NASA Technical Memorandum 89424

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ROTORCRAFT-BASED EMERGENCY MEDICAL SERVICES

IN THE CARIBBEAN BASIN

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SUMMARY

The countries of the Caribbean Basin are currently facing a number of socio-economic crises. The steps that are being taken now as the countries confront these problems will have a far-reaching impact on future development and alignment of the region. There is a pressing need for a cooperative effort to improve health care in general and emergency health care in particular throughout the region. We conclude that rotorcraft, in the form of conventional helicopters or a version of the new XV-15 Tilt Rotor, can play an important part in improving existing health care.

In conjunction with an investigation of the role of aviation technology in fostering growth and development of the countries of the Caribbean Basin, we have investigated the importance of rotorcraft as in integral part of a needed system of emergency medical care in the region. Many of the larger countries in the region currently have the needed infrastructure to implement a national system of rotorcraft-based emergency medical centers within their borders. Through cooperative effort, the small islands of the region can achieve a level of emergency health care which would be unobtainable if each country attempted this separately. By helping to establish a system of rotorcraft-based health care centers in strategic locations in the Lesser Antilles, the United States can assist the islands of the region by demonstrating the concept and establishing a potential training site for the other larger countries of the region. Hopefully, a lasting and highly visible source of goodwill could be developed.

According to initial estimates, there is sufficient demand for rotorcraft-based emergency health care within the Lesser Antilles to locate one center on the island of Puerto Rico and another on one of the southernmost islands. With the use of fixed-wing aircraft or long-range helicopters, the two rotorcraft-based centers could provide the region with rapid and efficient emergency health care. The superior speed and range of the new XV-15 Tilt Rotor aircraft make it an attractive possibility for emergency transport and rescue in this region.

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INTRODUCTION

The countries of the Caribbean Basin are presently undergoing a political and economic crisis. Recognition of this crisis has led to an awareness of the need to assist the numerous countries of the region to develop a healthy economic and political environment. President Reagan's Caribbean Basin Initiative has helped to foster much needed analysis of the problems that are faced by the region, and of the role the U.S. can play in solving these problems. Because of the small size of many of the economies involved, a high degree of cooperation will be required to face many of the developmental needs of the region. One such need is for an efficient system of emergency medical transfer and rescue.

One of the pressing needs of the region is to improve the general level of health care. Although the existing level of available health services varies considerably from one country to the next, there is a universal need for improvement. In the least developed countries such as Haiti, the most urgent need is for health care facilities and the corresponding infrastructure to provide basic health care to the population. Other countries including parts of Central America, Venezuela, Jamaica, and the Dominican Republic have a more developed system of health care, at least in the more populous regions. These larger countries have the population and economic base to support a system of rotorcraft-based emergency medical centers within their borders. We feel that once economic and political barriers are overcome, a rapid growth of such centers will parallel the growth of such centers in the U.S. The first successful center will serve as an example of the feasibility of the concept and should act as a catalyst for further development in the region. An attractive location for such a center is the Lesser Antilles.

In this report, we will investigate the feasibility and benefits of a system of rotorcraft-based emergency medical centers with sufficient range and capacity to serve the Lesser Antilles. None of the smaller islands of the Lesser Antilles has the financial resources of the local population to justify a rotorcraft-based major trauma center operating solely within their own boundaries. However, the isolation, transportation constraints, and level of existing medical facilities indicate the desirability of a system capable of rapidly transporting trauma victims throughout the region to an emergency center that is sufficiently equipped and staffed to handle a variety of medical situations. Such a system of health care facilities will improve the level of health care in the region and foster a sense of constructive cooperation among the islands and with the U.S.

The Caribbean community has recently become aware of the advantages of cooperation in the health field. At the meeting of Ministers Responsible for Health in the Caribbean Community (CARICOM) held in Dominica in 1984, the CARICOM countries agreed that a feasibililty study should be undertaken in the area of Regional Mass Casualty Management. The focus of our study will be on the feasibility and need for Rotorcraft Emergency Medical Services (REMS) on a day-to-day basis. There is no assumption that military facilities or commercial airlines will lend their support as would be the case in the event of major catastrophe such as an earthquake or

hurricane. This study and the one undertaken by CARICOM are clearly related, however, and an existing system of rotorcraft-based trauma centers would clearly play a major role in the event of any major catastrophe.

NEED ANALYSIS

In the U.S. trauma is the major cause of death for persons under 40 yr of age. In addition to accidental death caused by motor vehicle accidents, drownings, falls, burns, poisonings, and firearms, many thousands die prematurely from critical medical illness that did not receive urgently needed medical attention. The two most critical factors determining a trauma victim's chance of survival are rapid transport to a medical facility, and the ability of the medical facility to provide a high level of expert emergency health care. "Survival is directly proportional to the ability of the trauma system to respond to the accident with adequate and appropriate care, and is inversely proportional to the severity of the initial injury and to the square of the lapse between the injury and stabilization of the unstable patient" (ref.1). Small emergency rooms in community hospitals are seldom well-equipped, and unless the attending physicians have the experience born of a relatively high volume of trauma cases, they will not be able to provide optimal care.

There has recently been much improvement in emergency health care in the U.S. The number of states served by REMS has nearly doubled in the last 5 yr. This rapid growth has been due to the recognition of the inadequacy of the trauma care that is provided by small emergency rooms in which the staff have neither the experience nor the facilities to provide adequate service. The countries of the Caribbean Basin are characterized by inadequate transportation of trauma victims, and small, ill-equipped emergency facilities.

The existing level of services on the majority of the islands in the region indicates a need for improvement. However, in order to optimize resource allocation and to insure fiscal integrity, it is important to analyze the potential demand for REMS in the region. A common concern of all new REMS centers is the prediction of the number of patients who will require rotorcraft transfer. This is important from both an economic as well as a professional viewpoint. A high volume of patients is necessary to maintain the required level of experience and experties of the attending staff. Several methods of predicting usage have been utilized. The most common methods range from simple guidelines based on population served, to detailed analysis of emergency room data. No method has proved completely satisfactory since estimates based solely on population ignore many important factors. Complete emergency room data is a rarity even in the U.S. A separate analysis will be carried out for the island of Puerto Rico since more data are available for Puerto Rico and it is demographically more similar to the U.S. in comparison to the rest of the region.

