part of the Swiss Lifesaving Association, but was reorganized in 1960 as a separate organization. Since its inception, SAR has pioneered many rescue techniques involving aircraft, both fixed and rotary wing, and has conducted some spectacular rescue and life-

Dr. Christian Buhler

saving missions. In 1960, the SAR concluded that professional medical aid must be taken to the accident site, the patient must be transported expeditiously to a hospital for proper treatment. In 1980, SAR conducted 6,000 operational flights. The SAR has 15 operational bases, serving any place in Switzerland within 15 flying minutes from a SAR base. To put this in perspective, Switzerland is one-sixth the size of Colorado but has twice the population. It has 250 plus hospitals compared to 50 in Colorado.

SAR employs helicopters that have IFR capability. In 1981, 300 night flights were conducted. High powered search lights are mounted on the helicopters to aid in rescue missions at night. The SAR Mission is wide ranging and includes operations involving: mountain rescue; rescue with winch; avalanche conditions; glacier crevasse rescue; cable car evacuation; hospital-to-hospital transfer; aid to farmers in remote areas; firefighting utilizing water buckets; catastrophic situations; out of country aid such as earthquake relief; and repatriation of ill and injured Swiss citizens from foreign countries.

SAR operations are organized and coordinated by one central base. This central base knows the degree of readiness of each satellite base. SAR has a dedicated one-way radio network (32 stations) used by SAR control to designate the "how, when, and with which means" for each incident, i.e., SAR control transmits the medical indication, degree of emergency, technical conditions, weather and topographical information.

SAR is an independent, humanitarian and charitable organization, with most of its support coming from donations, voluntary contributions and legacies. Two-thirds of SAR's 20 million Swiss franc operating cost is donated. Financial support from the Swiss Government is less than 5 percent.

SAR is examining future requirements of its air rescue/ambulance system. Aircraft will be used solely for air rescue and ambulance services. Multipurpose use is being phased out. The helicopter cabin requirement must be able to carry two seated attendants and one or two patients on the same level. The helicopter should be twin engined for over water/town operations. Its characteristics should include, *inter alia:* maximum take-off weight - 8,000 pounds; hovering altitude 7,000-11,000 feet; reduced diameter of rotor blades; fast engine start up and no warm up time; lower external and internal noise; IFR; rescue winch (550 pounds/200' cable length).

There is a need to standardize air ambulance space and openings. SAR requires a 72" × 18" standard stretcher to be loaded into a helicopter without tilting the stretcher and with means of safely attaching the stretcher inside.

The interior cabin should be equipped the same as a road ambulance interior, with a minimum door opening of 1 meter by 1 meter. Some other features include: access to patient's head, neck and thorax; low cabin noise level; efficient cabin heating; oxygen storage of 10 liters per minute of flight time; ready access to medical appliance and supplies; suitable lighting of patient's upper body; 2-way helicopter-hospital radio. Medical equipment and supplies should include: incubator; monitor; suction pump; respirator; infusion pump; fibrolator; drugs.

Acquisition of this future system calls for heavy financial expense. When the question is asked, "Is there a justification for a costly air ambulance/rescue service", the response is usually negative—until the time comes for those individuals to make use of it.

Dr. Gerhard Kugler

Another well known international authority in the field of helicopters and EMS is Dr. Gerhard Kugler.

Dr. Kugler is Director of the Emergency Rescue Department, German Automobile Club (ADAC) and editor of the ADAC-Rescue Helicopter News in Germany. Following is an abstract of his presentation.

The Air Rescue System in the Federal Republic of Germany -West German Statistics of 10 Years of Operation, Helicopter Tasks and Technical Helicopter Requirements"

Improving the system of medical aid is not merely a question of quantity, but more so of the quality of the means of rescue. A decisive factor in the success of the treatment is ensuring optimum care of the emergency patient at the scene of the incident shortly after the injury has occurred. This has been the goal towards which the development of a dense air rescue service network has been directed since 1970 in the Federal Republic of Germany, for which ADAC laid the cornerstone with the first pilot tests. Standards for the organization of the air rescue service and the equipment of the rescue helicopter were established. According to these standards, not all helicopters are suitable for use in the rescue service. The most important criteria for deciding whether or not they qualify for use are, for example, turbine engines, because of their low vibration level, and sufficient room for treatment in the cabin with stretchers placed side by side.

At present, there are 30 air rescue centers in the Federal Republic of Germany at which helicopters are stationed daily from 6:00 A.M. until sunset exclusively for rescue purposes. The helicopters are always stationed at large hospitals which supply doctors for all rescue flights. The helicopters can take off in a maximum of two minutes after the accident report has been received, and they fly within a radius of 50 - 70 km. They are directed by the central rescue control centers.

Dr. Gerhard Kugler

Since 1970, the rescue helicopters have flown 106,000 missions. All data relating to the missions were evaluated by ADAC by electronic data processing. By sharing the costs, expenses have been kept at a minimum. The Federal Ministry of the Interior bears investment costs, while ADAC pays administrative costs. Running costs are refunded by the health insurance institutions. ADAC has signed contracts to this effect with the health insurance institutions.

Dr. R Adams Cowley

In the United States much of the credit for the development of EMS systems must go to Dr. R Adams Cowley, M.D., Director of the Maryland Institute for Emergency Medical Services System (MIEMSS). He is nationally and internationally recognized as the founder of the shock-trauma program concept and a leader on EMS systems development. The abstract of Dr. Cowley's presentation follows:

"MIEMSS - Organization, Accomplishments and Future Technology Needs"

The Maryland Institute for Emergency Medical Services Systems exists as a total and completely integrated statewide system with all phases and components interlinked to form a continuum of care for the critically ill or injured victim. This includes a statewide communications system, transportation, trauma center and rehabilitation centers.

The survival rate of patients admitted presently approaches 84%. Areawide regional trauma centers and specialty referral centers for definitive care are integrated into a network of EMS communications and "Med-Evac Helicopters" are operated by the Maryland State police for multi-purpose missions, with medical missions having absolute priority. The use of helicopters for quick transport of trauma victims, together with the rapid restoration of circulating blood volume, tissue perfusion, oxygenation and prompt surgery will decrease mortality by approximately 50%.

The vast experience of MEIMSS affords the opportunity to offer ideas on the future design and implementation of helicopters with the medical community. Some of Dr. Cowley's concepts are presented under "Medical aspects of EMS".

