THE LOCAL AUTHORITY

AMBULANCE SERVICE

Department of Finance
O R Section

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Contents

I INTRODUCTION

A THE FITZGERALD REPORT

In November 1967, the Minister for Health appointed a Consultative Council to examine the general hospital service. The Council's report[1] known as "The FitzGerald Report", published in June 1968, recommended that facilities for acute care should be concentrated into a small number of Regional and General Hospitals. The report noted that "the concentration of acute care hospital services into a small number of centres increases the importance of the ambulance service and makes it essential that it be brought to the highest level of efficiency." Accordingly, it recommended that the Minister establish an Ambulance Board to advise on the various medical and technical aspects of organising and operating an ambulance service.

B HEALTH ACT, 1970

In parallel with the Consultative Council's study the Minister for Health investigated the administrative structure of the health service. The Health Act, 1970, was drawn up, under which eight Health Boards were established to replace the existing 27 Local Health Authorities. Each Board was given responsibility for an area encompassing two or more counties. These Boards took over effective administration of the health service on 1 April 1971.

C AMBULANCE CONSULTATIVE COUNCIL

In line with the recommendations of the FitzGerald Report the Minister set up a Consultative Council on the Ambulance Service in May 1969. This Council

decided to undertake a detailed study of the service with a view to making recommendations on any necessary reorganisation. In August 1969, the Council asked the Operational Research Section of the Department of Finance to assist them with the study.

D TERMS OF REFERENCE

Following discussions with members of the Ambulance Consultative Council and a preliminary evaluation of the contribution OR might be able to make to the study, it was agreed that a detailed investigation into the service in the area to be administered by the Western Health Board, that is, Counties Galway, Mayo and Roscommon, should be carried out.

Specifically, the Council sought recommendations on the ambulance service required to service the area to be administered by the Western Health Board.

Two points in particular were stressed and were to be given special emphasis in the study. These were:

1 The main concern of the Minister for Health, and of the Council, was that any inadequacies in the performance of the ambulance service in dealing with emergency calls should be removed.

2 The Minister was anxious that public confidence in the capabilities of the ambulance service should remove misgivings about the distance factor in relation to the concentration of acute hospital services.

In addition, the Council made it clear that any recommendations on the reorganisation of the ambulance service should be based on the proposed reorganisation of the three counties into one unit under the Western Health Board.

Other aspects of the service relating to vehicle specification and equipment would be studied by a special sub-committee of the Council. These aspects of the service were not considered by the OR Section.

II SUMMARY AND MAIN RECOMMENDATIONS

A comprehensive analysis of the demand for ambulance service in Counties Galway, Mayo and Roscommon was made. The deployment of the ambulance fleet was studied and the ability of the existing system to meet the demand was measured. Using computer simulation techniques proposals for improving the service involving alternative numbers and deployments of ambulances were evaluated. A scheme which would ensure that 98% of all emergency cases would be reached by an ambulance within 30 minutes of the call being received was developed in detail. The ability of this scheme to cater for different demand patterns was analysed. Finally the general management of the service was examined and recommendations made on organisation, staffing and control.

The main recommendations are:

1 Ambulances should be distributed more uniformly throughout the area.

2 The normal staffing of an ambulance should be altered from the present driver/attendant and nurse to two driver/attendants.

3 A sufficient number of driver/attendants should be available to ensure that each ambulance is fully staffed during its duty period.

4 All ambulances in the area should be under one operational control.

A preliminary analysis seems to indicate that a fleet of minibuses should be provided to transport ambulant patients, but further examination of this aspect of the problem is necessary.

III TASKS PERFORMED BY THE AMBULANCE SERVICE

A PRIMARY TASK

The primary task of an ambulance is to transport non-ambulant patients to hospital. These non-ambulant patients may be:

1 Emergency Cases

Emergency cases include both medical and accident patients. A medical emergency would normally be so designated by a doctor. A personal injury accident is, ipso facto, an emergency.

2 Non-emergency Stretcher Cases

This category includes all patients who cannot or should not be transported by ordinary transport but who are not emergency cases.

B SECONDARY TASKS

Our investigations revealed that in addition to these primary tasks ambulances were also used for:

1 The transportation of non-urgent ambulant patients to and from hospitals and clinics.

2 The transportation of groups of retarded children to and from special schools.

3 Miscellaneous work, such as the transportation of medical supplies, equipment and hospital personnel.

C ALTERNATIVE TASKS

Originally an ambulance was a mobile hospital and this aspect of the service is not obsolete. The equipment recommended for stretcher ambulances,[2] and the trained nurse or attendant who travels with all non-ambulant cases, can provide sophisticated aid at the scene of an emergency and during transportation to hospital. The "Heart" ambulances which operate in Dublin and Belfast are a practical demonstration of this aspect of the service.

The Consultative Council emphasised that the provision of an efficient emergency service was, in their opinion, the primary role of the ambulance service. In addition, it was important to provide an adequate level of service for non-emergency stretcher cases. It was primarily to these two aspects of the service that the OR Section directed its attention.

IV STATEMENT OF THE PROBLEM

A EMERGENCY CASES

The ambulance service becomes involved in an emergency case when a request for an ambulance is received: involvement ceases when the patient is delivered to hospital.

When an emergency occurs a series of successive events takes place as follows:

1 The ambulance is contacted

Occasionally difficulty may be experienced in trying to contact the ambulance. This aspect of the problem would require a detailed study in itself and we shall refer to it later in Section XII.

