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Ambulance Services in Northwest South Dakota

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Part of the problem of providing medical services and accessibility to them involves the quality of ambulance service available to residents of an area. Ambulance service is closely related to hospital care because in emergencies the quality of care given at the scene and en route to a hospital is often more important to patient welfare than the care eventually given at the hospital. Availability of quality ambulance service is particularly vital in sparsely populated areas where it is likely that patients will need to be transported long distances before reaching an adequate hospital. The purpose of this publication is to point out the characteristics of existing ambulance services and analyze the cost and capabilities of three alternative ambulance systems available for use in Northwest South Dakota.

Description of the Area

The area designated here as Northwest South Dakota is composed of 16 counties and it is approximately 120 miles wide and 160 miles long.[1]

Northwest South Dakota is an area of diverse characteristics. It includes a metropolitan area as well as sparsely populated areas; pockets of poverty and the largest gold mine in North America. Most of the area is rural and suitable mainly for agricultural activities and tourism. Area farms and ranches have been growing progressively larger and fewer in number.

The tourism industry in the area is growing. The Black Hills, on the western edge of the area, are excellent for hunting, fishing and camping. Many South Dakotans and other Americans travel across Northwest South Dakota on their way to or from vacations in the Black Hills or at Missouri River recreational places.

The region between the Black Hills and the Missouri River is sparsely populated although it contains over half of the total population in the area. About one-sixth of the area is devoted to Indian Reservations and Ellsworth Air Force Base is in the southwestern part.

In general, Northwest South Dakota is characterized by a concentration of people at opposite ends of the area, with a vast space between devoted almost exclusively to farming and ranching and containing nearly half of the population. This presents some problems in providing easy access to medical and health care for all people in the area.

[1]Northwest South Dakota is defined for purposes of this study as encompassing the following counties: Harding, Butte, Lawrence, Pennington, Perkins, Meade, Corson, Ziebach, Haakon, Dewey, Stanley, Campbell, Walworth, Potter, Sully, Hughes.

Northwest South Dakota at the time of this study was served by both auto ambulances and one fixed wing air ambulance although other air-taxi services were sometimes used.

The location of auto ambulance services in Northwest South Dakota is shown in figure 1. It appears that an adequate number of services were available in all parts of the study area except the center portion around Ziebach County. This portion of the study area was dependant upon the ambulance services of surrounding towns, which were quite distant.[2]

Data available from the Department of Health showed that four of the nine ambulance services in the area planned to discontinue ambulance service, and one was undecided about future operations. Of those proposing to discontinue service, at least one has since been granted a subsidy by its county government and one has been replaced by a volunteer service.

The major problem facing ambulance services in the area seems to be of a financial nature. All services for which the Department of Health data were available reported a financial loss on the ambulance service portion of their business. Difficulties in collecting service fees, as well as high equipment and personnel costs, were the most commonly indicated reasons for this loss. It is interesting to note that the fee collection rate varied from 30% to 90%.

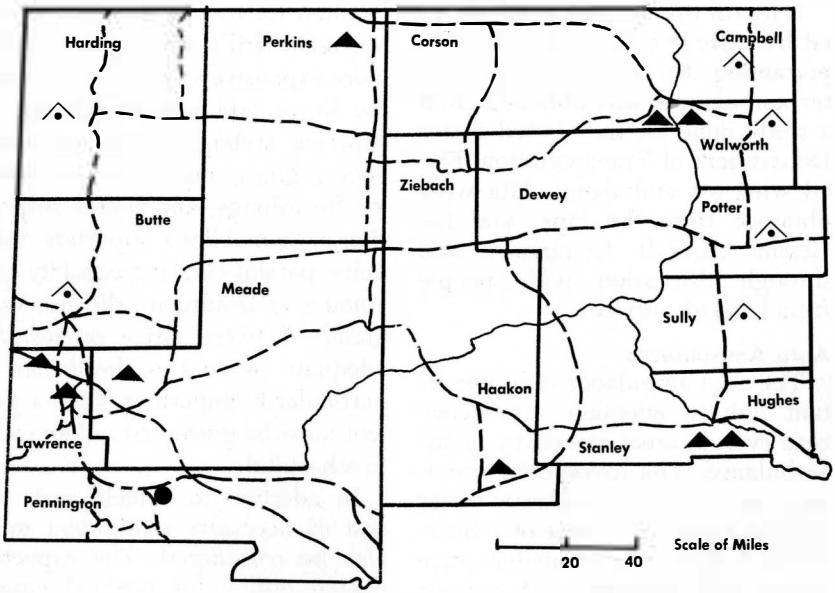
Probably most important for quality ambulance service is the availability of well-trained ambulance attendants with adequate equipment at their disposal. Six of the nine services indicated that they always carried both driver and attendant, two indicated they carried both sometimes, and one indicated it never carried both. The most common type of training given attendants was Red Cross training, although medical self-help and military training were also indicated. The most common type of vehicle used was the hearse type ambulance. Only one service used a station wagon as anything other than a back-up vehicle. All but one of the vehicles were equipped with two-way radio equipment. Nearly all of the services carried oxygen or resuscitation equipment.