The simplest method of estimating rotorcraft utilization mentioned in the literature is based solely on the size of the population served. The average number

of rotorcraft transports per 100,000 population is approximately 31/yr in the U.S. See table 1 for an average REMS profile. Traditionally there has been a learning period during which the population is educated as to the availability of REMS service and the primary responders to emergencies are trained to recognize how and when to request rotorcraft transfer. Consequently, during the first year of operation the call rate is often as much as 50% less than the rate of a more mature center. Table 2 indicates the diversity of experience of several REMS centers during their first year of operation and underscores the approximate nature of any estimate based solely on size of population served.

It is generally true that a center located in an isolated area will experience a greater demand rate for helicopter transfer than a center that is located in a densely populated metropolitan area. The apparent reason being that in a metropolitan area in which much of the population is located relatively close to an emergency center, rapid transport can usually be provided by ground vehicles. In the more isolated regions, ground transport is often not a viable option if speed and a smooth ride are important factors, as they are in most trauma situations. This observation is clearly pertinent when considering the numerous small islands of the Caribbean Basin and would tend to suggest that a higher percentage of trauma patients would benefit from helicopter transfer in this region than in most areas of the U.S. Another important factor which would tend to differentiate the Caribbean Islands from the U.S. is the fact that a high percentage of REMS requests in the U.S. arise from motor vehicle accidents. In the estimate of rotorcraft transfer requests by Rhee et al. (ref. 2), approximately 50% of the request were related to traffic accidents. Although the motor vehicle accident rate in Puerto Rico is similar to that in the U.S. (ref. 3), this may not be the case for the rest of the islands. In an attempt to counteract this difference, we will base motor vehicle accident (MVA) estimates for the Lesser Antilles on the number of motor vehicles rather than on population size.

REMS Utilization Estimate for Puerto Rico

In order to estimate the potential utilization of REMS for Puerto Rico, we rely on MVA data for Puerto Rico provided by the U. S. Department of Transportation (ref. 3). We assume other causes of trauma are similar to those in the U.S. As in the U.S. and in the majority of the Caribbean islands, heart disease is the major cause of death (ref. 4). In the U.S. a major source of emergencies after traffic accidents is myocardial infarction with a very high deaths-per-incident rate on the order of 40% (ref. 5). We will estimate the number of myocardial infarctions by applying the U. S. average of 0.0075 heart attacks per person per year (ref. 6). The following analysis is for the first year of operation, consequently after a REMS center has matured it would be reasonable to expect the rate of utilization to double. In our analysis we follow the method of estimation and apply some of the frequency and utilization rates presented by Rhee et al. (ref. 2) in which an analysis of REMS demand was developed for southern Michigan. The corresponding utilization rate may be different for Puerto Rico, but the resulting estimate should serve as a first approximation.

In the U.S. MVA trauma is one of the major causes of accidental death. Whereas between 30% and 50% of MVA deaths occur almost instantaneously (ref. 7), approximately 20% of the victims are potentially salvageable if transported quickly to an adequate medical facility (ref. 8). Approximately 50% of those victims who eventually die are taken to an emergency facility (ref. 2). This information along with records of the number of MVA deaths in Puerto Rico can be used to estimate the number of patients who would benefit from REMS transfer. The number of traffic fatalities in Puerto Rico for the period between 1978 and 1983 has averaged 516 per year (ref. 3). We estimate that 70% of the population of Puerto Rico is served by basic or less than basic emergency services and the remaining 30% are located in areas served by a major medical facility. Following the analysis presented by Rhee et al. (ref. 2), we estimate that 50% of the fatal accident victims located in areas with basic or less than basic emergency services needed REMS and 5% of those located in the major service area would have benefitted from REMS. This analysis indicates that $516 \times 0.70 \times 0.50 = 180.6$ of those accident victims in areas with basic or less than basic medical service needed rotorcraft transfer. Similarly 7.74 victims in the major service areas needed REMS.

Continuing the analysis presented by Rhee et al. (ref. 2), in a system in which patients are taken to the nearest hospital and then are transferred, actual transfer might occur in 25% of the cases. This leads to an estimate of 47.09 REMS requests for those MVA victims who would otherwise die. A similar analysis is carried out for REMS calls for an estimate of the number of traffic accident victims who are not likely to die as well as for victims of falls, spinal cord injuries, burns, myocardial infarction, cerebrovascular accidents, and pediatric and other emergencies. The results are summarized in table 3 in which we estimate approximately 442 REMS calls for the first year of operation of a REMS center located in Puerto Rico. This compares favorably with the national average of 370 calls per year for the first year of operation of centers within the U. S. mainland. However, this is not our final estimate for such a center since we have not yet included several sources of REMS calls. The above analysis is based on a service area comprising only the island of Puerto Rico. If a vehicle with an effective range of 300 miles is used, the population served is approximately three times that considered in the above analysis. Our initial estimates clearly indicate that there will be sufficient demand to support a REMS center on the island of Puerto Rico.

REMS Utilization Estimate for the Lesser Antilles

In order to estimate REMS utilization for the islands of the Lesser Antilles, the islands between Puerto Rico and Venezuela, we will use much the same techniques as for Puerto Rico. However, for these islands we do not have complete MVA data and will have to estimate the number of fatal traffic accidents as well as the number of MVA survivors. We do this by interpolating from the number of motor vehicles on the islands rather than from the population. Once again, this will only provide a rough estimate but we feel any error is on the conservative side given the congestion and poor road conditions found in most of these islands. Another difference is that since we envision the establishment of only one REMS center in the southernmost

islands, approximately 98% of the total population of the Lesser Antilles will be considered to be located in an area with basic or less than basic emergency service. The 98% estimate is derived by assuming that the REMS center will be located on the island of Grenada and approximately 50% of the population of Grenada is sufficiently remote from the capital to be considered in a basic or less than basic medical service area. After making these assumptions and applying an analysis parallel to that for Puerto Rico, we estimate that during the first year of operation there will be 342 calls for REMS from the islands of the Lesser Antilles. See table 4 for a summary of these calculations. As states previously, the number of REMS calls will increase as the center becomes better known and the communication system improves.