2 The ambulance leaves its base and travels to the scene of the emergency

The time taken for the ambulance to reach the scene of the emergency depends on:

(a) Where the ambulance happens to be relative to the scene of the emergency when the call is received,

(b) Whether or not the ambulance is free to travel immediately to the scene of the emergency,

(c) The vehicle used. The vehicle specifications were examined separately as mentioned in Section I.

Assuming that all ambulances are equipped with radio, as is the case at present, factors (a) and (b) are governed essentially by:

(i) The number of ambulances available to service a given area,

(ii) The way in which these ambulances are deployed throughout the area.

3 The patient is placed in the ambulance

The staffing of an ambulance is an important factor here. Generally an ambulance is staffed by a driver and a nurse. On a number of occasions we found that bystanders or neighbours had to come to the assistance of a driver to load a stretcher case into an ambulance.

4 The ambulance transports the patient to hospital

The time to transport a patient to hospital depends on:

(a) The distance the patient is from the hospital.

(b) The condition of the patient. Some cases, for example spinal injuries, may require slow smooth transportation.

(c) The vehicle used.

5 The patient is admitted into the hospital

In general, little delay is experienced here. The ability to radio ahead to alert the hospital to be ready to receive an emergency admission is often a big advantage.

B NON-EMERGENCY STRETCHER CASES

When a request for an ambulance for a non-emergency stretcher case is received a similar series of events take place. In this situation, however, immediate response to the call is not essential.

C THE ROLE OF OR

The particular event or activity which we felt competent to advise on was that which concerned the length of time required for an ambulance to reach the patient

from the time the request was received.

Expressed in specific terms the problem was to determine for any required level of service (see Section V below for a discussion of level of service):

1 The number of ambulances required in the area to service both emergency and non-emergency stretcher calls.

2 Where these ambulances should be stationed.

In addition, as a result of our studies, we considered we would be in a position to advise on:

1 The control and organisation of the service.

2 Staffing arrangements.

3 The extent to which it is economic to provide minibuses to perform the non-urgent secondary tasks of the service.

V LEVEL OF SERVICE

The effectiveness with which the ambulance service fulfils its primary objective might be measured by the number of deaths it prevents or by the amount of suffering it alleviates. These measures are difficult to apply as suffering cannot be measured, and in very few fatalities, or near fatalities, was it possible to show that the ambulance service was a deciding factor[3].

Following discussions with members of the Ambulance Consultative Council it was agreed that the level of service, or the performance, of the ambulance service would be measured essentially by the speed with which it responded to emergency calls. The precise method of measuring the performance would be judged by the proportion of emergency cases reached within certain specified time periods from the moment the call was received by the service. For example, the ability to reach 95% of all emergency cases within 30 minutes of the receipt of the call would denote a certain level of service. Alternatively, the performance could be judged by the proportion of urgent cases which may have to wait longer than (say) one hour before being picked up.

This method of assessing the level of service was considered to be more meaningful than the performance which would be indicated by measuring the average time taken to reach an urgent case.

VI METHOD OF APPROACH

The first stage of the study consisted of a thorough analysis of the existing ambulance system in Counties Galway, Mayo and Roscommon. The demand for service for four months of 1969 was analysed in detail to determine the hourly and daily pattern of calls. The level of service now being provided was measured using the criteria discussed in Section V. Using computer simulation techniques a model of the system was developed. Experiments were carried out on this model to assess the effect on the level of service of various numbers and deployments of ambulances. The effects of possible changes in the pattern of demand were also investigated. The results of these experiments are discussed in Sections IX, X and XI, and form the basis for determining the number and deployment of the ambulance fleet which would be required to provide whatever level of service is decided upon.

The model is a general model and can be used to simulate the operation of the ambulance service for any of the Health Board areas provided the characteristics and demand patterns for the area are known.

VII CHARACTERISTICS OF THE WESTERN HEALTH BOARD AREA

A summary of the main characteristics of the Western Health Board area is given in this Section. A more detailed account can be found in Appendix I.

A POPULATION AND GEOGRAPHY

The area to be administered by the Western Health Board is comprised of Counties Galway, Mayo and Roscommon. The population of the area is 320,115[4]. There are six towns, Galway, Ballina, Ballinasloe, Castlebar, Tuam and Loughrea, which have a population greater than 3,000. The total population of these towns is 51,579. The majority of the population live in small towns and local communities scattered throughout the area.

The combined area of the three counties is 5,442 square miles, and includes large tracts of mountain and bog which are sparsely populated. The average population density is 59 persons per square mile. The road network in some parts of the area is poor.

B HOSPITALS

The FitzGerald Report recommends two acute care hospitals for the area, a Regional Hospital in Galway and a General Hospital in Castlebar. In addition to these two hospitals there are at present 19 other hospitals, including three County Homes, three Fever Hospitals and three Psychiatric Hospitals.

C AMBULANCE SERVICE

1 General Organisation

The area is at present served by 19 ambulances. Eight are stationed in County

Galway, at Galway (5), Loughrea (1), Ballinasloe (1) and Clifden (1); four in County Roscommon, at Roscommon (2) and Boyle (2); and seven in County Mayo, at Castlebar (5), Ballina (1) and Belmullet (1). All the ambulances are based either at hospitals or county homes. It is noteworthy that there is no ambulance stationed in the relatively populous area of North County Galway and South County Mayo.

Each county operates its own independent service; there is very little co-operation between counties and county boundaries are seldom crossed to pick up patients. Within each county each ambulance depot is virtually autonomous; it services the calls it receives itself and calls are rarely transferred between stations. Each ambulance depot has its own radio transmitter and controls the ambulances which operate from that depot, usually without any reference to the other ambulances in the county.