Eleven of the 18 air taxi services in the area were providing a significant amount of patient transportation in 1968. A total of 203 flights were made for this purpose in 1968. Most of the flights were made in transporting patients to or from hospitals outside the area, such as to the University of Minnesota Hospital.

Air services providing air ambulance service were not specially equipped for this purpose. Only one service reported it had a specially equipped air ambulance plane. None of the planes used carried radio equipment other than that

[2]A Public Health Service ambulance was located in Eagle Butte, near the center of the area, but its services are limited mainly to the Indian population in the area.

Figure 1. Ambulance services located in Northwest South Dakota, 1968.



KEY TO FIGURE

Type of Ambulance Services

- **Funeral home services**
- **Volunteer services**
- **Commercial services**

Other Symbols

- **Paved road**

which is standard for a plane of its size. All of the services were also dependent upon local auto ambulance services and hospitals for furnishing an attendant and much of the medical equipment carried.

Need for Improvement in Area's Ambulance Services

Probably the most important medical resource which small towns can maintain are ambulance services because they improve access to the medical facilities of neighboring towns. In 1967 some parts of the study area did not have an ambulance service reasonably available. Services in other towns were planning to discontinue. In all towns primary reliance was placed on auto ambulances, which may be sufficient for patient transportation to the local hospital, but lack the speed desired for transporting patients to distant facilities. Because of its speed and flexibility, increased interest has been focused on the use of helicopter ambulances for patient transportation. To understand what role various types of ambulance vehicles might perform in satisfying the future health needs of Northwest South Dakota, three types of vehicles were analyzed.

Differences in Cost and Capabilities of Three Ambulance Vehicles

Data for this section were obtained from three sources. Information pertaining to auto and helicopter ambulances was obtained from a study done for the United States Department of Transportation. Fixed wing air ambulance data were obtained from the Piper and the Cessna Aircraft Companies and through discussion with people from local air services.

Auto Ambulances

The auto ambulance is an important link to adequate emergency care even in areas served by an air ambulance. The investment necessary for an auto ambulance varies depending upon the type of vehicle. Table 1 shows the estimated price ranges and capacities of various types of ambulances. Prices ranged from $3,600 for the cheapest converted station wagon to $18,000 for the most expensive limousine. Of course, cost to a specific community could be reduced by purchasing a suitable used vehicle.

Price is not a good measure of service utility of ambulance vehicles. Much of the price differential between types of vehicles can be accounted for by the inclusion of unnecessary frills and luxuries. The more expensive vehicles differ from the lower cost models because of superior styling, higher performance engines, more luxurious interior furnishings, and better suspension systems.[3] Two important variables, patient carrying capacity and amount of headroom, did not vary greatly between price ranges. An adequate amount of headroom is particularly important when a patient must be given first aid en route to a hospital.

In addition to vehicle cost, the cost of necessary equipment must also be considered. The expected capital outlay for medical equipment is about $1,900 per vehicle. In addition cost of furnishing a suitable ambulance installation was estimated at $1,700 with the largest single cost item being radio equipment. See tables 1 and 2 for details on cost components and equipment.

[3]Dunlap and Associates, *Economics of Highway Emergency Ambulance Services,* Study for the United States Department of Transportation, (Washington, D. C.: Department of Transportation, 1968.

Table 1. Basic body styles for auto ambulances.

Ambulance body type	Patient carrying capacity (supine only)	Headroom (patient compartment)	Price range
Limousine	1-2	50 in.	$12,000-$18,000
Converted Stationwagon	1	41 in.	3,600- 8,000
Custom Van Truck	1-3	77 in.	10,000- 12,000
Converted Panel Truck	1-2	51 in.	8,000- 9,000
Detachable Cab Truck Chassis	2	50 in.	6,000- 8,000

Source: Dunlap and Associates, *Economics of Highway Emergency Ambulance Services,* Vol. 1. Prepared for United States Department of Transportation, (Darien, Conn.: Dunlap and Associates).

Table 2. Estimated annual fixed cost for ambulance service using one auto ambulance.