The above estimates of demand are sufficient to support a second REMS center located in one of the southern islands. That our estimates of REMS demand are probably somewhat conservative can be seen by considering that use of the rule of thumb estimate of "31 calls per 100,000 population served" would lead to an estimate of 600 calls per year for a center located in Grenada with an operating range of 150 miles. Note from table 5 that there are approximately 2 million people within a 150-mile radius of Grenada.

Existing Health Facilities

Although there are a number of relatively large hospitals in the region, there are no existing trauma centers on any of the islands including Puerto Rico. In general the level of health service is not considered to be adequate. Table 6 provides general information about the total number of doctors and hospitals beds for each of the islands, and table 7 gives more detailed informationa about some of the larger hospitals on the islands. Currently none of the existing hospitals in the region can qualify as a trauma center as defined by the American College of Surgeons (see table 8 for the American College of Surgeons recommendations for staffing a trauma center). The general health care in the region is in need of improvement. By utilizing the concept of centralized REMS centers to serve relatively large geographic areas, more efficient use can be made of the limited resources available.

Puerto Rico has at least three hospitals with more than 400 beds and a medium size medical school. There is also a medical school located on the island of Grenada. The largest hospitals in the southern islands are located on the islands of Trinidad and Barbados. Although we have tentatively located a trauma center on the island of Grenada because of its central location among the southern islands, it may be more feasible to locate such a center on either Barbados or Trinidad since these islands both have a large hospital. Note that Queen Elizabeth Hospital on Barbados is equipped with heliport facilities.

Although is it doubtful that a full-scale trauma center as defined by the American College of Surgeons can be established in the short term on any of the islands, such a center is a reasonable goal in the intermediate term. An investigation should be made into the possiblity of a cooperative developmental and training

effort between one or more medical facilities in the U.S. and selected hospitals in the region. Dr. Colon Soto, Director of the Emergency Medical Office in Puerto Rico has indicated a willingness to cooperate in any initial planning effort. We feel that the matter should be pursued and will present no major difficulty if sufficient funding arrangements can be made.

The Tilt Rotor as an Emergency Medical Vehicle

Bell Helicopter Textron under contract to NASA/Army has developed the (XV-15) Tilt Rotor aircraft which we feel is destined to constitute a milestone in emergency medical rescue technology. The Tilt Rotor is an aircraft which can be flown either as a helicopter or as fixed-wing aircraft, combining the versatility of a helicopter which the speed and range of the fixed-wing aircraft. The transition from one mode to the other is done smoothly in a matter of 12 sec. The implications for medical rescue operations are obvious.

Since its use in the Korean War, the helicopter has shown the importance of quick response time in emergency rescue operations. But the helicopter has neither the speed nor the range of a fixed-wing aircraft. The Tilt Rotor combines the speed and range of a fixed-wing aircraft with the ability to fly directly to the scene of an accident and back to the medical facility. This new technology is beyond the initial planning stages; two XV-15 Tilt Rotor proof of concept vehicles have been flying since 1977 and a commercial version of the Tilt Rotor could be on the market in less than 10 yr.

The advantages of the Tilt Rotor concept are illustrated with a speed envelope comparison. In figure 1 we see that the Tilt Rotor is capable of flying 300 mph, fully twice the speed of current emergency medical helicopters. The range of the Tilt Rotor is equally impressive with an effective range of approximately 700 miles (see fig. 2). The cabin dimensions of the XV-15 are roughly 1.5 × 1.5 × 4 m. An EMS vehicle of this size can be fitted for a multipatient, casualty evacuation role, or it can be tailored to serve as a fully equipped flying emergency medical facility (see fig. 3).

The initial cost of the Tilt Rotor will be higher than either a helicopter or fixed-wing aircraft; the current cost projections are approximately 10% more than a helicopter of the same passenger size. However, because the Tilt Rotor can go twice the speed and distance that a helicopter can on the same amount of fuel (ref. 9), there will be many situations where the Tilt Rotor will be very cost effective. Furthermore the Tilt Rotor will be exceptionally useful and cost effective in situations where it is necessary to cover large sparsely populated areas. The higher initial cost must then be measured against the benefit of serving a large region with a single medical facility. This situation is found in the Caribbean Basin as well as in many sparsely populated areas of the world.

Computer Simulation of REMS

In an attempt to analyze the results of locating REMS centers in the islands of the Caribbean, a Monte Carlo simulation of REMS centers was developed and run for various configurations of locations and helicopter types. The program generates accidents in a given region according to criteria input by the user and then it calculates the time required to provide assistance to each accident using the closest available aircraft. The availability of an aircraft depends on its location, range, speed, and whether or not it is currently being used for a previous rescue, or is out of service because of repairs or bad weather. The program accepts as input the locations and categories of hospitals, the number and capacity of helicopters at each hospital, the region in which a given percentage of accidents will occur, and other data relating to rescue time, response time, etc. The program was initially developed on a Macintosh microcomputer and makes extensive use of graphics for both input of data and illustration of the simulation. The output of the program includes the average wait time before an accident victim is reached, the average rescue time before the victim is taken to the nearest appropriate hospital, the number of accident victims which were not rescued because of the lack of an available helicopter, and the number of hours per week that each helicopter speeds flying. Figure 4 illustrates the results of two simulations.

In one case, the trauma centers were located on the islands of Puerto Rico and Grenada. A helicopter was located at each of these trauma centers and an additional helicopter was located on the island of Guadeloupe to provide transport from the middle islands to either of the two trauma centers. The helicopters were assumed to have a speed of 150 mph and an effective range of 150 miles. This speed and range correspond to the limitations of the REMS helicopters that are currently available. The third helicopter located in the middle islands was necessary in order to cover the entire region. We did not assume that there was a third trauma center in the middle islands, however, since the population of that region would not currently support a full trauma center.