2 Demand for Service

From the analysis of the records kept at each ambulance depot we were able to determine the following characteristics of the demand. A comprehensive analysis of the demand pattern can be found in Appendix I.

(a) Number of Calls

Approximately 1600 emergency calls and 4700 non-emergency stretcher calls are received in the area during a year. During the day-time, that is, from 10 a.m. to 10 p.m., an average of 1.14 calls, both emergency and non-emergency are received every hour. A slight peak in the demand occurs between 1 p.m. and 2 p.m. but otherwise the demand is fairly uniform throughout the day. Demand drops off markedly after 10 p.m. to a night-time rate of approximately 0.3 calls per hour. These are generally emergency calls.

(b) Origin of Calls

The number of calls per year per 1000 inhabitants varies from county to county and from district to district within each county. We tested the data to see if this variability could be accounted for by such factors as distance from hospital or ambulance depot, relative wealth of the community, age structure and population density. No firm relationship could be established although, in general, the incidence of calls tends to decrease as the distance from an ambulance depot increases.

3 Present Performance

In Section V, we stated that the performance of the ambulance service could be measured by the proportion of urgent cases reached within certain specified time periods after the call was received. From the records held at each ambulance depot we calculated the approximate present performance of the service for the area. These figures, shown in Table A below, are only an approximation, because the records do not contain sufficient data for an accurate calculation to be made.

Time (minutes)	15	30	45	60	90
Percentage of emergency cases reached within the specified time	41%	60%	78%	90%	99.9%

TABLE A

This table shows that, at present, approximately 40% of all urgent cases are not reached within half an hour and 10% have to wait longer than one hour for an ambulance to arrive.

4 Ambulance Utilisation

We calculated that the average utilisation of the five ambulances based at Galway Regional Hospital was 20.4%. The maximum possible utilisation under the present staffing arrangements is 30%. In effect, under the present staffing arrangements, the ambulances are not available for duty 70% of the time. These figures are typical of the area in general.

VIII THE MODEL

A PURPOSE

One possible way of attempting to improve the service would be to increase the number of ambulances in the area. This course of action would not have a significant effect, however, as urgent cases never have to queue for service. The delays in getting to the scene of emergencies are not due to the lack of ambulances but rather to the distances the ambulances have to travel to reach the scene.

This suggests an alternative which could be considered, that is, to alter the existing deployment of the ambulances throughout the area. For example, an ambulance could be taken from the Regional Hospital Galway and based in Tuam to serve the relatively heavily populated area of North County Galway and South County Mayo. If this scheme was put into effect it would be necessary to operate it for at least six months to determine whether or not any improvements had resulted. At the end of that period, if the service was still unsatisfactory, a further rearrangement of the ambulance bases could be made and the trial period extended. Numerous alternative deployments could be devised and tried out in this manner. Obviously, although the idea might be attractive, it would be completely impractical and take years to accomplish, apart altogether from the expense and administrative difficulties involved in setting up and dismantling each experiment in turn.

OR, however, allows experiments like this to be performed, but, instead of performing them on the real situation, with all the attendant difficulties, they are performed on a model of the situation. A model is essentially a mathematical expression of the relationships which exist between the main features of the system. With the aid of a computer a year's operation of the service can be simulated on the model in a matter of minutes.

B MAIN ELEMENTS

A model representing the situation in the Western Health Board area was developed using information about the geography of the area, the location of the hospitals, the location of the existing ambulance bases and the demand for ambulance service. Some simplifying assumptions had to be made - it would not be possible to reproduce exactly the infinite variety of the real world, but the essential features of the situation in which the ambulances operate were represented in the model.

The model was constructed so that the number of ambulances and the location of the ambulance bases could be altered as desired. A demand which was statistically similar to the actual demand which had been experienced in the area during 1969 was generated by the computer. We had however the facility to alter this demand pattern if we so desired. This was important as it allowed us to test the sensitivity of various schemes to changes in the demand pattern.

C OPERATING CHARACTERISTICS

In Section IV, we saw that both emergency and non-emergency stretcher cases give rise to the same train of events. The only essential difference as far as the ambulance service is concerned is the urgency of the emergency call. Emergency calls must receive priority over non-emergency calls. This basic rule allowed the following operating procedures to be adopted in the model:

1 All calls are dealt with immediately they arrive except that emergency calls are given priority over non-emergency calls. No allowance is made for delays which may occur in practice as, for example, waiting for a nurse to be made available by the hospital.

2 All ambulances are fully staffed while on duty.

3 Each call is serviced by the nearest available ambulance.

4 An ambulance travelling to pick up a non-emergency patient can be diverted if necessary to service an emergency call. (We assume that all ambulances are equipped with radio).

5 An ambulance travelling to hospital with a non-emergency patient on board would not be diverted to answer an emergency call.

6 During the driver's meal times ambulances were considered to be available to service emergency calls but not the non-emergency calls.

A number of experiments were performed on the model using different numbers and deployments of ambulances. Details of these experiments are given in the next Section.

IX EXPERIMENTS

Each experiment we performed simulated a year's operation of the emergency and non-emergency stretcher service for whatever particular deployment of ambulances we wished to make. The "input" for each experiment consisted of specifying:

1 The number of ambulances we wished to allocate to the area.

2 Where we wished the ambulances to be stationed.

The computer then automatically reproduced a demand pattern statistically similar to the demand which had actually been experienced during 1969.

The "output" from each experiment consisted of the following data:

1 The proportion of emergency and non-emergency stretcher cases reached within each 15-minute time-period from the time the call was received.

2 The average time taken to reach both emergency and non-emergency patients.

3 The longest time an emergency and a non-emergency patient had to wait for an ambulance after it was called.

4 The number of times emergency and non-emergency patients had to queue because an ambulance was not available immediately to service a call.