Fixed cost elements	Total annual fixed costs with each of the following: Private firm	Private firm also operating complementary business*	Volunteer service
Driver attendant wages†	$23,489	$11,745	
Support personnel wages†	11,745	5,873	
Employee benefits‡	2,784	1,392	
Vehicle depreciation§	964	964	964
Equipment depreciation§	275	275	275
Facilities rental‖	5,600	2,800	1,400
Utilities	2,000	2,000	2,000
Insurance	714	714	714
Other fixed costs	600	600	600
Total	48,171	26,363	5,953

*This category would include funeral homes which provide ambulance service.
†Driver, attendant, and support personnel assumed available 24 hours a day.
‡Employee benefits were assumed to be 7.9% of total wages—4.4% for Social Security and 3.5% for workman's compensation.
§It was assumed that all of the services used a $9,000 vehicle depreciated over 7 years with 25% residual. Equipment was depreciated over 10-year period with no residual assumed.
‖Facility rental was assumed to be lower with volunteer service and private firm operating a complementary business, because these services usually serve smaller towns where property values are lower.

Source: Dunlap and Associates, Inc., *Economics of Highway Emergency Ambulance Services,* Volume I, U. S. Department of Commerce, July, 1968.

The cost figures in table 2 show the expected annual fixed costs involved in operating three different types of auto ambulance services. The major difference between these three services is the cost of labor. The commercial service operating a complementary business can utilize ambulance personnel when they are not out on a call; consequently, labor costs can be reduced. The volunteer service generally has no paid personnel thus no allowance needs to be made for manpower. An average variable cost of $6.00 per trip was assumed for all three types of services.

Helicopter Ambulances

The helicopter is unsurpassed for rapidly transporting the sick or injured to medical care. Presently, helicopters are most frequently used in urban areas to avoid traffic congestion in transporting auto accident victims to hosptial care; however, many of the benefits from the urban use of helicopters are also possible in low population density rural areas. These areas are characterized by poor roads, often only indirectly leading to a hospital of sufficient size to provide the type of medical care needed.

The aircraft chosen for use as a helicopter ambulance should have pay-load capacity to carry two litter patients in addition to a pilot and a medical attendant. The aircraft also ought to have sufficient fuel capacity to permit at least 3 hours flying time without the need for refueling or the addition of reserve tanks which reduce carrying capacity.

The medical attendant used on a helicopter needs to be more highly trained in some ways than the usual ambulance attendant. In addition to a high degree of skill in general first aid and trauma treatment, he must be aware of the possible complications which may occur during flight because of changing air pressure, patient anxiety, etc.

One of the most important capabilities of the helicopter is its ability to land almost anywhere. A helicopter can land on any clear, flat space with a diameter of 100 feet. Many newer hospitals are being built with heliports and nearly all hospitals in rural areas such as Northwest South Dakota provide sufficient space on lawns or parking lots for helicopter landings.

Weather conditions such as fog, icing, or severe turbulance may prohibit the use of helicopters at some times. Helicopters are, however, able to fly at low altitudes under conditions which would ground fixed wing aircraft. This is especially true in relatively flat terrain with few natural or man-made obstacles. Experience in Northern cities have shown that a helicopter ambulance could fly approximately 88% of the time.[4]

Some type of indoor storage of the aircraft will be necessary if it is going to be ready to respond to emergencies in all types of weather. Heliport facilities should include a landing zone, hangar facilities, office space, and communications equipment. Maintenance facilities for daily and 100-hour maintenance inspection and minor engine and airframe maintenance are also necessary. Major overhauls on the airframe every 1,200 hours and on the engine every 900 hours will likely need to be done at a maintenance and overhaul depot outside of the service area. If a helicopter ambulance were to be used in Northwest South Dakota, perhaps some agreement could be made for use of the facilities and personnel available at the Ellsworth Air Force Base in Rapid City, particularly during "down" times for the helicopter.

Efficient use of a helicopter requires a capability for continuous air-to-ground communications. The helicopter typically should have an airborne transceiver capable of contacting air traffic control, an ambuance dispatcher and law enforcement agencies. Medical facilities can normally be contacted by telephone.

Fixed Wing Air Ambulance

Most characteristics desired in a helicopter would also be needed in a fixed wing air ambulance, that is: (1) capacity for carrying two litter patients plus one attendant, (2) sufficient fuel capacity, (3) appropriate radio equipment, (4) cruising speed of at least 100 m.p.h., (5) landing area with aircraft storage and some maintenance equipment available.