Dr. R Adams Cowley

Dr. Howard Champion

A further insight into a functioning EMS program was provided by Dr. Howard Champion, M.D., Director, Shock-Trauma Program, Washington Hospital Center. From 1972-1976, Dr. Champion assisted in the clinical program at Maryland's Shock-Trauma Unit in Baltimore. Dr. Champion has been associated with the use of helicopters in EMS for over 10 years. The abstract of his paper follows:

"Technical and Medical Requirements of Future Helicopters"

The problem with trauma is that the death rate is increasing and it is the most expensive disease in modern society. The prospects for increases in trauma situations mandates technology developments in the medical and helicopter emergency medical services field.

Presently there are no good studies documenting the impact of trauma centers and helicopters on trauma victim outcome. There is no system or data to normalize the case mix in patient population. Twenty percent of trauma victims die at the accident scene; 77% of those who die in the hospital do so in the first 24 hours, with the highest percentage dying within the first 3 hours. The value of the helicopter in reducing mortality has been documented, but the selection of trauma victims needed to be transported by helicopter based on injury severity must be improved. A common language is being developed to provide medical personnel with a description of injury severity.

In the treatment of trauma, "swoop and scoop" is essential. Stabilizing the patient at the scene is a myth. A trauma score has been developed by which the patient's survival chances can be predicted. Perfection of this system will lead to more efficient use of helicopters.

Beyond the development of trauma systems, there is a need for high technology support as helicopters emerge in EMS systems; however, documentation of the need does not yet exist.

Dr. Howard Champion

Some of the EMS areas or needs that require more attention are:

- Cost effectiveness - less important to stress, i.e., don't overdo
- Develop more effective triage guidelines
- Incorporation of high technology diagnostic equipment in helicopters
- Incorporation of high technology life support technology in helicopters.

There is a need for a new generation of EMS helicopters, civilian and military, focusing on the modular design.

There is no National leadership for Disaster Preparedness and there needs to be.

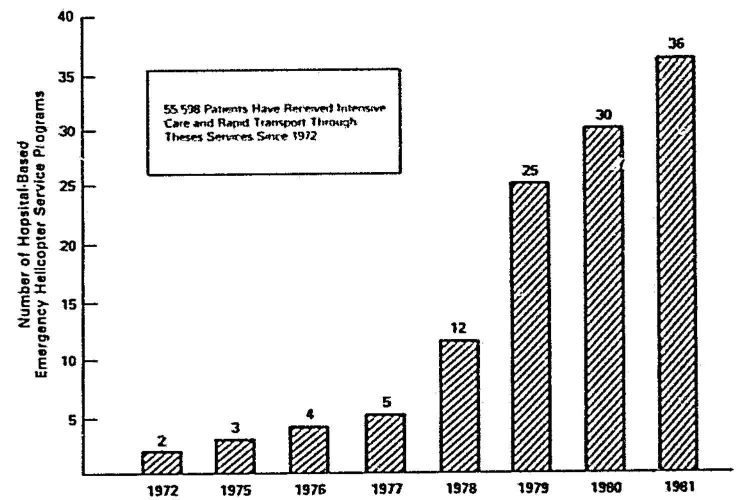
SYNOPSIS OF EMS INTEREST GROUP PRESENTATIONS/DISCUSSIONS

The Operators

Presentations by the EMS helicopter operators provided the attendees with the various approaches used by their organizations in conducting helicopter evacuations. Current and projected rotorcraft R&T needs from the perspective of the operators were also presented. Key points were:

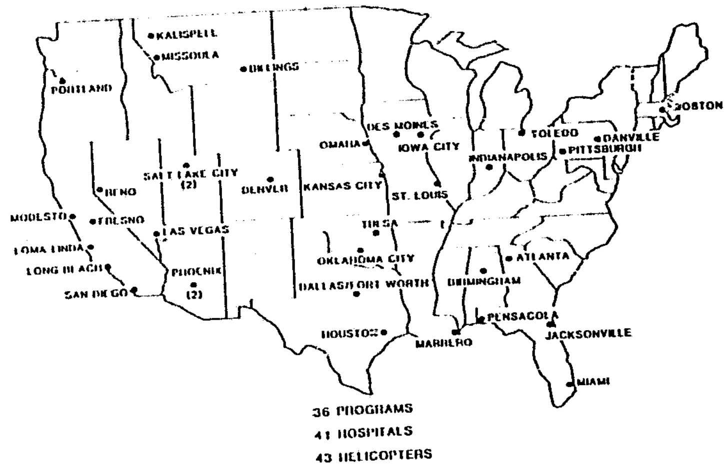
- Increasing sophistication of medical procedures have been accompanied by increases in costs. The health care economy of the 1980's makes this a stimulating challenge for health care administrators. This has been the genesis of the regionalization of health care. The rapid growth of hospital-based emergency air medical services (from two in 1972 to 36 in 1981) has clearly demonstrated the need for a national organization to support the development of high quality patient care. The growth of sophisticated inpatient care has presupposed equally sophisticated patient delivery systems. A well run patient delivery system leads to economies in patient care. It is expected that pressure to further develop advanced patient delivery mechanisms will continue through the next decade.
- The findings of the Public Services Helicopter User's Workshop EMS Working Group were reiterated. (See Appendix C).
- Accidents are the largest cause of death for those under 38. The cost to society each year is $87 billion. 10.2 million people each year are hospitalized for one day or more, using 1 out of 8 hospital beds.

Evolution of a Nationwide Network of Hospital-Based Emergency Helicopter Services



- There is a need for an advanced helicopter to provide the ability to deliver its crew at high speed (300 knots) directly to an urban roadway or rural area without being affected by roadway traffic, and not being limited by darkness, rain or snow.

Geographic Distribution of Hospital-Based Emergency Helicopter Services



- Over the past fifteen years, public service agencies across the nation have experimented and developed new uses of the helicopter to the point it has become in indispensable tool. New techniques created additional demands for services such as EMS.

- Present day EMS needs require extensive modification of helicopters that were not designed for the multipurpose missions required by public service agencies. NASA is the logical agency to assume the design and development role, up through a prototype of the future needs of airborne public service agencies, including hospital-based emergency helicopter services. These needs, both long and short term, would then be presented to the manufacturers for further development and eventual production.

- There are five elements essential to a successful helicopter EMS operation.
  - —The Helicopter
  - —Ground Ambulances
  - —Hospital Emergency Rooms
  - —Centralized Communication System
  - —The Emergency Medical Technician

- EMS helicopters are an important supplement to ground ambulances; however, they cannot possibly replace strategically located ground ambulances. The helicopter is reserved for critically injured victims whose risk of mortality or morbidity is greatly increased by ground transport. Only 2 to 5% of all accident victims are severe enough to warrant helicopter transport.