5 The length of time each patient spent in the queue.

6 The number of times an ambulance was diverted from a non-emergency call to service an emergency call.

The analysis of the demand for service in Appendix I, shows that demand during the day-time is significantly heavier than that experienced during the night. This means, in effect, that there are two distinct problems. We concentrated initially on devising a system to satisfy the day-time demand and then tested this system under night-time conditions.

A DAY-TIME OPERATION

For the first experiment we allocated three ambulances to the area, one stationed in Galway, one in Roscommon and one in Castlebar. We simulated a year's operation of the service reproducing the day-time demand pattern and obtained the following results for the proportion of emergency cases reached within each 15-minute time-period from the time the call was received.

Time (minutes)	15	30	45	60	75	90	105	120
Percentage of emergency cases reached within the specified time	13%	33%	52%	70%	80%	88%	92%	95%

TABLE B

(The full results of this experiment and of each of the following experiments can be found in Appendix II. The results contained in this part of the report refer to the criterion by which it was agreed that the performance of the service would be assessed, that is, the proportion of emergency cases reached within certain specified time-periods after the call was received.)

The level of service provided by three ambulances as demonstrated by this experiment would hardly be acceptable, only one-third of all emergency cases could be reached within 30 minutes, and 30% of emergency cases would have to wait longer than one hour for an ambulance to arrive. Reference to Appendix II, will show that the service offered to non-emergency stretcher cases would be very unsatisfactory.

The number of ambulances was increased to 5 and the experiment repeated. The ambulances were stationed in Galway, Castlebar, Ballinasloe, Boyle and Ballina. The performance obtained on this occasion is shown by the following result for emergency cases:

Time (minutes)	15	30	45	60	75	90	105	120
Percentage of emergency cases reached within the specified time	27%	56%	76%	88%	95%	98%	99%	99.5%

TABLE C

It is interesting to compare these results for 5 ambulances with the estimated level of service now being provided by the 19 ambulances in the area (Section VII, Table A). It must be remembered however, that these 5 ambulances are fully staffed during their duty period.

Three additional ambulances were stationed in Roscommon, Belmullet and Clifden and the experiment re-run. The results of this experiment were as follows:

Time (minutes)	15	30	45	60	75	90
Percentage of emergency cases reached within the specified time	43%	78%	91%	96%	99%	100%

TABLE D

These results indicate that with 8 ambulances suitably stationed throughout the area 78% of all emergency calls would be reached within 30 minutes and only 4% would have to wait longer than one hour.

Further similar experiments were performed, the number of ambulances being increased by two each time. Details of these experiments can be found below in Table E and in Appendix II. Instead of stationing ambulances in particular towns as we had done for the first three experiments described above, we now

located them according to North-South, East-West coordinates on a grid system we devised for the area. This method enabled us to find locations for the ambulance bases which would, in theory, give the best results. Some slight adjustments to these positions would be necessary in practice as it was not possible to take account of all the physical characteristics of the area in the model. However these adjustments would have a negligible effect on the performance of the system.

Number of Ambulances	Percentage of emergency cases reached within (minutes)							
	15	30	45	60	75	90	105	120
3	13	33	52	70	80	88	92	95
5	27	56	76	88	95	98	99	100
8	43	78	91	96	99	100		
10	55	86	97	99	100			
12	63	94	100					
14	71	96	100					
16	76	98	100					
20	81	99	100					

TABLE E

These results are illustrated graphically in Figure 1, Appendix II.

B NIGHT-TIME OPERATION

There are two main factors which distinguish the night-time demand from the day-time demand:

1 There is a reduced number of calls at night.

2 All calls at night are emergency calls.

Similar experiments were performed on the model for the night-time operation of the service. The demand pattern generated by the computer was statistically similar to the actual night-time demand which had been experienced in the area during 1969.

Full results of these experiments are presented in Appendix II. The levels of service provided by various numbers of ambulances are shown in Table F, below.

Number of ambulances	Percentage of emergency cases reached within (minutes)					
	15	30	45	60	75	90
5	40	74	92	97	99	100
6	44	78	95	99	100	
7	48	82	98	99	100	
8	51	88	99	100		
10	60	92	99	100		
12	69	96	100			
16	77	99	100			

TABLE F

Five or six ambulances on duty during the night would be capable of providing an appreciably better service than a similar number during the day. However the difference in performance (night-time versus day-time) decreases as the number of ambulances is increased. There are two main reasons for this:

1 If a small number of ambulances was on duty during the day, queues of emergency cases would form. This would not happen during the night due to the low demand for service.

2 The number of ambulances required for a high level of service is determined more by the distances the ambulances have to travel than by the level of demand.

X INTERPRETATION OF RESULTS

The number of ambulances and their deployment throughout the Western Health Board area can now be determined when the level of service to be provided in the area has been decided. The question of what would constitute an acceptable level of service was discussed with members of the Ambulance Consultative Council. We were anxious to receive some guidelines so that we could specify in detail the ambulance system which would be required in a given set of circumstances . They indicated that they would be satisfied to be able to guarantee that 95% of all emergency cases would be reached within 30 minutes of the call being received. This specification enabled us to determine in detail an ambulance system which would be capable of fulfilling this objective. The cost of this scheme could then be determined and the marginal costs involved in altering the level of service calculated. For example, the desirability of being able to reach 99% of all emergency cases within the same time period could be balanced against the extra costs involved. We will refer to the cost of the ambulance service in Section XIV.