The capability of the fixed wing air ambulance is different from the helicopter ambulance because of its need for some type of prepared landing strip. The typical air ambulance plane operating at the elevations characteristic of Northwest South Dakota requires a runway of at least 2,000 feet for normal take-

[4]Ibid, p. 95.

off. The runway may be of either hard surface or sod construction. This need for an appropriate landing strip implies that all patients carried in a fixed wing ambulance need to be transported to and from an airport by auto ambulance or some motor vehicle.

Cost Comparison, Helicopter and Fixed Wing Air Ambulance

A number of different models of helicopters and fixed wing aircraft would be suitable for air ambulance work. However, the Bell Ranger and the Cessna Skywagon 206 were chosen for the analysis.

Table 3. Comparison of initial investment for helicopter ambulance and fixed wing air ambulance.

Item of equipment	Investment	
	Helicopter*	Fixed Wing Plane†
Basic Aircraft		
Purchase price	$95,000	$25,275
Registration fee (3%)	2,850	758
Communications and Avionics‡		
Channelized transceiver with intercom	1,895	1,895
Ambulance dispatch transceiver	500	500
DF, Omni and transponder	5,620	5,620
Switch panels and cabin speakers	550	550
Utility Equipment		
Heater	3,250	
Heavy duty battery	925	
Fire extinguishers	40	40
Night and flood lights	1,050	
Rotor brake	1,195	
Medical Equipment§	1,150	1,150
TOTAL	114,025	35,788

*Dunlap and Associates, *Economics of Highway Emergency Ambulance Services,* Volume I, U. S. Department of Commerce, July, 1968.

†"Aircraft and Accessary Price List," Cessna Aircraft Company, Wichita, Kansas, February, 1969.

‡Both aircraft were assumed equipped with radio equipment of same price and type.

§Medical equipment included here was the same as that used with the auto ambulance. See Appendix Table D-2.

Table 3 shows that initial investment in a helicopter ambulance was considerably higher than the investment in a suitable fixed wing air ambulance. The major contributor to this inequality was differences in cost of the basic aircraft. The allowance used for medical equipment and radio equipment was the same for both types of air ambulances.

The cost figures in table 4 indicate that annual fixed costs were considerably higher for the helicopter ambulance than for the fixed wing plane. This fixed cost differance was caused mainly by the higher investment necessary with the helicopter ambulance. Cost of extra equipment items, such as flood lights, contribute to the added capabilities of the helicopter, however.

The variable costs per hour were also found to be nearly twice as high for the helicopter ambulance as for the fixed wing plane. The difference was caused by the higher allowance for maintenance and overhaul necessary with the helicopter, and a slightly higher oil and gas cost per hour flown.

Helicopter, Fixed Wing Ambulance Costs at Various Levels of Use

Table 5 shows total hourly costs of both fixed wing and helicopter ambulance at various hours of use. The hourly costs decrease with increased aircraft use, because it is possible to spread fixed costs over more hours of flight time.

Since total cost per hour decreases with increases in total hours of use,

it was necessary to estimate the number of flight hours which an air ambulance would be used. In making this estimation a number of assumptions were made. First, it was assumed that the air ambulance would be used mainly in the most sparsely populated portions of Northwest South Dakota. All of Northwest South Dakota was included in this category except Lawrence, Campbell, Walworth, Potter, and Sully Counties. The towns of Belle Fourche, Mobridge, Pierre, Fort Pierre, Sturgis, and Rapid City, although located in counties considered to be sparsely populated, were also excluded from air ambulance coverage (see figure 2).

The air ambulance service installation was assumed to be situated

Table 5. Total Annual Hourly Cost of Helicopter and Fixed Wing Air Ambulances at Various Hours of Use.

Annual number of flight hours	Helicopter cost per hour	Fixed wing ambulance cost per hour
300	$306	$199
600	169	109
800	134	86
1,000	114	72
1,400	90	57
2,000	72	45

Table 4. Comparison of annual costs of helicopter ambulance and fixed wing air ambulance

Cost items	Costs for helicopter ambulance‖	Costs for fixed wing air ambulance**
Annual Fixed Cost		
Depreciation (5 years, 30% residual)*	$15,964	$ 5,010
Interest†	3,421	1,074
Hull and liability insurance	12,000	6,400
License fee (based on weight)	25	35
Miscellaneous, hangar expense, etc.	2,000	2,000
Two full-time pilots‡	24,000	14,400
Two full-time attendants	12,600	12,600
Support personnel	12,600	12,600
TOTAL FIXED COSTS	82,610	54,295
Variable Costs Per Flight Hour§		
Fuel and oil	9	7.81
Reserve for airframe maintenance	2	
Reserve for engine maintenance	1	2.15
Reserve for spare parts	3	
Reserve for retirement life items	7	
Reserve for engine overhaul	9	2.00
Pilot		6.00
TOTAL VARIABLE COST	31	17.96

*Cost of equipment and 3% initial registration fee are included in aircraft cost used in calculating annual depreciation.