In the second case we simulated two trauma centers, one located in Puerto Rico and the other in Grenada. In this case we assigned one rotorcraft to each center with a speed of 300 mph and an effective range of 300 miles. This speed and range correspond to the capacity of a proposed Tilt Rotor. In this case a third helicopter is not necessary since the increased range of the Tilt Rotor enables two vehicles to cover the entire region.

A comparison of the results of the two simulations underscores the advantages of using the two Tilt Rotors rather than three helicopters. In the simulation using two Tilt Rotors, the average rescue time was 88 min verses 140 min for the system of three standard helicopters. The average time before arrival of the rescue vehicle was 54 min using Tilt Rotors and 92 min using helicopters. The percentage of out-of-range calls was also reduced by using the Tilt Rotors. Although these results are tentative and no firm conclusions should be inferred from this initial comparison, it does point out some of the potential advantages to be derived from the speed and range benefits of the Tilt Rotor technology.

Recommendations

Our initial recommendation is to investigate the feasibility of locating one REMS center on Puerto Rico and a second center on one of the three islands: Grenada, Trinidad, or Barbados. Grenada is the more centrally located but its local population and level of existing health facilities are not as advantageous as either Barbados or Trinidad. Any final decision as to the location of a REMS center in the southernmost islands should clearly depend on further study and consultation with representatives of the islands involved. Contact should be sought with the ministers responsible for health care in CARICOM for the purpose of selecting an appropriate location. Puerto Rico, on the other hand, seems a rather clear choice because of location, population, and existing medical facilities.

As can be seen from figure 5, if only two REMS centers are located in the proposed sites, there will be a central region which is out of normal range of either center. Figure 5 illustrates the effective range of REMS centers located at the proposed sites. The smaller circles correspond to an effective radius of 150 miles and the larger circles to a 300 mile radius. The majority of REMS centers in the U.S. are currently using helicopters with an effective radius of 150 miles. As can be seen from this figure, if the helicopters used have a 150-mile effective radius, many of the central islands will not be within range of either center. Possible solutions to this problem include incorporating fixed-wing aircraft into the system or locating a third center on either Guadeloupe or Dominica. Our analysis indicates that REMS center located in the central islands would not, at least initially, have sufficient utilization to function as a viable trauma center. A better solution, at least in the initial stages, would be to base a helicopter in these central islands which could serve as an air ambulance for the trauma centers to the north and the south. The optimal solution, however, would be to utilize faster rotorcraft in the proposed REMS centers with an effective range sufficient to cover the entire region. We feel that this is an ideal situation to use a Tilt Rotor of the XV-15 size when it becomes commercially available. The effective range and speed would enable the two centers to serve the entire area.

A variety of issues must be addressed before proceeding with any definitive plans for the proposed REMS system. Following is a list of some of these issues.

1. Initial and ongoing funding: Possible sources of funding must be investigated for both the initial implementation and ongoing support of the REMS centers.

2. System of communication: A viable system of communication will have to be set up between the islands to enable rapid, trouble-free communication.

3. Administration of cooperative effort: Since a high degree of cooperation between sovereign nations is necessary for the successful operation of any such system, a crucial question will be the determination of the appropriate means of administering the initial stages as well as the operation of the system.

4. Training and staffing: Wherever the REMS centers are located, it will be necessary to upgrade and train the personnel involved in the operation of a high quality REMS center.

5. Compensation: A basic problem that must be addressed is the determination of who is responsible for payment for services rendered. This question is particularly pertinent since several sovereign nations will be involved.

CONCLUSION

It is clear that there is a need for the level of medical service which could be provided by strategically located REMS centers in the Lesser Antilles. In addition to improving the quality of health care that is available for residents and tourists in the area, a system of rotorcraft-based medical centers would foster a sense of cooperation between the islands of the region as well as with the U.S. Such a system will also serve as an example and training site for other countries in the region which have both the resources and the need for such medical services. If appropriate sources of funding and guidance are provided by the U.S., a lasting and highly visible source of goodwill will have been set in motion. We feel that the benefits of such a system warrant further serious consideration. The significantly larger range and higher speed of the Tilt Rotor aircraft appear to offer important advantages in providing efficient emergency medical services in large, sparsely populated regions.

REFERENCES

1. Symbas, P.: in Principles and Practice of Emergency Medicine. Schwarts, G. R.; Safer, P.; Stone, J. H.; Story, P. B.; Wagner, D. K.; and W. B., eds. Saunders, Co., Philadelphia, 1978.

2. Rhee, Kenneth J.; Gurfield, R; Sidel, V. W.; Action, J.; Lown, B.; Stephany, S. J.; Frey, C.; Huel, K. D.; Symbas, P.; and Borland, Robert R.: Predicting the Utilization of Helicopter Emergency Medical Services: An Approach Based on Need. Annals of Emergency Medicine, vol. 13, no. 10, Oct 1984, pp. 916-923.

3. U.S. Department of Transportation: Fatal Accident Reporting System 1983. Washington, D. C., 1983.

4. U.S. Agency for International Development, Office of Foreign Disaster Assistance: Countries of the Caribbean Community, A Regional Profile. Washington, D. C., 1982.

5. Gurfield, R.: Expected Medical Emergencies, an Index of Need for a Region. JACEP, vol. 6, 1977, pp. 94-99.

6. Sidel, V. W.; Action, J.; and Lown, B.: Models for the Valuation of Prehospital Coronary Care. Am. J. Cardiology, 1968, p. 679.

7. Stephany, S. J.: An Evaluation Methodology for Multi-element Emergency Medical Services Systems. IEEE Transaction on Vehicular Technology, vol. 6, 1976, pp. 128-141.

8. Frey, C.; and Huel, K. D.: Resuscitation and Survial in Motor Vehicle Accidents. J. Trauma, vol. 9, 1969, pp. 292-310.

9. Borland, Robert R.: The Tilt Rotor Aircraft in the Medical Role. Bell Helicopter Textron, Inc. staff report, 1985.

TABLE 1.- SUMMARY DATA FOR HELICOPTER BASED EMERGENCY MEDICAL CENTERS IN THE UNITED STATES. (DATA PROVIDED BY ROCKY MOUNTAIN HELICOPTERS, INC.)