A DAY-TIME OPERATION

Reference to Table E, Section IX, shows that for day-time operation, it would be possible to reach 99% of all emergency cases within 30 minutes, with a fleet of 14 ambulances suitably dispersed throughout the area.

When the coordinates of each of the 14 ambulance bases were marked on a map it was found that some adjustments to their locations had to be made to cater for the heavily indented coastline of Connemara. Other minor adjustments were made so that all the ambulances would be stationed in towns or large villages.

As a result of these adjustments two further ambulances were allocated to the area so that the actual performance of the 16 ambulances would at least equal the theoretical performance of the 14 ambulances as predicted by the model.

The expected performance of these 16 ambulances is as follows.

Average waiting-time (emergency case) = 13 minutes

Maximum waiting time (emergency case) = 45 minutes

Time (minutes)	15	30	45
Percentage of emergency cases reached within the specified time	76%	98%	100%

TABLE G

The suggested bases for these 16 ambulances are given in Table H, below. Their geographic locations can be found in Appendix III, Figure I.

Location	Number of ambulances
Galway city	2
*Bealadangan	1
Loughrea	1
Ballinasloe	1
Clifden	1
*Dunmore	1
Castlebar	1
*Louisburg	1
*Achill Sound	1
Belmullet	1
Ballina	1
*Ballinrobe	1
*Ballaghaderreen	1
Boyle	1
Roscommon	1

TABLE H

This proposed deployment would ensure that each existing ambulance base would retain at least one ambulance.

Proposed new ambulance bases are located at towns marked *.

B NIGHT-TIME OPERATION

Fifteen ambulances would be required at night to guarantee the same level of service as that being provided during the day, one ambulance less being required in Galway city.

The utilisation of these ambulances during the night would be extremely low. Only two of the ambulances would receive, on average, more than one call per night while most of the others would receive, on average, one call per week. This may make it difficult to justify keeping 15 fully staffed ambulances on duty all night.

The total expected number of emergency calls received at night during a year would be approximately 1000. Reference to Table F, Section IX, shows that with 10 ambulances 92% of emergency calls would be reached within 30 minutes; the remaining 8% would be picked up within 60 minutes. With six ambulances on duty 78% of the calls would be reached within half an hour. Practically all of the remaining 22% would be picked up within the following 30 minutes.

Although it is not the function of the OR Section to specify the level of service to be provided, we think that it would be more realistic to reduce the number of ambulances on duty during the night to six. These ambulances, which should be stationed at Galway, Ballinasloe, Clifden, Boyle, Castlebar and Belmullet, should be fully staffed and ready to respond immediately to an emergency call.

This scheme would guarantee that 98% of all day-time emergencies and 78% of night-time emergencies would be reached within 30 minutes of the call being received. Should it be decided to alter these specifications a different number of ambulances and a different deployment would be required. Experiments could be performed on the model to determine exactly how many ambulances would be required and where they should be stationed. The particular system implemented depends ultimately on the level of service it is decided to

provide.

C OPERATING PROCEDURE

If the level of service provided by 16 ambulances during the day-time was considered to be satisfactory new ambulance bases would be required at Bealadangan, Dunmore, Louisburg, Achill Sound, Ballinrobe and Ballaghaderreen. We do not envisage that ambulances would be based permanently in these towns. Instead we would suggest that ambulances should drive from the nearest permanent base each morning, operate from the outlying base during the day and return again to the permanent base at 10 p.m. It would be necessary to provide an office for the ambulance staff at each of these outlying bases.

The following scheme of operation is suggested:

1 Base the Bealadangan and Dunmore ambulances permanently at Galway.

2 Base the Louisburg ambulance at Clifden.

3 Base the Achill and Ballinrobe ambulances at Castlebar.

4 Base the Ballaghaderreen ambulance at Boyle.

For both day-time and night-time operation all ambulance drivers and attendants should be on duty with their ambulances. The system of having drivers "on-call" can cause delays and should be discontinued.

D STAND-BY FACILITIES

Stand-by vehicles would be required to allow for routine maintenance and breakdowns. Each ambulance would require a routine maintenance check each month, and while out of service would have to be replaced by another vehicle. A second stand-by ambulance would be necessary as insurance against breakdowns.

We calculated from the records on vehicle downtime for maintenance, that two stand-by ambulances would be sufficient to keep 16 ambulances on the road for at least 98% of the time.

XI SENSITIVITY ANALYSIS

The proposals in Section X, are based on the demand which was experienced during 1969. Demand for ambulance service may not always remain at this level so it would be important to know how sensitive these proposals are to changes in the demand pattern.

We performed a number of experiments on the model to test the effect of such changes. The day-time demand experienced during 1969 was increased by 50% and a year's operation of the service using 16 ambulances simulated. The demand was further increased to twice, three times and then four times the 1969 figure, and the experiment repeated in each case. The results of these experiments can be seen in Table J below. The deterioration in service with increasing demand is remarkably small. Again this is due to the number of ambulances being influenced more by the size of the area than by the demand.

Demand	Percentage of cases reached within (minutes)				Average pick-up time (minutes)
	15	30	45	60	
(1969)	76	98	100		13.0
(1969) X 1.5	71	96	99	100	14.1
(1969) X 2	69	94	99	100	14.6
(1969) X 3	63	92	99	100	16.3
(1969) X 4	60	90	98	99	17.8

TABLE J

XII CONTROL AND COMMUNICATION

A CONTROL

Under the existing system each of the three counties has its own separate radio control system. Each ambulance base has its own transmitter and controls only the ambulances which operate from that base. Generally there is very little cooperation between counties or even between bases.