- With rotorcraft of advanced design and speed, accident response time can be reduced by as much as 80% and mortalities by 50% in both trauma and high risk neonates.

- One aircraft with modular capability can perform all Public Service functions.

The Medical Aspects of EMS

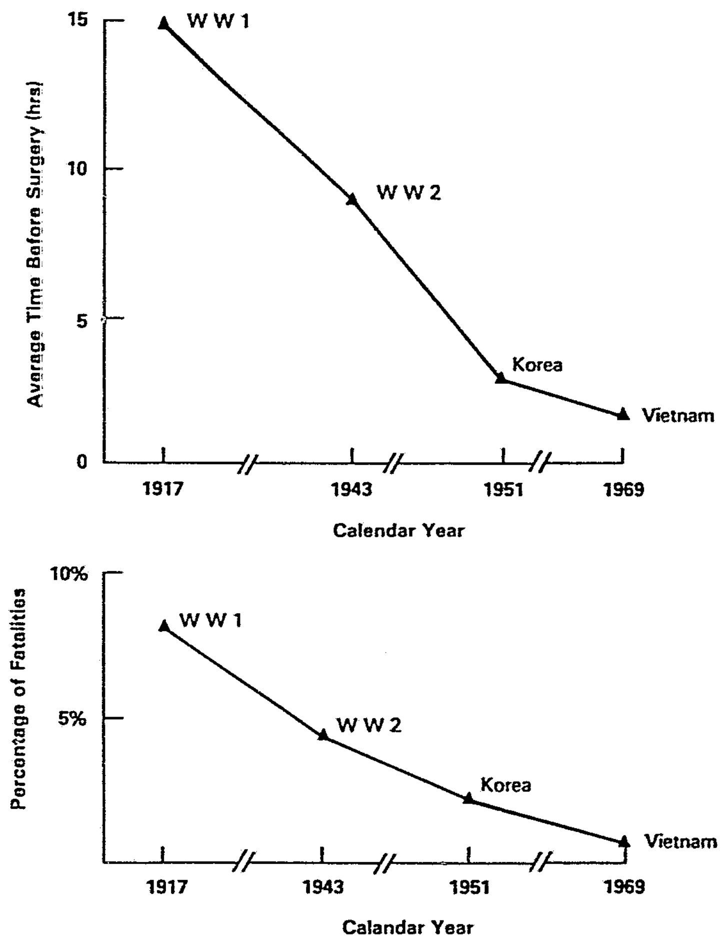
Presentations by EMS physicians and hospital administrators provided the attendees with views of helicopter design and technology needs as they impact on civilian emergency medical applications, including costs and benefits. Key points in these presentations were:

- Helicopters are being used increasingly for civilian emergency medical applications, particularly for traumatized patients. While this role is common in the military, it is still in its infancy in the civilian sector. In general, the military employ the "swoop and scoop" philosophy with the helicopter serving merely as a transport vehicle. These are usually larger than their civilian counterparts because of their accessibility and are rarely "retrofitted" or suited for sophisticated medical treatment. While the military models are being employed successfully for the transport of patients with multiple-organ system trauma, most notably in the State of Maryland, most new systems are hospital based and are transporting patients with a broad spectrum of medical problems.

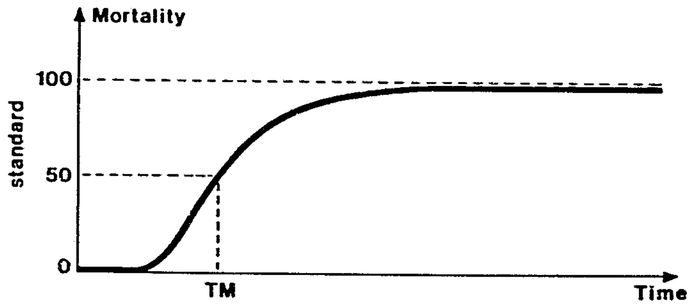
- Trauma team care must be available within first hour or "golden hour" of traumatic injury or critical illness to have any impact on reducing mortality.

  —Within the "golden hour", patient must be reached, field treatment initiated, stabilized and transported to a trauma center.

  —A response time of ten minutes or less after the initial call is the acceptable limit.

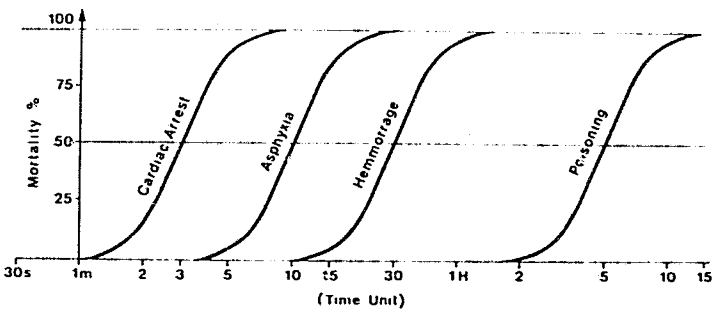


The Reduction in Time Before Surgery and Fatality Rates of War Wounded Due to Faster Transport to a Medical Facility



Standard mortality curve for emergency medical events against time when the patient is left without care.

TM: Time of 50% mortality



Mortality Against Time for Various Emergency Events

- Cost has proved to be a major factor limiting the expansion of hospital-based programs and has dictated the use of light utility helicopters. Weight limitations and cabin configurations have placed severe restrictions on the level of treatment that can be provided. Physicians have been forced to compromise on crew composition and the quantity of medical equipment.
- The hospital emergency department environment cannot be reproduced in a helicopter. Thus, there are a number of important trade-offs in choosing a helicopter such as:

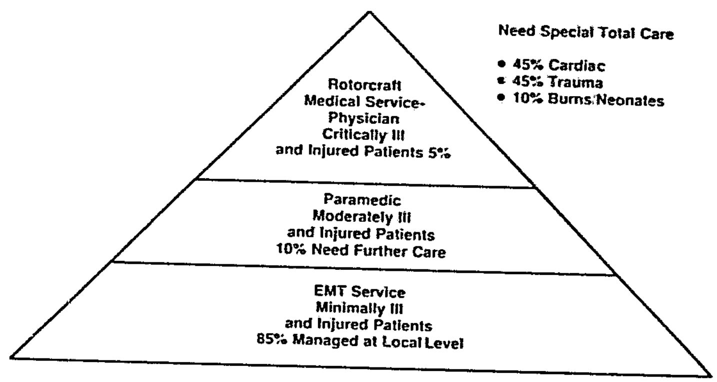
  —Affordability

  —Capability to perform all types of public service helicopter missions

  —Configured to permit excellent access to the head, neck, airway and thorax

  —Capable of carrying medical equipment and supplies needed for the critically ill patient

  —Low noise levels, vibration free and fast.
- It is imperative that the medical profession have input into the cabin design of any future EMS helicopter design. There are trade-off strategies that can be used to optimize medical care despite the limitations of presently available rotorcraft.
- With the emergence of the worldwide use of the rotorcraft for medical care over the last ten years, one striking development has failed to take place—the design and production of a helicopter by the rotorcraft industry specifically for EMS application.
- The full EMS system can be visualized as a pyramid.