Population with 50 miles of sponsoring hospital	1,177,850
Number of beds of sponsoring hospital	675
Annual transports:	
first year	370
second year	462
Annual transports per 100,000	31
Percentage of transports to sponsor hospital	60%
Length of stay for helicopter transported patient	16 days
Percentage of transports within 50 mile radius	75%
Type of helicopter response:	
Hospital transfers	75%
Scene pickups	25%
Patient diagnosis:	
Trauma/Surgical	45%
Cardiac	15%
Other medical	25%
High risk mother/infant	10%
Burns	5%
Helicopter response to requests:	
Completed	90%
Not completed:	
Bad weather	5%
Other	5%

TABLE 2.- COMPARATIVE ANALYSIS OF THE FIRST YEAR OF OPERATION OF EIGHT HOSPITAL-BASED REMS SYSTEMS

Hospital/location	Flights per 100,000 population
John Lincoln/Phoenix, AZ	41
Emanual/Portland, Oregon or Maine?	8
University/San Diego, CA	24
Hermann/Houston, TX	12
St. Vincent/Toledo, OH	25
Baptist/Pensacola, FL	71
Latter Day Saints/Salt Lake City, UT	63
St. Anthony's/Denver, CO	48
Mean	36.5

TABLE 3.- SUMMARY CALCULATIONS FOR PREDICTING REMS REQUEST FOR CENTER LOCATED IN PUERTO RICO

	Total cases	Pop. (%)	Need (%)	HEMS needed	Demand (%)	Predicted REMS calls
MVA trauma, death likely	516					
Basic service area		70	50	180.6		
Major service area		30	5	7.74		
Sub Total				188.3	25	47.09
MVA accident survivors	38000					
Basic service area		70	5	1330		
Major service area		30	2.5	285		
Sub Total				1615	7.5	121.13
Falls and spinal cord inj.	280					
Basic service area		70	75	147		
Major service area		30	10	8.4		
Sub Total				155.4	33	91.28
Burn victims	1088					
Basic service area		70	10	76.16		
Major service area		30	5	16.32		
Sub Total				92.48	40	36.99
Myocardial infarction	5984					
Basic service area		70	10	418.9		
Major service area		30	5	89.76		
Sub Total				508.6	7.5	38.15
Cerebrovascular accid.	5542					
Basic service area		70	5	194		
Major service area		30	2.5	41.57		
Sub Total				235.5	7.5	17.67
Pediatric and other emer.	10200					
Basic service area		70	10	714		
Major service area		30	5	153		
Sub Total				667	15	130.05
TOTAL REQUESTS						442.35

TABLE 4.- SUMMARY CALCULATIONS FOR PREDICTING REMS REQUEST FOR CENTER LOCATED IN GRENADA

	Total cases	Pop. (%)	Need (%)	HEMS needed	Demand (%)	Predicted REMS calls
MVA trauma, death likely	127					
Basic service area		98	50	62.23		
Major service area		2	5	0.127		
Sub Total				62.36	25	15.59
MVA accident survivors	10088					
Basic service area		98	5	494.3		
Major service area		2	2.5	5.044		
Sub Total				499.4	7.5	37.45
Falls and spinal cord inj.	249					
Basic service area		98	75	183		
Major service area		2	10	0.498		
Sub Total				183.5	33	60.56
Burn victims	960					
Basic service area		98	10	94.08		
Major service area		2	5	0.96		
Sub Total				95.04	40	38.02
Myocardial infarction	5280					
Basic service area		98	10	517.4		
Major service area		2	5	5.28		
Sub Total				522.7	7.5	39.20
Cerebrovascular accid.	4890					
Basic service area		98	5	239.6		
Major service area		2	2.5	2.445		
Sub Total				242.1	7.5	18.15
Pediatric and other emer.	9000					
Basic service area		98	10	882		
Major service area		2	5	9		
Sub Total				891	15	133.65
TOTAL REQUESTS						342.62

TABLE 5.- POPULATION WITHIN RANGE OF SELECTED ISLANDS OF THE CARIBBEAN BASIN

	Population in 1982 Est.	Population within 150 miles	Population within 200 miles	Population within 300 miles
Antigua and Barbuda	77000	825000	1076000	4846000
Barbados	260000	924000	2164000	2614000
Br. Virgin Islands	11000	3438000	3527000	9582000
Dominica	75000	1077000	1449000	2741000
Dominica Republic	5660000	10805000	10805000	14202000
Grenada	112000	2089000	2164000	2573000
Guadeloupe	320000	949000	1193000	4846000
Haiti	5145000	10805000	10805000	13040000
Jamaica	2235000	2235000	2235000	7380000
Martinique	300000	1408000	1449000	2730000
Montserrat	12000	825000	1076000	1576000
Puerto Rico	3270000	3397000	3438000	95070000
St. Kitts, Nevis, Angila	41000	652000	4222000	4734000
St. Lucia	124000	1319000	2573000	2614000
St. Vincent, Grenadines	128000	2164000	2484000	2614000
Trinidad, Tobago	1165000	1405000	1789000	2164000
U. S. Virgin Islands	116000	3438000	3847000	9880000