The Western Health Board will administer the health services in the three counties as one unit. As pointed out in the introduction to this report, the Ambulance Consultative Council asked us to base our analysis and recommendations on this arrangement. Apart from obvious administrative advantages there are a number of definite economic advantages to be gained from having one unified ambulance system under one central control for the whole area. These advantages are chiefly as follows:

1 A given number of ambulances serving the whole area as one unit would provide a better level of service than that which would be obtained by dividing the ambulances between the three counties and allowing each county to run its own service separately. The results of experiments on the model which illustrate this fact can be found in Appendix II.

2 The control centre will have to be staffed for 24 hours a day. One person would be capable of handling all the traffic even at peak hours, so that having one control centre instead of three (or nine if the present system whereby each base controls its own ambulances was continued) would result in an obvious saving in staff.

3 The opportunities for the coordination of ambulance journeys to Dublin Hospitals and the organisation of transport for ambulant patients are obviously better if the area is under one central control.

4 Two stand-by ambulances would be required for the whole area to allow for maintenance or breakdowns (see Section X), while a total of five would be required if the three counties operated separately.

It will be essential for the control centre to be in touch by radio with all the ambulances in the area and to have complete control over their movements. All requests for an ambulance will come through the control centre and it will be the function of the controller to decide how each request will be met. If, for example, an ambulance is required to transport a patient from Castlebar town to Castlebar hospital, the request should be made to the control centre. If an ambulance driver receives a directive from some other person with local authority, e.g. the matron at his local base, he should check with the control centre before carrying out the directive. The smooth and effective operation of the system depends on the controller knowing at all times the exact whereabouts of each ambulance and whether or not it is free to answer an emergency call.

B STAFF

We expect that the demand for ambulance service will average approximately 1.20 calls per hour during the day time period. The distribution of the time of arrival of the calls is such that twice in a month we would expect five calls to arrive within the space of an hour and six calls within an hour once every two months. One person (the controller) should be able to handle this traffic and direct the ambulances. In addition to dealing with emergency calls the controller should be made responsible for routing non-emergency vehicles, arranging clinic transportation and keeping records.

During the night-time we expect an average of approximately 0.33 calls every hour, or one call every three hours. Once a month three calls would come

within the space of an hour and only three times during a year do we expect four or more calls within an hour.

The control centre should be staffed 24 hours a day. This would require four controllers, assuming each works a 42 hour week, plus one relief controller to substitute during sick leave and holiday periods. It may be possible to make arrangements for the hospital telephone switchboard operator (if the control centre is placed in a hospital), to handle the very light night-time traffic. Alternatively the night-time control could be linked in with the Garda control. Arrangements such as these would reduce the number of controllers required to two with one relief.

C COMMUNICATION

There are two problems which must be examined here:

1 Communication between the Control Centre and the Ambulances

At present each of the three counties has its own separate radio communication system between the local control centres and the ambulances. These systems should now be adapted to enable one control centre to cover the entire area. New repeater masts may have to be erected and new equipment will be required to relay the signal from one county to another.

2 The facilities provided to enable the public to contact the ambulance service

All requests for service should be made to the control centre. Requests will usually come in the form of:

(a) Telephone calls.

(b) Radio calls, i.e. requests received by the ambulance drivers and relayed to the centre.

(c) Written requests.

Most requests will be made by telephone.

The effectiveness of the ambulance service will be greatly reduced, no matter how quickly it responds to an emergency call, if the public cannot contact it with the minimum of delay. This is a problem which requires a special study in itself and could include such considerations as the placing of special telephone kiosks at accident "black spots".

The first essential however is to ensure that the public are given clear directions as to how to contact the ambulance service by telephone. These directions could take the form of a special notice made available to all private telephone subscribers and displayed in all public telephone kiosks. Much of the area at the moment is served by small automatic or manual exchanges but the Post Office intends to extend the automatic system to cover the entire area in the future. However it will be some years before this automisation programme is completed. In the meantime an emergency system could be worked out in co-operation with the Post Office which could be adapted as the telephone system develops.

D LOCATION OF THE CONTROL CENTRE

It is not essential to locate the control centre at the largest hospital or at the administrative centre of the area. What is important is that it be located in a suitable position from the point of view of communications. It would thus be advisable to discuss the location of the centre with the Post Office before a decision is made.

Locating it at a hospital which is also an ambulance depot would have the advantage that the hospital switchboard operator could act as controller during

the slack night-time period. In addition the local ambulance charge-hand (see Section XIII, following) would be available to act as relief controller.

XIII ORGANISATION AND STAFFING

We suggest that the Programme Manager, General Hospitals,[5] should be given responsibility for the ambulance service for the Western Health Board area.

A OFFICER-IN-CHARGE

The responsibility for the actual operation of the service should be delegated to an officer of a rank approximately equivalent to that of an Assistant County Engineer. This officer would have responsibility for:

1 The efficient operation of the service.

2 The investigation of possible improvements.

3 The purchasing and maintenance of vehicles and equipment.

4 The recruitment and training of drivers and controllers.

5 Discipline.

6 Liaison with hospitals, clinics and medical practitioners.

B ASSISTANT TO OFFICER-IN-CHARGE

The Officer-in-Charge should be provided with an assistant with rank approximately equivalent to that of a County Council Overseer. The assistant would be in direct control of the men and the vehicles. His duties would include:

1 Arranging duty rosters.

2 Organising vehicle maintenance.

3 Ensuring that the vehicles are at all times fully and properly equipped.

C CONTROLLER

We have referred already to the Controller in Section XII. This is a key position and will require an officer with intelligence and initiative. The intelligent organisation of the movements of the ambulances will be an important factor in the effective operation of the service. For example, if the Belmullet ambulance has to travel to Galway, the ambulance stationed at Achill could be moved to Bangor Erris until the Belmullet ambulance returns.