- There are some existing helicopters that are considered suitable for each level of EMS by retrofitting the cabin to accommodate the type of equipment necessary for monitoring of critically injured and ill patients and somewhat more access to the patient. The point remains, however, that the EMS user is still forcing the craft to do something its designers had not envisioned it to do.
- The preferred rotorcraft from the medical practitioners view is:

EMS Helicopter

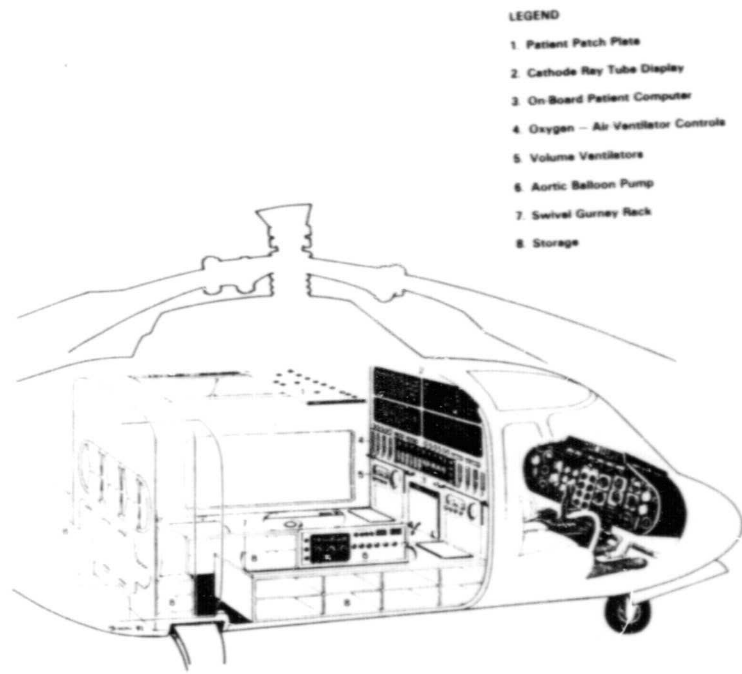
DESIGN:

TWIN ENGINE
LAND IN 60 FOOT DIAMETER
FULL GURNEY ACCESS SLIDING DOOR
NO TAIL ROTOR
MEDICAL CABIN 10 FT. LONG, 5 FT. WIDE, 5 FT. HIGH
CARGO HOLD 5 FT. LONG, 4 FT. WIDE, 4 FT. HIGH
SINGLE PILOT IFR

PERFORMANCE:

SPEED 250 KNOTS
RANGE 400 STATUTE MILES
ROTOR STARTUP OR SHUTDOWN 30 SECONDS
SERVICE CEILING 20,000 FT. MSL
PAYLOAD 3,000 POUNDS
HOVER OUT OF GROUND EFFECT 10,000 FT. MSL

- The preferred in-cabin configuration is depicted below:



The Manufacturers

Presentations by industry representatives highlighted the dilemma faced by the EMS community - the need for dedicated, high technology EMS helicopters versus the high cost of this technology. Key points in the discussion were:

- Present family of helicopters dedicated to the EMS role may be somewhat constrained by the limited internal dimensions.
- There are some large helicopters in operation now that are readily adaptable as a mobile medical surgical center, but they are too large for many EMS missions.
- The market for EMS configured helicopters required for a National EMS system is too small to justify the high R&D expenditures by industry.
- Great opportunities exist for current vehicles (single litter, light helicopter) but medical specialists desire an advanced vehicle, particularly with advances in medical technology and forecast trends in health care.
- Modifications to make existing helicopters more EMS-capable can be accomplished, but at great cost.

The Government

The consensus reached by the Workshop participants was that the government role in EMS helicopter technology development should be performed by NASA. The key points made during the NASA/Industry Panel Discussion were:

- NASA is the proper agency to address special technology needs of the EMS helicopter.
- Continuing interchanges between NASA and technologists, operators and medical profession are essential to the establishment of research and technology programs responsive to EMS-Helicopter system needs.

ISSUES AND FINDINGS

Issue #1—Is speed necessary in transporting a patient from an accident scene to a medical facility?

Findings

- The outcome of the trauma patient (mortality/morbidity and costs) is improved by reducing time between accident/incident and definitive medical care.
  - —Trauma kills 115,000 persons a year and is third biggest killer in American Society
  - —Monetary value of human life estimated by U.S. Department of Labor to be $287,000
  - —Accidents hospitalize 10,200,000 persons a year for one day or more, with patients occupying one out of eight beds in general hospitals.
  - —Cost to society is estimated by the U.S. Department of Transportation to be 87 billion dollars per year
  - —DOT forecasts an increase in deaths/injury severity due to large/small car mix on highways

Issue #2—What is the helicopter role in EMS?

Findings

- Response to severe accidents requiring time sensitive specialty care that cannot be provided by ground ambulances

Accident	Speciality Care
—Traffic —Recreational —Industrial —Residential	Shock Trauma Unit, Burn Center, Neonatal Center, Hand Center

- Situations too delicate or time critical to be performed by ground ambulances

Barriers to Ground Transportation	Time Critical Movements
—Traffic congestion —Snow clogged roads —Flooding —Terrain	Interhospital transfers of patients, medical supplies, organs and equipment

Issue #3—What are the benefits of the EMS helicopter?

Findings

- Accident response time reduced by 30-80%
- Mortalities in both trauma and high risk neonates reduced by 50%
- Patients transported to treatment centers consistent with their needs
- Relatively quick EMS provided to areas where none is currently available
- Timely evacuation of patients provided from remote or inaccessible areas
- Utilization of critical care facilities increased.

Issue #4—What are the technology needs for the EMS helicopter of the future?