TABLE 6.- SUMMARY DATA FOR SELECTED ISLANDS OF THE CARIBBEAN BASIN

	Population 1982 est	Area sq. mi.	Population density per sq. mi.	% Urban	Vehicles	Vehicles per person	Doctors	Hospitals	Population per bed
Antigua and Barbuda	77000	170	452.94	0.34		0.000	32	6	113
Barbado Br.	260000	166	1566.27	0.4	30000	0.115	201	13	123
Virgin Islands	11000	59	186.44		2000	0.182	10	1	382
Dominica	75000	290	258.62			0.000	10	6	240
Dominican Republic	5660000	18704	302.61		130000	0.023	2374	339	351
Grenada	112000	133	842.11	0.51	5000	0.045	25	6	172
Guadeloupe	320000	687	465.79		100000	0.313	313	10	138
Haiti	5145000	10714	480.21		30000	0.006	600	57	239
Jamaica	2235000	4244	526.63	0.37	155000	0.069	759	34	287
Martinique	300000	425	705.88		94000	0.313	364	13	94
Montserrat	12000	40	300.00			0.000	7	2	116
Neth. Antilles	260000	383	678.85		50000	0.192	120	8	109
Puerto Rico	3270000	3435	951.97		970000	0.297	4057	129	252
St. Kitts-Nevis	41000	104	394.23		3000	0.073	16	7	131
St. Lucia	124000	238	521.01		7500	0.060	40	7	202
St. Vincent, Grenadines	128000	150	853.33		5000	0.039	19	7	170
Trinidad & Grenadines	1165000	1980	588.38	0.22	170000	0.146	786	25	224
U.S. Virgin Islands	116000	133	872.18		38000	0.328	96	___	271
Total	19311000	42055	608.19		1789500		9829	670	
U.S.A.	232000000	3617229	64.14		151869300	0.655	424000	7159	164

TABLE 7.- SUMMARY DATA FOR SELECTED HOSPITALS IN THE CARIBBEAN BASIN

	No. of beds	No. of doctors	Radio fac.	Morgue cap.	No. of op. rms	Power supply	Emerg. power	Disaster plan	Heliport facilities	Blood bank capacity	No. of ambulances
General Hospital, Grenada	240	14	no	2	2	220/50	yes	yes	no	150	3
Joseph N. France, St. Kitts/Nevis	152	9	no	2	2	220/60	yes	no	yes	80	4
Peebles, Br. Virgin Islands	50	7	no	2	1	208/60	yes	no	no	24	2
Port of Spain General, Trinidad	927	73	no	-	7	220	yes	no	yes	700	2
Princess Margaret, Jamaica	455	78	yes	20	7	-	yes	yes	yes	60	4
Queen Elizabeth, Barbados	541	116	yes	18	7	220/50	yes	yes	yes	200	5
Rand Amemorial, Bahamas	78	21	yes	10	1	110/60	yes	no	no	20	3
San Fernando General, Trinidad	638	116	no	21	5	-	yes	no	no	60	3
University Hospital, Jamaica	512	196	yes	12	6	-	yes	no	yes	300	7
Victoria Hospital, Jamaica	211	17	yes	-	2	230	yes	no	no	422	0

TABLE 8.- STAFF RECOMMENDATIONS OF THE AMERICAN COLLEGE OF SURGEONS FOR AN EMERGENCY MEDICAL TRAUMA CENTER

Staff	No. for 24 hr cov.	Salary	Total
General surgeon	5	$52500.00	$262500.00
Anesthesiologist	5	$55000.00	$275000.00
Neurogurgeon	5	$58910.00	$294550.00
Orthopedic surgeon	5	$62240.00	$311200.00
Thoracic surgeon	5	$60000.00	$300000.00
Urologist	5	$52240.00	$261200.00
Internist	5	$43590.00	$217950.00
Pediatrician	5	$39260.00	$196300.00
Radiologist	5	$55000.00	$275000.00
Emerg. room physician	5	$52000.00	$260000.00
		Subtotal	$2653700.00
Nurses			
ER	15	$14400.00	$216000.00
OR	10	$14400.00	$144000.00
PAR	10	$14400.00	$144000.00
ICU	10	$14400.00	$144000.00
Other			
Blood bank technician	5	$15660.00	$78300.00
Lab technician	5	$15660.00	$78300.00
Inhalation therapist	5	$14500.00	$72500.00
X-ray technician	5	$10764.00	$53820.00
X-ray technician (vascular)	5	$10764.00	$53820.00
Medical records technician	5	$8200.00	$41000.00
		Subtotal	$1025740.00
		TOTAL	$3679440.00

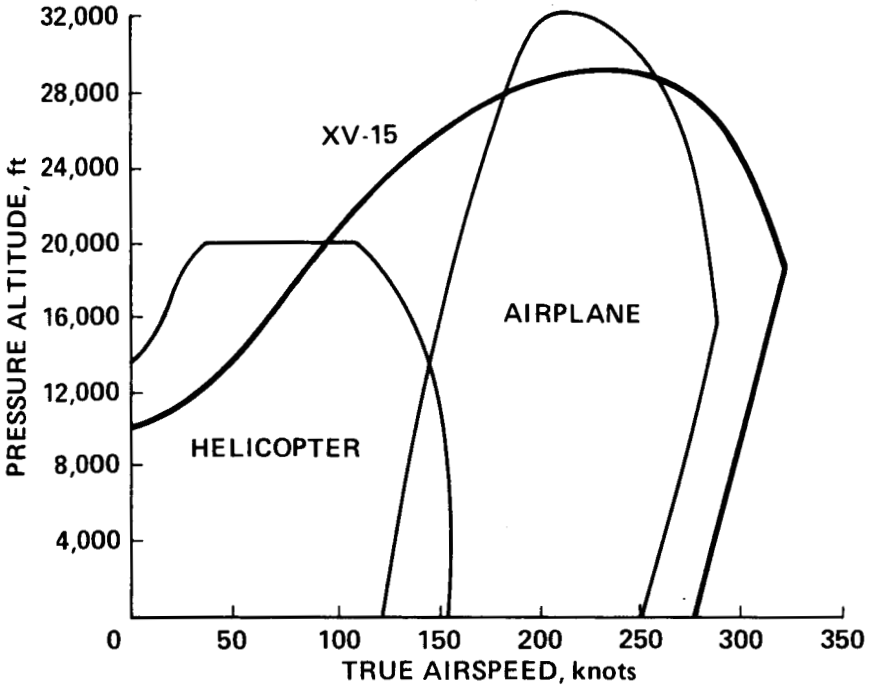


Figure 1.- Speed envelope comparison of XV-15 Tilt Rotor.