D AMBULANCE STAFF

Under the existing system when an ambulance is called to an emergency or a non-emergency stretcher case a nurse from the local hospital is sent with the driver. This system operates throughout the country except for the emergency services in Dublin, Cork and Limerick, where the ambulances are staffed by two men.

In the country the amount of time spent in an ambulance en route to hospital can be much greater than in the city. Medical opinion, however, tends towards the view that a trained man would be as useful as a nurse during this time. Maternity cases may be an exception, but we found that even for these cases the preference for a nurse was neither strong nor unanimous. Maternity cases account for approximately 3% of the traffic.

There are a number of disadvantages associated with taking a nurse from a hospital to accompany the driver. Principally these are:

1 The departure of an ambulance on an emergency call can be delayed by 5 to 10 minutes, and sometimes even longer, while a nurse is being sought from the hospital.

2 The Ambulance Service takes nurses away from hospital work. There is no nursing work on an ambulance during, at least, half the nurse's time on board.

3 Normally two men are required to carry a stretcher. This assistance has to be obtained locally. In approximately 40 per cent of the stretcher calls we investigated assistance was provided by neighbours or bystanders.

4 Attending to road accident victims often requires heavy skilled work. While bystanders or Gardaí are usually available they are not trained in the handling of injured people.

5 Should a driver become incapacitated on a call there is no one to take over from him.

We suggest that an ambulance should be staffed by two men (driver/attendants). These two men should be on duty with the ambulance, ready to respond immediately to an emergency call. Apart from countering the disadvantages listed above, this staffing arrangement would be necessary if it is decided to locate ambulances at remote bases as suggested in Section X.

If objections to this staffing arrangement materialise in the case of maternity patients, a system of having maternity nurses available on an "on call" basis could be devised. In the case of ambulances located at hospitals a maternity nurse could be borrowed from the hospital.

The number of driver/attendants required depends on the number of ambulances it is decided to use. For day-time operation, assuming each ambulance would be staffed by two men and that each man works a 42½ hour week, 4.5 men per ambulance would be required (see Appendix IV). This means that 72 driver/attendants would be required to staff 16 ambulances fully for the 12 hour day-time period.

Six ambulances on duty during the night, if staffed by two men, would require a further 27 driver/attendants. Thus the scheme outlined in Section X, would require a total of 99 driver/attendants.

Initially,however,the Health Board may wish to continue with the present staffing arrangement for ambulances based at hospitals, that is, a driver and a nurse. This would include the night-time operation. In the case of an ambulance staffed by a driver and a nurse each ambulance would require 2.25 drivers to ensure a driver would be available for each 12-hour period the ambulance was on duty. Under the scheme suggested in Section X, ten of the day-time ambulances and all of the night-time ambulances would be based at hospitals. To operate this system a total of 63 driver/attendants would be required.

These proposals would require a big increase in the number of driver/attendants employed by the Health Board. At present there are 18 full-time and 7 part-time drivers in the Western Health Board area. The cost of this proposal is discussed in Section XIV.

E CHARGE HANDS

One of the regular drivers should be appointed as a charge hand in each ambulance depot. This man would be responsible for good order in the depot. The charge hand in the depot nearest to the control centre might also act as relief controller.

F EXTENSION OF THE RESPONSIBILITIES OF THE OFFICER-IN-CHARGE

The Officer-In-Charge in the area could perform the same function for the other Health Boards in the Region.(1) He would then become a sub-programme manager for two or more areas with appropriate assistants and subordinate staff in each area.

XIV COST

We are primarily interested in the difference between the cost of continuing the existing system compared with the cost of implementing our proposals. The main elements of cost in operating the ambulance service are equipment costs, including depreciation and maintenance, fuel costs and staff costs. Equipment includes both ambulance vehicles and radio. Our proposals do not require additional ambulances so we can assume that all costs directly associated with the actual vehicles, including fuel costs, would be about the same under both schemes. Capital costs will be involved in adapting the radio system to allow for one central control, but after this initial investment annual maintenance costs should not differ greatly from those incurred under the existing scheme. We were not in a position to estimate the cost of the adaptation but it should be relatively low compared to the installation costs already incurred. The main difference in costs will come under the heading of staff costs.

A STAFF COSTS

As pointed out in Section XIII, our proposals would require a large increase in the number of ambulance drivers. Under the existing system nurses are taken from the local hospital to accompany the ambulance on practically all journeys. The cost of providing these nurses is not included in the cost of the ambulance service except in the case of the ambulance stationed at the Portiuncula Hospital, Ballinasloe. In this case a sum of £1795 for nursing services was debited to the ambulance service for 1969/70. In 1969/70 the average annual salary of a nurse was approximately £1000. The sum of £1795 would thus represent two nurses practically full-time on ambulance duties.

From this evidence and from consultations and general observations we think that,

in the absence of actual data, a reasonable estimate of the cost of providing nurses for ambulances would be obtained by assuming that one nurse is required for every full-time ambulance driver in the area.

There are 18 full-time and 7 part-time drivers in the area at present, the equivalent of 21.5 full-time drivers. Assuming that an equal number of nurses are required, a sum of £26,000 should be a reasonable estimate of the present cost of providing nurses for the ambulances. This is based on the mid-point of the current nurses' salary scale of £1035 - £1375 per annum. The drivers' salaries amount to approximately £27,000, bringing the total staff costs to approximately £53,000 per year.