Findings

- The medical community considers that current helicopter designs are inadequate for EMS
- Confirmed EMS helicopter needs identified in July 1980 Public Service Helicopter User's Workshop (Appendix C)
- Key technology needs
  - —ride quality of fixed wing aircraft, i.e., reduced internal and external noise, reduced vibration
  - —No tail rotor
  - —Small rotor diameter
  - —Improved visibility
  - —Crashworthy vehicle
  - —IFR capability
  - —More affordable
  - —High reliability
  - —Fuel efficient
  - —Specialized cabins for advanced medical/diagnostic and communications equipment
- Trade-off modular design (internal/external) versus dedicated vehicle

Issue #5—Can the helicopter become a cost-beneficial addition to the health care system?

Findings

- The cost-benefit of present helicopter ambulance programs, especially hospital-based systems, is generally based on the value of the patient occupying a bed and producing hospital revenue
- The cost-benefit justification for life-saving services remains for the most part intuitive and qualitative
- The financial viability of a helicopter EMS program should be evaluated on the basis of:
  - —Qualitative value of the program on reducing the morbidity and mortality of the patients transported
  - —Management of costs so as to minimize expense and maximize reimbursement
- Much more effort is needed to quantify and document the clinical value of the helicopter as a tool, including, but in addition to, its singular value of speed
- Tradeoffs can be made in requirements for higher speed helicopter versus on-site stabilization of the patient
- Reimbursement from insurance is based on ambulance due to medicare/medicaid stipulation; hence, emergency medical helicopter service must be subsidized from hospital revenues and ultimately borne by all health system users
- Since 90% of current helicopter transports are a single patient, this suggests an opportunity for a single litter, light helicopter. (Current Federal guidelines preclude this possibility.)
- Most cost/benefit studies to date have been microscopic, i.e., single hospital, and have not considered the macroscopic or national benefits

- Cost/benefit analyses are only a tool to help decide where dollars would be spent to benefit society when money is scarce
  - —Ultimately, the public through pressure on law makers, will decide, unless funding is through private resources.

Issue #6—What is the most cost beneficial method of developing, organizing, managing and utilizing an advanced helicopter EMS system?

Findings

- A lead organization on the National level should be designated to establish concepts, locations and number of shock-trauma air medical services
- A national cost/medical benefits scientific data base is required for existing U.S. air medical services
- Holistic systems including fixed wing and rotorcraft utilizing advanced medical and aeronautical technology offer potential cost savings benefits.

RECOMMENDATIONS

- The organizations listed below should be informed concerning the potential benefits of a National EMS program.

  FEDERAL/STATE

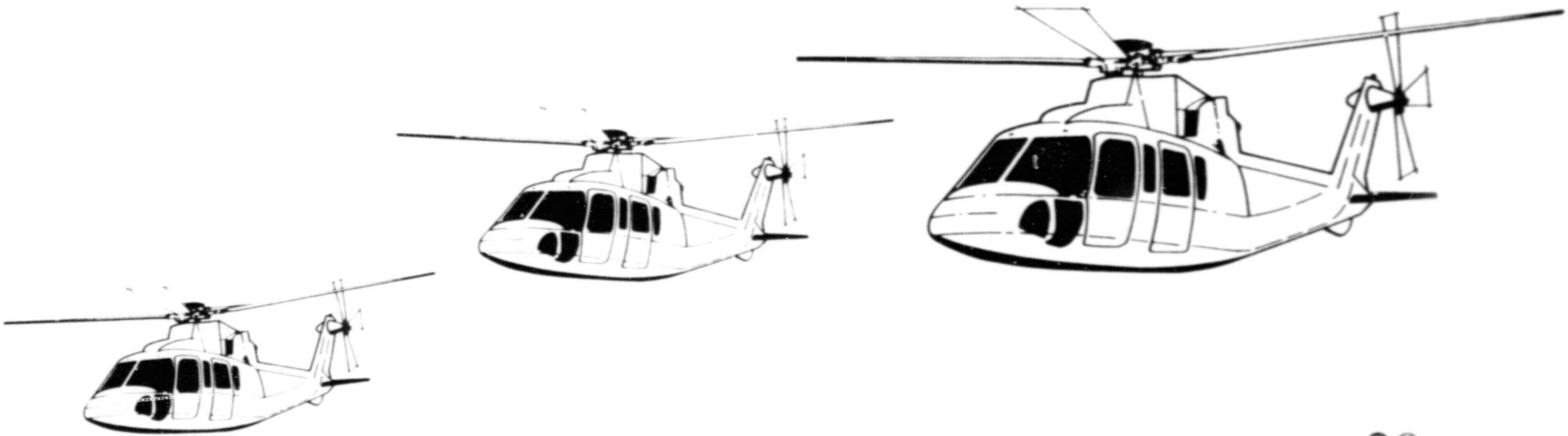
  Federal Emergency Management Agency (FEMA)
  Office of Emergency Services (OES)
  Military Services
  Office of Civil Defense
  Department of Transportation/National Highway Traffic Safety Administration (DOT/NHTSA)
  Department of Health and Human Services (DH&HS)
  National Aeronautics and Space Administration (NASA)

  PRIVATE SECTOR

  Insurance Industry
  American Medical Association (AMA)
  Medical Life Support and Diagnostic Equipment Manufacturers
  Helicopter Manufacturers

- Establish a national cost/medical benefits of EMS scientific data base for existing U.S. air medical services
  - Data collection should be a centralized and coordinated effort through organizations such as the American Society of Hospital-Based Emergency Air Medical Services (ASHBEAMS) or the American Trauma Society
- Undertake a macro level cost benefit analysis of Helicopter EMS (consolidation of health care services/improved health care)
- Institute a National public information program on the impact that trauma has on American society.
  - Third largest cause of death
  - Affects primarily young productive persons

- NASA should institute the following in coordination with EMS user hospitals, EMS medical equipment manufacturers and the medical industry:
  - —A study on modular design trade-offs
  - —A technology tradeoff analysis to analyze the interaction of desired advanced aircraft performance/capabilities with acquisitions/operation costs and technical feasibility.
  - —A study to determine the tradeoff between expeditious patient transport versus on-site stabilization
- NASA should assume the lead in integrating Technology Requirements to define the potential market for Advanced Public Service Helicopters in the following areas:
  - —EMS
  - —Law enforcement
  - —Disaster Relief
  - —Civil Defense
  - —Fire Fighting
  - —Military
- NASA should continue integrative effort on advanced EMS helicopters via forums, workshops, studies and technology development.
- Identify one or more third party organizations required to finance a National Helicopter EMS effort and to assist in the development of appropriate capabilities at the local level
- Establish creative financing/financing options
- Establish within an existing Federal agency an organization to establish concepts, locations and number of shock-trauma air medical services.