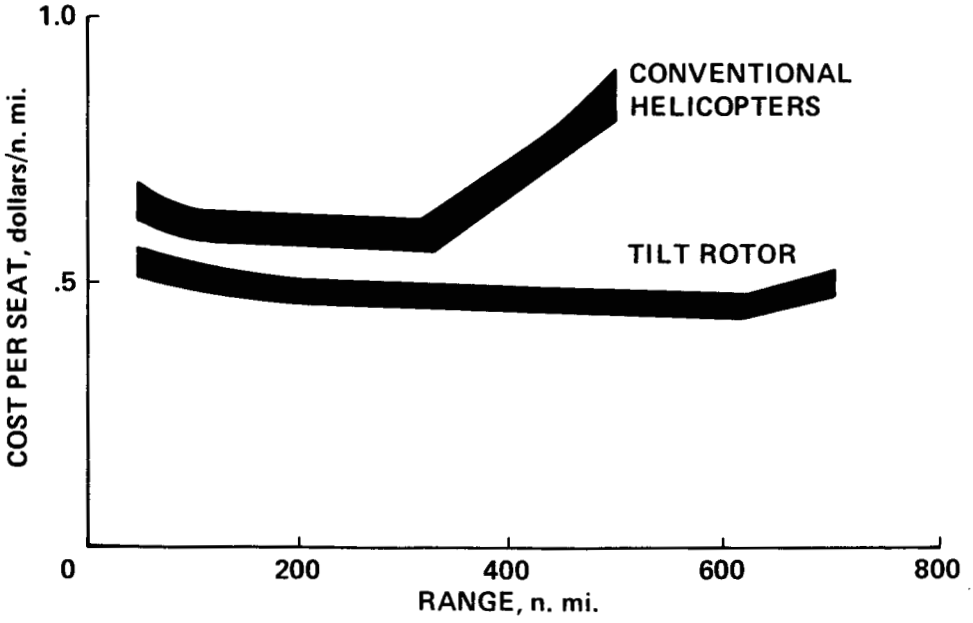
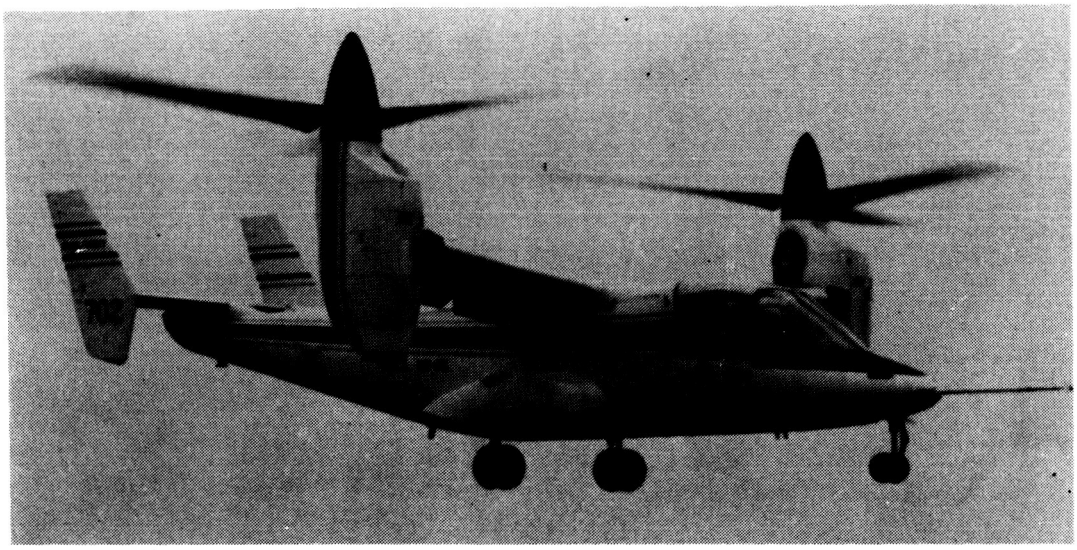
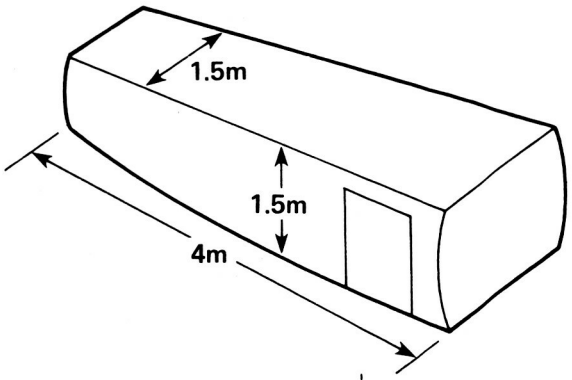


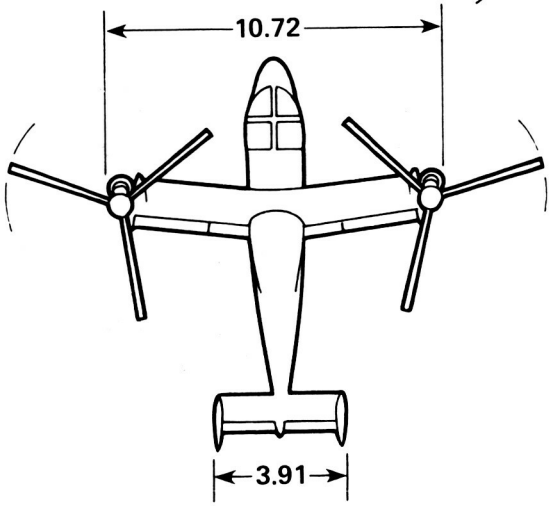
Figure 2.- Seat/mile costs of XV-15 Tilt Rotor.