†Includes 6% interest on one-half initial investment in aircraft and equipment.

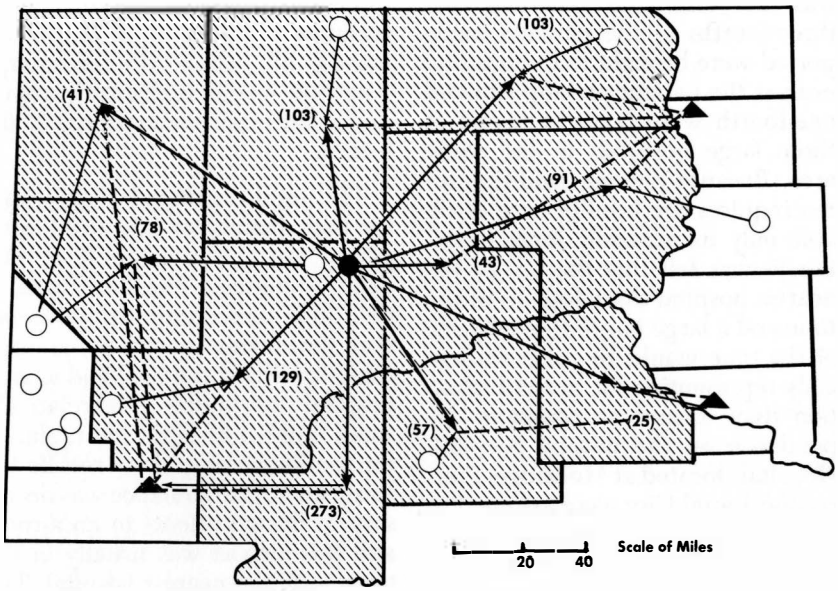
‡Wage of $1,000 per month assumed with helicopter and $600 per month plus $6 per flight hour assumed with fixed wing plane.

§All maintenance calculations on helicopter were based on $8 per hour for FAA licensed mechanics. Overhaul is necessary every 1,200 flight hours and on engine every 900 flight hours.

‖Dunlap and Associates, *Economics and Highway Emergency Ambulance Services,* Volume I, U. S. Department of Commerce, July, 1968.

**"Aircraft and Accessory Price List," Cessna Aircraft Company, Wichita, Kansas, February, 1969.

Figure 2. Area to be served by air ambulance.



KEY TO FIGURE

- **Area assumed served by air ambulance**
- **( ) Ambulance utilization per county 1967**
- **Distance from air ambulance installation to patient location**
- **Distance to nearest hospital**
- **Distance to large hospital**
- **Air ambulance installation**
- **Small hospital**
- **Large hospital**

near the center of the area to be served. Flight time was estimated assuming an average speed of 135 m.p.h. for the helicopter and 164 m.p.h. for the fixed wing plane. Flight time per trip was broken down into three parts: (1) flight time from ambulance location to patient location, (2) flight time from patient pick-up site to hospital, and (3) flight time from hospital back to airport. Fight time between the installation housing the ambulance and the geographic center of each county assumed served by an air ambulance was used as an estimate of flight time to patient location (see figure 2). Flight time between the center of each county and the hospital utilized was used as an estimate of the time necessary to bring the patient to a hospital. Flight time between the hospital to which the patient was brought and the air ambulance storage location made up the remainder of flight time per trip. Flight time per trip to each county was then multiplied by the expected number of trips to each county in order to find total expect-

ed flight time for the entire area served.[5] Total expected flight time was first estimated assuming that three-fourths of the patients transported were brought to the hospital nearest the patient pick-up site and one-fourth were brought to one of three large hospitals in the study area. Because patient condition often requires the level of care available only in relatively large hospitals, it was felt that the use of the nearest hospital three-fourths of the time and a large hospital one-fourth of the time would be more realistically representing the present situation than to assume complete dependence on the nearest hospital. Hospitals located at Mobridge, Pierre, and Rapid City were assumed to be the large hospitals utilized. These hospitals were chosen because they were the largest in their respective portions of Northwest South Dakota.

Total expected flight time was estimated a second time. In this case the assumption was that all patients from the portion of the study area served by air ambulance would be brought to the nearest of any one of three large hospitals in the study area (see figure 2). Because of the trend away from small town medical facilities, it was assumed that transporting all patients to three large hospitals would realistically represent what might be expected in the future.