Appendix A
Emergency Medical Service (EMS)-Rotorcraft Technology Workshop
October 14-16, 1981
Final Agenda

Emergency Medical Service (EMS)-Rotorcraft Technology Workshop

Final Agenda

Wednesday, October 14, 1981

7:30 REGISTRATION

9:00 NASA WELCOME
Dr. Walter B. Olstad, Deputy Assoc. Admin. OAST NASA HQ
Introductions—Dr. John Zuk, NASA Ames

9:15 KEYNOTE REMARKS
Today's Accomplishments and Tomorrow's Requirements for EMS Aircraft
Dr. Christian Buhler, Swiss Air Rescue

10:00 ALEA AND NASA'S ROLE IN EMS
Lt. Robert Morrison

10:15 ASHBEAMS
Thomas Morgan, Director for Life Flight

10:45 COFFEE BREAK

11:15 NASA PUBLIC SERVICE HELICOPTER STUDY (EMS Highlights)
Richard Adams, SCT

11:45 MIEMSS-ORGANIZATION, ACCOMPLISHMENTS AND FUTURE TECHNOLOGY NEEDS
R Adams Cowley, M.D., Maryland Institute for EMS Systems

12:30 LUNCH

2:00 MEDICAL EMS PERSPECTIVE-ESSENTIALS VS. NICETIES
Dr. Richard Melker, Shands Teaching Hospital and Clinic

2:30 WEST GERMAN STATISTICS OF 10 YEARS OF OPERATION, HELICOPTER TASKS AND TECHNICAL HELICOPTER REQUIREMENTS
Dr. Gerhard Kugler, ADAC

3:15 COFFEE BREAK

3:45 COSTS/BENEFITS PANEL DISCUSSION
Donald Richardson, SCT, Moderator

- Michael Stringer, UCSD Hospital
- Dr. Boyd Bigelow, St. Anthony's Hospital System, Denver, CO
- Dennis Brimhall, Utah University Hospital
- John Waters, Emergency Systems Consultant

5:00 A FUTURE PERSPECTIVE ON HELICOPTER EMS
Dr. William Baxt, UCSD Hospital

5:30 NASA REMARKS AND ADMINISTRATIVE COMMENTS
Betty Berkstresser, NASA Ames

7:30 COCKTAIL BUFFET, FORT MCNAIR OFFICERS' CLUB
Guest Speaker, Office of the Surgeon General U.S. Army

Thursday, October 15, 1982

8:30 SIGNIFICANT MEDICAL REQUIREMENTS
Dr. John Zuk, NASA Ames

8:45 DEDICATED HOSPITAL OPERATORS
Jean Ross Howard, Aerospace Industries Association, Moderator

- Evergreen Helicopters, McMinnville, Oregon
  Kenneth McFadden
- Hermann Hospital, Houston, Texas
  William Smith
- Rocky Mountain Helicopters, Provo, Utah
  Floyd Helm
- Air West Helicopters, Denver, Colorado
  William Keeney
- St. Anthony's Hospital System, Denver, Colorado
  Daniel Reich
- Baptist Hospital, Phoenix, Arizona
  William J. Walsh

10:45 COFFEE BREAK

11:00 PUBLIC SERVICE (CIVIL) OPERATORS
Robert Richardson, Helicopter Association International, Moderator

- State Rescue
  Major Gary Moore, Maryland State Police
- Rural Rescue
  Capt. Terry Jagerson, San Bernardino County Sheriff's Office
- Urban Rescue
  Capt. Ken DeFoor, Houston Police Department

11:45 AIR AMBULANCE GUIDELINES
Leo Schwartz, Chief EMS Branch, DOT-NHTSA

12:30 LUNCH

2:00 FEDERAL VIEWPOINTS ON EMS
Dr. Phillip Bobo, Druid City Hospital, Regional Medical Center, West Alabama EMS

2:30 TECHNICAL AND MEDICAL REQUIREMENTS OF FUTURE HELICOPTERS
Dr. Howard Champion, Washington Hospital Center
Officer Butch Cronin, U.S. Park Police

3:00 TECHNOLOGY ALTERNATIVES FOR THE FUTURE EMS OPERATOR
John Zugschwert, American Helicopter Society, Moderator

- R.E.R. Borland, Bell Helicopter, Textron
- Larry Levine, Sikorsky Aircraft
- Rod Taylor, Hughes Helicopter
- Leonard LaVassar, Boeing-Vertol

4:00 NASA/INDUSTRY PANEL DISCUSSION
Glen Gilbert, Glen Gilbert Associates, Moderator

- R.E.R. Borland, Bell Helicopter Textron
- Larry Levine, Sikorsky Aircraft
- Rod Taylor, Hughes Helicopter
- Leonard LaVassar, Boeing-Vertol
- John Ward, NASA Headquarters
- William Snyder, NASA/Ames
- Norman Fujisaki, FAA Helicopter R&D Program

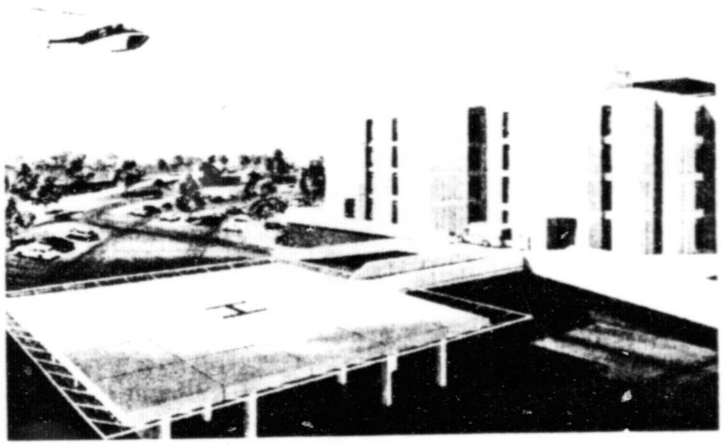
4:45 CLOSING REMARKS
Dr. John Zuk, NASA Ames

5:00 ADJOURNMENT

Washington Hospital Center Tour and Static Helicopter Display

9:00-12:00 Friday, October 16, 1981

Workshop participants were privileged to have a tour of the Washington Hospital Center's Medical Shock-Trauma Acute Resuscitation (MedSTAR) unit conducted by its Director, Dr. Howard Champion, and the MedSTAR staff. The tour included a realistic demonstration of MedSTAR's handling of shock-trauma victims, as well as static displays of some helicopters used in EMS systems.



An architect's rendering of the new MedSTAR facility. The unit is housed on the first floor of the Center's intensive care wing, with immediate access to the only burn unit for adults in the region, as well as specialized units for coronary, surgical, medical and psychiatric intensive care. A full-service operating room is an integral part of the facility.