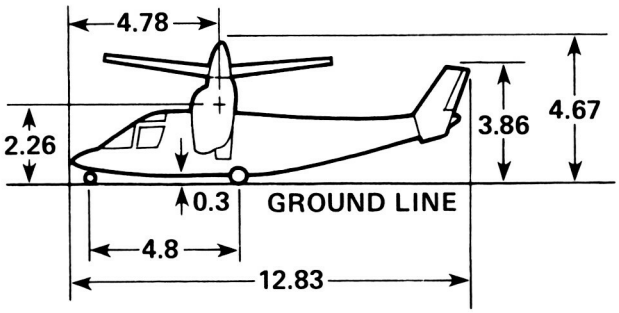


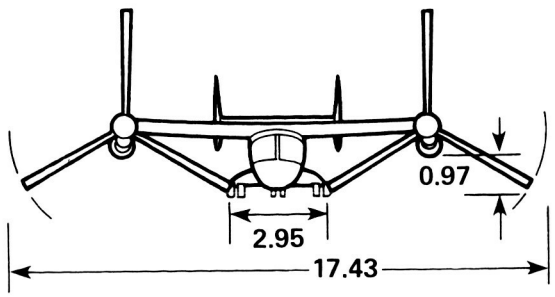
(a)



XV-15 CABIN DIMENSIONS





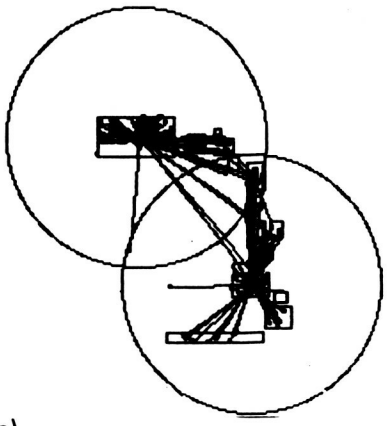


(b) XV-15 THREE-VIEW

(a) XV-15 cabin dimensions.

(b) XV-15 three-view.

Figure 3.- Dimensions of XV-15 Tilt Rotor in meters.

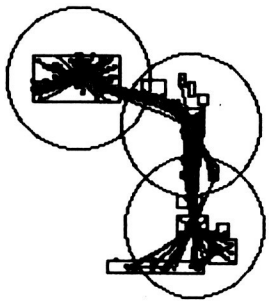


(a)

ENTER SIMULATION TIME IN WEEKS
8

CNTR	STATUS	CASES	BIRD NUM.	RANGE	TOTAL FLIGHTS	AV. RESC., min.	AV. WAIT, min.	FLT HRS./ WEEK
1	3	58	1	300	65	114.5	83.8	13.9
2	3	74	1	300	72	64.7	27.9	7.0
3	2	3						
4	2	0						
5	2	2						
		137				88.3	54.4	

THERE WERE 4 "OUT OF RANGE" CALLS AND 3 NON-RESPONSES DUE TO "IN-SERVICE" OR "IN-REPAIR"



(b)

ENTER SIMULATION TIME IN WEEKS
8

CNTR	STATUS	CASES	BIRD NUM.	RANGE	TOTAL FLIGHTS	AV. RESC., min.	AV. WAIT, min.	FLT HRS./ WEEK
1	3	70	1	150	63	144.3	108.6	16.3
2	3	77	1	150	64	150.2	109.1	17.8
3	2	4	1	150	31	110.6	24.7	10.9
4	2	4						
5	2	3						
		158				140.1	92.4	

THERE WERE 9 "OUT OF RANGE" CALLS AND 4 NON-RESPONSES DUE TO "IN-SERVICE" OR "IN-REPAIR"

(a) Using two tilt-rotor-based REMS centers located in Puerto Rico and Grenada.

(b) Using two helicopter-based REMS centers located in Puerto Rico and Grenada and one helicopter located at a smaller hospital in Guadeloupe.

Figure 4.- Results of simulation.

Figure 5.- REMS center coverage comparison.

NASA National Aeronautics and Space Administration

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM 89424		

4. Title and Subtitle

Rotorcraft-Based Emergency Medical Services in the Caribbean Basin

5. Report Date

July 1987

6. Performing Organization Code

7. Author(s)

R. W. Smith (University of Puerto Rico, San Juan, Puerto Rico) and L. R. Alton

8. Performing Organization Report No.

A-87092

10. Work Unit No.

505-01-51

9. Performing Organization Name and Address

Ames Research Center
Moffett Field, CA 94035

11. Contract or Grant No.

13. Type of Report and Period Covered

Technical Memorandum

12. Sponsoring Agency Name and Address

National Aeronautics and Space Administration
Washington, DC 20546

14. Sponsoring Agency Code

15. Supplementary Notes

Point of Contact: Larry R. Alton, Ames Research Center, M/S 237-11, Moffett Field, CA 94035, (415)694-5887 or FTS 464-5887

16. Abstract

The countries of the Caribbean Basin are currently facing a number of socio-economic crises. The steps that are being taken now as the countries confront these problems will have a far-reaching impact on future development and alignment of the region. There is a pressing need for a cooperative effort to improve health care in general and emergency health care in particular throughout the region. We conclude that rotorcraft, in the form of conventional helicopters or a version of the new XV-15 Tilt Rotor, can play an important part in improving existing health care.

In conjunction with an investigation of the role of aviation technology in fostering growth and development of the countries of the Caribbean Basin, we have investigated the importance of rotorcraft as in integral part of a needed system of emergency medical care in the region. Many of the larger countries in the region currently have the needed infrastructure to implement a national system of rotorcraft-based emergency medical centers within their borders. Through cooperative effort, the small islands of the region can achieve a level of emergency health care which would be unobtainable if each country attempted this separately. By helping to establish a system of rotorcraft-based health care centers in strategic locations in the Lesser Antilles, the United States can assist the islands of the region by demonstrating the concept and establishing a potential training site for the other larger countries of the region. Hopefully, a lasting and highly visible source of goodwill could be developed.

According to initial estimates, there is sufficient demand for rotorcraft-based emergency health care within the Lesser Antilles to locate one center on the island of Puerto Rico and another one of the southernmost islands. With the use of fixed-wing aircraft or long-range helicopters, the two rotorcraft-based centers could provide the region with rapid and efficient emergency health care. The superior speed and range of the new XV-15 Tilt Rotor aircraft make it an attractive possibility for emergency transport and rescue in this region.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Emergency Medical Rotorcraft Caribbean	Unclassified - Unlimited Subject Category - 03

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified	26	A03

NASA FORM 1626 OCT 86

For sale by the National Technical Information Service, Springfield, Virginia 22161