The total estimated flight times for both helicopter and fixed wing planes are shown in table 6. The data in columns one and three of this table were compiled assuming that the nearest hospital was used three-fourths of the time and a large hospital one-fourth. The relatively small number of flight hours shown for the fixed wing plane results because an auto ambulance was necessary to bring patients to an airport and this airport was usually in the town with the nearest hospital. The flight times shown in columns two and four in the table were computed

[5]The following relationship was found in the Dunlap Study for a sample of ambulance services serving populations of less than 10,000 people:

$Y = 17.3X$ where Y is number of emergency calls per year and X is the population of the area served divided by 1,000.

Table 6. Expected flight times using helicopter and fixed wing air ambulance.

	Helicopter		Fixed wing air ambulance	
	Flight time using nearest hospital (hours)*	Flight time using large hospital (hours)	Flight time using nearest hospital (hours)*†	Flight time using large hospital (hours)
Flight time to location of patient	439	439	90	361
Flight time for transportation of patient to hospital	271	368	75	303
Flight time for return to storage location	541	618	127	509
Total flight time	1,251	1,425	292	1,173

*75% of the trips were assumed to be to the nearest hospitals and 25% to one of the previously designated large hospitals.

†Little use would be made of the fixed wing plane in transporting patients to nearest hospital because it was often in the same town as the nearest airport.

assuming all patients to be brought to the nearest of any one of three large hospitals in the area.

Using the flight hour data in table 6 as a guide, the helicopter ambulance would be flown approximately 1,250 hours per year if three-fourths of the patients transported were brought to the nearest hospital and one-fourth were brought to a large hospital in the area. If all patients were brought to a large hospital, total flight time would be 1,425 hours. Total annual cost would be $121,360 at 1,250 hours of use and $126,785 at 1,425 hours of use. Cost per hour at the two levels of use would be $97 and $89 per flight hour, respectively.

Total annual cost for the fixed wing air ambulance would be $59,539 if three-fourths of all patients were assumed to be brought to the nearest hospital and one-fourth were assumed brought to one of three large hospitals. If all patients were assumed brought to a large hospital, total annual costs increased to $75,362. Cost per hour at these two levels of use would be $188 and $60 per flight hour, respectively. It is interesting to note that with major dependence on the small hospital in the area, the hourly cost exclusive of the costs of getting to and from the airport, for the fixed wing air ambulance was over twice that of the helicopter ambulance. It is also significant that total expected costs for the helicopter ambulance increased by only $5,000 when all patients were assumed to be delivered to one of the three large hospitals in the area.

Estimating Service Times and Total Costs Associated with Three Alternative Ambulance Systems

The three systems considered were: (1) auto ambulance, (2) joint use of helicopter ambulance and auto ambulance, and (3) joint use of fixed wing air ambulance and auto ambulance. The location of the services are shown in figure 3. The average service times possible with each system were first calculated, after which the cost of each system was presented.

Approximating Auto Ambulance Service Areas

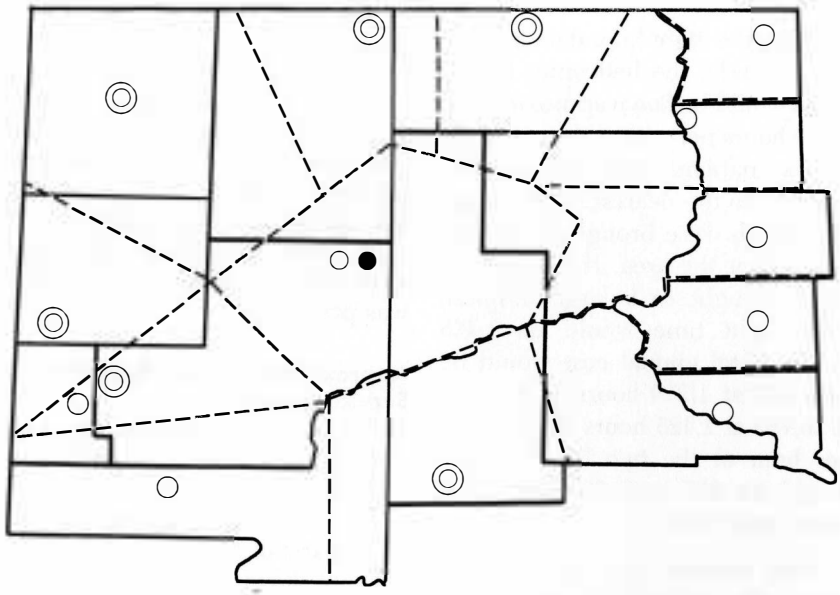
The assumed number and location of auto ambulance installations necessary to provide ambulance service within reasonable distance of all parts of Northwest South Dakota are shown in figure 3. To better understand the size of the area which would be dependent upon each auto ambulance installation, service area boundaries were drawn one-half the road distance between ambulance services.[6]