Appendix B
Emergency Medical Services (EMS)-Rotorcraft Technology Workshop Participants

PARTICIPANTS

Stephen A. Acai, Jr., NC Department of Human Resources
Ronald E. Ace, Systems Control Technology
Glen Adams, Federal Aviation Administration
Richard Adams, Systems Control Technology
James E. Akers, Baptist Medical Center
Michael Altieri, M.D., Children's National Medical Center
Marguerite J. Badger, Hermann Hospital
James, Bauchspies, ORI, Inc.
William G. Baxt, M.D., University of California Medical Center, San Diego
Judi Beaver, ORI, Inc.
Louie R. Bell, Cascade Commercial Helicopter, Inc.
Lowell E. Bender, Grindle & Bender
Betty Berkstresser, NASA Ames Research Center
Boyd Bigelow, M.D., St. Anthony Hospital System
John Blake, Davidson Army Airfield
Phillip Bobo, Tuscaloosa, AL
Henry C. Bock, M.D., Methodist Hospital, Indianapolis
Kathleen J. Boehm, Clinical Association, Ltd.
William E. Boehm, Eastern NM EMS Corporation
Richard Bohlinger, Detroit Police Aviation
Robert Borland, Bell Helicopter Textron
Joseph G. Brady, U.S. Park Police
Sylvia J. Brennan, Spectrolab, Inc.
Dennis Brimhall, University of Utah Hospital
Paul R. Brockman, NASA Headquarters
Bob Brown, Heliflight Systems, Inc.
Kenneth P. Brown, Kenn Air
Christian Buhler, Swiss Air Rescue
Eloise M. Calhoun, Medina Community Hospital
Obie D. Calhoun, Fly-by-Helicopter - Lifeguard Rescue Division
Linda C. Carl, Loudoun M&M Hospital
Edward S. Carter, Sikorsky Aircraft Corporation
Lou Casanova, EMS Coordinator-Pima County, Arizona
Howard Champion, M.D., Washington Hospital Center
Samuel W. Channel, Office of EMS Health Department
Robert C. Chinn, The PRADO EAST
Richard T. Chittick, U.S. Park Police
Leonard E. Colp, Metropolitan Police Department, Washington National Airport
Ray E. Conrad, Bell Helicopter Textron
Larry T. Cooper, Lincoln Samaritan Air Evac
R Adams Cowley, M.D., Maryland Institute for Emergency Medical Services
Earl (Butch) Cronin, U.S. Park Police
Albert J. Crook, FAA Air Transportation Division
C. E. Crowell, Evergreen Helicopter
Michael Curtis, St. Louis University Hospital
Alfredo Dabrowski, Inspector, Detroit Police Aviation
William E. Davis, Helicopter Systems, Inc.
Ken T. Defoor, Houston Police Department
Charles R. Eastwood, NASA Headquarters
Chuck Eckert, Broward County Sheriff's Department
William G. Fenlon, Western Ohio Emergency Medical Services
Stephen J. Fincher, Westland Helicopters, Ltd.
Florence B. Fiori, DHHS Public Health Service
Rene Fonseca, Cascade Commercial Helicopter, Inc.
Norman Fujisaki, Federal Aviation Administration
Glen A. Gilbert, Consultant, Helicopter Association International
Joseph H. Goodman, M.D., Ohio State University
Michael B. Gormley, P.G.C. HC
John Hall, Davidson Army Airfield
William E. Hall, D.C. Motropolitan Police Department
Thomas F. Hamlette, D.C. Metropolitan Police Department
Phillip Hanna, Miami Valley Hospital
Willard E. Hardwick, Methodist Hospital of Indianapolis
Floyd I. Helm, Rocky Mountain Helicopter, Inc.
Lynn W. Heninger, NASA Headquarters
Sharon R. Heyka, Alexandria, VA
Edward M. Holmes, Leigh Memorial Hospital
John R. Hopkins, Life Flight Emanual Hospital
Jean Ross Howard, Aerospace Industries Association
Cheryl Hutton, Methodist Hospital
Caleb Hyatt, Broward County Sheriff's Department
Ray Ingham, Bell Helicopter Textron
Richard J. Iseke, M.D., Boston City Hospital
Irving Jacoby, M.D., University of Massachusetts Medical Center
Terry Jagerson, San Bernardino County Sheriff, Aviation Division
William James, Agusta Aircraft Corp.
Doug Johnson
Warren H. Kaye, Aero Interior Design, Inc.
William Keeney, Air West Helicopters, Inc.
Stephen M. Kelsey, Colorado EMS Division
Boyd Kesselring, Sikorsky Aircraft
Donald J. Keune, Fly-by-Helicopter, Inc.
Wayne B. Kielsmeier, Life Support International
Ronald Krome, M.D., Detroit Receiving Hospital
Gerhard Kugler, Emergency Rescue Department, ADAC, West Germany
Ludwell Lake, Phoenix Baptist Hospital and Health System
Hyder Lakhani, ASI
Harry Lamb, Airport Planning Administration
Andrew Lathan, Borgess Medical Center
Leonard J. LaVassar, Boeing-Vertrol
Glenn A. Leister, Federal Aviation Administration