A Method of Service Time Estimation for Each Service Area

Service time was defined as the time elapsing between departure from the ambulance storage location and arrival at an appropriate hospital. Service times for each ambulance service area were calculated for three different situations: (1) patient was transported to nearest currently operating hospital, (2) patient was transported to the nearest of three large hospitals in the area, (3) patient was transported

[6]The decision as to type of service was made mainly on the basis of what currently exists in the town.

Figure 3. Assumed location of ambulance services in Northwest South Dakota with each of three ambulance systems.



KEY TO FIGURE

- ◯ **Auto ambulance installation.**
- ◎ **Auto ambulance installation assumed eliminated with use of helicopter ambulance.**
- ● **Air ambulance installation.**
- **Auto ambulance service area boundaries.**

to a large hospital outside Northwest South Dakota. In order to provide a comparison among the service times possible using different ambulance vehicles in each of the above situations, service time was calculated three times: first, assuming exclusive use of the auto ambulance; second, exclusive use of the helicopter ambulance; and third, exclusive use of a fixed wing air ambulance-auto ambulance combination.

The assumptions made in computing service time reflect differences in vehicle capacities. The air ambulances were each assumed to be in one centralized location, while one auto ambulance was assumed in each ambulance service area (see figure 3). The average speeds possible with the three vehicles were assumed to be 135 m.p.h., 164 m.p.h. and 60 m.p.h., respectively, for the helicopter, fixed wing air ambulance, and auto ambulance. Road miles were used in calculating service times using the auto ambulance, while air miles were used in calculating service times using the two types of air ambulance.

The major problem involved in estimating service times for each of the ambulance service areas was ap-

proximating patient location. Because much of the demand for ambulance care results from auto accidents, road midpoints were used as approximations of where ambulance care would be needed. Road midpoints were defined as a point one-half the road distance between the service area's auto ambulance installation and the border of the service area. Average service time for a service area was computed by first calculating service time for each road midpoint in the area and then finding the average of these service times. The service time for a midpoint would be the time necessary for getting to a midpoint with an ambulance and taking a patient from that point to a designated hospital. The same basic model was used for estimating the service time possible using each type of vehicle.

It was first assumed that patients were brought to the nearest hospital. The computations in table 7 show that in the case of four of the ambulance service areas a helicopter located at a centralized installation could fly to the area and bring patients to the local hospital in less time than it would take using a locally-stationed auto ambulance. Because an auto ambulance is necessary for bringing patients to an airport before boarding a fixed wing plane, the use of the fixed wing plane was assumed not applicable for bringing patients to the nearest hospital.

Service time necessary for bringing patients to a large hospital was next computed. The hospitals included in this category were in Rapid City, Pierre, and Mobridge. Table 7 shows that patients from

Table 7. Service times possible using auto ambulance, helicopter ambulance, or fixed wing air ambulance in Northwest South Dakota.

Ambulance service areas	Service time to nearest hospital			Service time to large hospital in area			Service time to large hospital out of area		
	Auto amb. (min.)	Helicopter amb. (min.)	Fixed wing amb.	Auto amb. (min.)	Helicopter amb. (min.)	Fixed wing air amb. (min.)	Auto amb.	Helicopter amb. (min.)	Fixed wing air amb. (min.)
Lemmon	28*	31	—	123	64	62*	—	179	156*
Faith	58	24*	—	125	45*	90	—	169*	186
Philip	49	37*	—	93	55*	74	—	183	169*
McIntosh	45	37*	—	78	51*	64	—	185	158*
Mobridge	36*	48	—	35*	48	—	—	195	160*
Herreid	46*	64	—	46*	64	56	—	206	169*
Gettysburg	35*	50	—	74	61	50*	—	199	165*
Pierre	36*	53	—	36*	53	—	—	199	164*
Rapid City	34*	47	—	34*	47	—	—	194	162*
Sturgis	26	42	—	53	49	43*	—	192	159*
Belle Fourche	33*	44	—	75	60	59*	—	193	162*
Buffalo	92	55*	—	175	79*	134	—	187	172*

*Shortest service time possible with any of the three vehicles.
Note: Service time was defined as the time between leaving the ambulance installation and arriving at a hospital with the patient.
The Deadwood service area was so small in geographic area that the analysis of service time for the area was not considered applicable.

eight service areas could be brought to a large hospital in less time with a helicopter ambulance or fixed wing air ambulance than with the auto ambulance; also the difference in service time is quite large in most cases. The fixed wing air ambulance has a service time similar to the helicopter for most service areas.

The third possible patient transportation need is the transportation of patients to a hospital outside Northwest South Dakota, such as to the University of Minnesota Hospital. It was assumed that on the average the distance would be 350 miles from the point of patient pick-up. In this situation the fixed wing air ambulance could provide faster service for nearly every service area than was possible with the helicopter ambulance. In the one service area where it did not, patients had to be transported considerable distance to an airport before boarding the air ambulance.

Initial investment and operating costs associated with each of the three ambulance systems analyzed are in table 8. Use of the auto ambulance alone was shown to require the lowest initial investment and annual operating cost. The helicopter ambulance with some support from an auto ambulance had a lower annual operating cost than the system using the fixed wing air ambulance. This lower cost resulted because the helicopter could replace several auto ambulance installations which would have been needed with the other two systems.

Table 8. Initial investment and total annual operating costs for three alternative ambulance systems

Type of system	Initial investment	Annual operating cost
Auto ambulance only	$176,400	$282,962
Auto ambulance and fixed wing air ambulance	215,788	342,501
Helicopter and auto ambulance	231,025	307,328

Financing Ambulance Services

Historically most ambulance services have been financed through the use of fees charged to the patients served. Because of rising costs, caused in part by federal legislation aimed at increasing quality, the fee financing of services is beginning to prove more and more impractical. One of the major problems with fee financing is the difficulty in collection. The small size, often less than $50, of the fee makes it easily forgotten. The small amount involved makes legal action against non-paying customers diffcult. Furthermore, the life and death nature of ambulance care nearly always assures repeated service to those not paying for previous services.

One alternative to complete reliance upon fee financing is support by some level of government. If local control is desired, primary reliance for financial support will probably need to come from local town or county government units. One method of financing such support might be a special tax levy on a multi-county or regional level. However, since the use of an ambulance service is not restricted to those living in an area, state and federal financial help also seem justified.

The Federal Government's concern for the adequacy of ambulance services is shown by its passage of the Highway Safety Act of 1966 (P. L. 89-564). This act authorized the Secretary of Transportation to issue Standard No. 11, *Emergency Medical Services.* Under this Standard, states are expected to identify deficiencies in their emergency medical services and establish remedial priorities in order to apply for Federal Highway Safety funds to assist in alleviating deficiencies. If funds available under this act prove insufficient in South Dakota, perhaps resources could be reallocated from highway construction, because one important reason for highway construction is to provide rural areas with access to medical care and other public services, a function which a helicopter ambulance also performs.

A second alternative to complete reliance upon fee financing is the establishment of volunteer services. With such services the expenditures for labor are greatly reduced. Volunteer services do have some unique problems, such as reduction in ambulance service availability when volunteers are at their jobs, and keeping a sufficient number of trained volunteers.

SUMMARY

Some portions of Northwest South Dakota do not have ambulance services readily available at the present time. In all parts of the study area, auto ambulances were relied upon almost completely for emergency transportation to hospitals; some air services were providing patient transportation to distant hospitals outside the area.

The least costly type of ambulance service per installation was found to be the auto ambulance. The auto ambulance was also found to be the most restricted in terms of areas it can serve and distance it can transport patients within acceptable time periods.

Both the helicopter and fixed wing air ambulances are capable of providing ambulance service to a larger geographic area than the auto ambulance. This capability results from the fact that they are not bound to roads and are able to travel at relatively high speeds. The fixed wing air ambulance is, however, limited primarily to picking up patients at airports.

When cost of the two types of air ambulances were compared, it was found that the helicopter ambulance required a higher initial investment and had both higher fixed and variable costs than did the fixed wing aircraft. However, when the costs of alternative ambulance systems were analyzed, it was found that the system utilizing a helicopter ambulance in conjunction with an auto ambulance provided service at a lower total annual cost than the system utilizing a fixed wing ambulance. This lower level of cost was possible because the helicopter could replace several auto ambulance installations. Furthermore, with the helicopter system serving the sparsely populated counties the service time between these areas and large hospitals in the study area was greatly reduced from what it was using auto ambulances only. The long service time necessary with the auto ambulance would be a serious limitation to the quality of the service which these ambulances could provide, even when well staffed and equipped.

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