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Larry Levine, Sikorsky Aircraft
Richard E. Livingston, Federal Aviation Administration
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Susan D. McHenry, State EMS, Virginia Department of Health
Nancy Lee McKay, Mast West Central Florida
Preston V. McMurray, Phoenix Baptist Hospital
Geoff W. McNamara, Fairfax Fire and Rescue Training Division
Edward F. Martin, Delaware State Police
Kimball I. Maull, Medical College of Virginia
Forrest E. Meeks, Maryland State Police Aviation
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Deborah Menne, ORI, Inc.
Gary E. Moore, Maryland State Police
Thomas Morgan, University of California Medical Center
Robert M. Morrison, Aero Bureau, Huntington Beach Police Department
Stephen Moushegian, Evergreen Helicopters
Jerry Murray, Westover AFB, MA
Frank Mustico, Bell Helicopter Textron
Lawrence M. Mustico, Omniflight Group
Roger P. Neeland, Federal Aviation Administration
Stan Nelson, NASA Kennedy Space Flight Center
Richard Nensel, M.D., Toledo Hospital
James O. Donnell, Evergreen Helicopters, Inc.
Walter B. Olstad, PAST, NASA Headquarters
Morris Ostroff, EMS, University of Massachusetts
Michael Peikert, Borgess Medical Center
Charles Peterson, Sikorski Aircraft
Lawrence J. Pietropaulo, MBB Helicopter Corporation
Greg Plechus, Aerospatiale Helicopter
Paul C. Proctor, Pro Pilot Magazine
Joseph B. Pronesti, Allen County Police Aero.
John Ray, Agusta Aircraft Corp.
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John W. Reese, USDHHS HRA Bur. Health Fac.
Daniel R. Reich, St. Anthony Hospital System
Donald Richardson, Systems Control Technology
Robert Richardson, Helicopter Association International
Michael Robeano, Ohio Army National Guard
John W. Saddler, Cedar Rapids Aviation Department
Nick E. Samanich, NASA Lewis Research Center
William T. Sampson, U.S. Park Police Aviation
Terry Sanders, Volusia County Sheriff Department
Thomas Santamauro, Department of Health Services (OEMS)
Leo Schwartz, EMS Branch, DOT/NHTSA
Thomas D. Scott, II, Southern Regional EMS Council
Russell P. Seneca, M.D., General Surgeon
Ronald Shackelford, Arizona Department of Public Safety
James E. Smith, Geisinger Medical Center
James T. Smith, Kenn Air Corp
Kim Smith, Rotor & Wing International
William F. Smith, Hermann Hospital
William J. Snyder, NASA Ames Research Center
Robert Sommer, NASA Headquarters
George Spence, Dare County EMS
Joseph Sperrazza, Maryland Institute EMS
David Spottheim, Reisterstown, MD
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Joseph A. Stein, Press
Curt Steinhart, Children's Hospital
Sam E. Stephenson, Jr., M.D., Baptist Medical Center
Bruce Stoehr, Chespeake & Potomac Airways
Michael Stringer, University Hospital
Jim Sturm, Bell Helicopter Textron
Robert D. Taylor, California Highway Patrol
Rodney S. Taylor, Hughes Helicopters
James H. Thach, III, Sikorsky Aircraft
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Jon P. Varian, Southwest Vert-All
William J. Walsh, Baptist Hospitals and Health Systems
David Warburg, World Aid
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Steve B. Wartenberg, Vertiflite
John M. Waters, Emergency Systems Consultant
W. E. R. Watt, Aero Interior Design, Inc.
Bill Williams, M.D., Arkansas St. University
Keith Williams, Agusta Aviation Corp.
Neil Williams, Aerospatiale Helicopter
Barak Wolff, New Mexico Health and Environment Department
Paul Wowk, Toledo Hospital
John F. Zugschwert, American Helicopter Society
John Zuk, NASA Ames Research Center

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Appendix C
Excerpts
From
NAS CR 166469
NAS CR 166470
Helicopter Technology Needs
Public Service Helicopter User's Workshop
NASA Ames Research Center
July 14-16, 1980

Profiles of the Mission

Emergency Medical Services

Accidents are the largest cause of death for those under 38. The cost to society each year is $62 billion. 10.2 million people each year are hospitalized for one day or more, which is one out of every eight hospital beds.

The Workshop identified the following challenges:

- To sustain the life functions of the trauma victim.
- To transport the trauma victim to a regional trauma facility where the victim will receive definitive care from a highly skilled trauma staff with the aid of a specially designed and equipped facility.
- To reduce significantly the time of transport; for time is the enemy of the trauma victim.
- To transport the victim in all types of weather conditions at any hour.
- To transport the victim in a manner independent of conventional roadways which are often congested.
- To transport the trauma victim from an urban or rural environment.

How are these challenges met? The helicopter, which has become an important part of the Emergency Medical System, meets all of these challenges.

The helicopter with a skilled crew can maintain the trauma victim's life functions with advanced life support equipment. This combination has proved invaluable in the first few minutes of care.

A need for an advanced rotorcraft was identified by the EMS working group to provide the ability to deliver its crew at high speed (300 knots) directly to an urban roadway or rural area without being affected by roadway traffic, and not being limited to darkness, rain, or snow.

With rotorcraft of advanced design and speed, accident response time can be reduced by as much as 80% and mortalities by 50% in both trauma and high risk neonates.

Public Service Technology Needs

VEHICLE DESIGN

1. Increased Speed (300 Kt dash, 30 min max, 200 KT max continuous)
2. HIGE 20000 feet (single engine)
3. HOGE 10000 feet (single engine)
4. Twin engine
5. Endurance - 4 hours
6. 10000 lb max G.W.
7. 20′ rotor diameter
8. Eliminate tail rotor
9. Internal cabin area (60″ high × 52″ wide × 96″ long)
10. Modularized cabin
11. Pressurization*
12. Autorotation capability
13. Internal & external noise reduction
14. Pilot operated hoist
15. Compatible electrical system
16. Shutdown power capability
17. Quick access maintenance
18. Water/retardant capability
19. Improved all terrain landing gear
20. Improved visibility
21. Improved maneuverability
22. Sliding cargo door
23. Internal access to cargo cabin
24. Equipment storage
25. Cold interior lighting
26. Hot refueling capability

*Optional

Public Service Technology Needs

PROPULSION
1. Non-petroleum fuels
2. Multiple fuel capability
3. Low fuel consumption
4. Dual power band
5. Increased shaft HP
6. Lightweight power plant
7. Emergency power capability
8. Particle separators (FOD proofs)
9. Main rotor clutch
10. Minimal Warm-up time

SAFETY & RELIABILITY
1. Crashworthy structure
2. Crashworthy seats
3. Crashworthy fuel system
4. Eliminate dynamic roll-over
5. Improved restraint system
6. Improved helmets
7. Improved egress system
8. Increased main rotor clearance
9. Reduced tail rotor hazard (remove tail rotor)
10. Birdstrike protection
11. Removable ballistics protection & detection
12. Fuel dumping capability
13. Fire protection
14. Hazardous material storage

NAVIGATION GUIDANCE & FLIGHT CONTROLS
1. Automatic flight control
2. Combined controls
3. Stabilization
4. All weather capability
5. Low airspeed measurement
6. Electronic map display
7. Precision location/navigation

AUXILIARY SYSTEMS
1. Hoist locations & capabilities
2. Rappel attachments
3. Improved litter
4. Litter suspension
5. Night vision system
6. Improved searchlight
7. Optical equipment
8. Photo/TV equipment
9. On-board APU
10. A/C visual identification
11. Car identifier
12. Car lock-on
13. Car stopper
14. Towing equipment

HUMAN FACTORS
1. Improved seats
2. Environmental control
3. Noise and vibration
4. Control standardization
5. Dual controls
6. Visibility
7. Integrated flight instruments

MONITORING & DIAGNOSTIC SYSTEMS
1. Trend warning
2. Computerized monitoring system
3. Warning/caution system
4. Color coded annunciation
5. Aural warning
6. Head-up display
7. Performance limitations