Under the scheme proposed in Section X, the nurses would be replaced by full-time driver/attendants. We calculated that 99 driver/attendants would be required to ensure that the 16 day-time ambulances and the 6 night-time ambulances would be staffed continuously by two men. The salaries of the 99 driver/attendants would amount to £124,000 per year. Under the alternative staffing proposal suggested in Section XII, whereby only the ambulances at remote bases would be staffed by two men, 63 driver/attendants costing £79,000 per year, would be required. The reduction from 99 would have to be made up by borrowing nurses from the hospitals, thus the real saving would not be significant.

The advantages of having two driver/attendants on duty with an ambulance, rather than continuing with the existing system of having one driver, sometimes "on call," and a nurse, borrowed from the local hospital, were outlined in Section XIII.

Further extra costs would be incurred in providing accommodation for driver/attendants at remote locations. Six remote locations are suggested but the accommodation requirements would be modest.

The cost of supervisory staff, the Programme Manager, General Hospitals (part-time) the Officer-in-Charge, his assistants and the Controllers should also be debited to the cost of the service. Some of these officers have no direct equivalents

under the existing system but, at present, medical personnel, Local Authority Engineers and particularly Hospital Matrons are involved in the operation of the ambulance service. The cost of this involvement would be difficult to estimate.

B MARGINAL COST OF ALTERING THE LEVEL OF SERVICE

Should it be decided to provide a level of service superior to that suggested in Section X, extra ambulances would be required. The cost of each additional ambulance can be esimated as follows:

1 Equipment

A new ambulance costs £3000. Assuming a straight-line depreciation over 4 years, this represents an annual charge of £750. We calculated from figures supplied by the Galway Health Authority that maintenance would cost £300 per year, fuel £350 and Insurance £25, giving a total estimated annual cost of £1425 per vehicle. The cost of the radio apparatus (£160), depreciated over 8 years would add an extra £20 to this.

2 Staff

The average wage of an ambulance driver is £1252 per annum. In Section XIII, we pointed out that 4.5 men per ambulance would be required to ensure that two men would be available to staff an ambulance for 12 hours per day. The annual staff costs per ambulance would thus amount to £5634.

The direct cost of providing an ambulance fully staffed by two men for 12 hours a day would amount to approximately £7100 per annum. The improvement in performance which would be obtained by increasing the number of ambulances can be compared with this extra cost for each additional ambulance.

XV TRANSPORTATION OF AMBULANT PATIENTS

The main emphasis of our study was on the service provided for emergency and non-emergency stretcher patients. However the Health Authorities also provide transport for ambulant patients to and from outpatient clinics, hospitals and special schools. Public transport and taxis as well as ambulances are used for these journeys.

In 1969/70, the Galway Health Authority spent approximately £12,200 on hired transport, including public transport, for ambulant patients. During the same period this service cost the Mayo and Roscommon Health Authorities approximately £15,000 and £9,000 respectively. Thus approximately £36,200 was spent in one year by the three Health Authorities on hired transport for ambulant patients. About half of this sum was spent on public transport and half on taxis. This is in addition to any journeys the ambulances may have made for similar reasons.

As an alternative to hired transport the Health Board could purchase minibuses to transport ambulant patients. We estimate that the annual cost of a minibus would amount to approximately £2,600, made up as follows:

Initial capital cost £1,500, depreciated over 3 years		
Depreciation	=	500
Driver's wages including replacement during holiday and sick periods	=	1350
Repairs and Maintenance	=	100
Insurance	=	30
		£ 1980
Assume 30,000 miles per year @ 2p /mile	=	600
		£ 2580

From the data available, which are records of payments only and not of actual journeys, it would be very difficult to make an accurate calculation of the number of minibuses which would be required. However, a rough estimate seems to indicate that approximately six minibuses would be sufficient to cater for most of the ambulant traffic in the area.

In the meantime, pending a more thorough analysis of the problem, there appears to be scope for economy by coordinating the use of taxis. This coordinating function should be the responsibility of the ambulance controller. All requests for transport whether for ambulant or non-ambulant patients should be directed through him.

Apart from economic considerations there are a number of other factors which should be taken into account before a decision is made to introduce minibuses.

1 Minibuses, equipped with radio, could be diverted to an emergency call and would thus augment the ambulance service. The medical equipment carried by the minibus would be available at the scene of the emergency and first aid could be rendered until the ambulance arrived.

2 It is, in general, more comfortable for ambulant patients to travel by minibus than by ambulance.

3 Minibuses could carry more patients than an ambulance or a taxi.

4 On the other hand, a taxi would probably be quicker and more convenient for an ambulant patient than a minibus.

The brief analysis of the problem which we carried out does seem to indicate that minibuses would be a more economical way of transporting ambulant patients than the present system, but a more thorough analysis would be necessary before any decisions are made.

XVI FURTHER CONSIDERATIONS

A HELICOPTERS

Helicopters are used to transport emergency patients from islands and special cases to Dublin hospitals. At present this service is hired as required. We recommend that this practice should be continued. The very heavy cost and the practical difficulties involved would, in our opinion, preclude the permanent retention of a helicopter for ambulance duties in the Western Health Board area.

B SEPARATE EMERGENCY SERVICE

It has been suggested that two separate services should be provided, one to deal exclusively with emergency calls and the other to handle all other cases.

The emergency service alone would require 15 ambulances to provide the same level of service to emergency cases as they would receive from 16 ambulances catering for both emergency and non-emergency stretcher cases. The utilisation of the emergency ambulances would be extremely low, as the demand would average approximately 2 calls per vehicle per week.

A further four vehicles would then be required to cater for the non-emergency demand. Each one of these vehicles would receive an average of 3.5 calls per day.

Unless the demand for ambulance service in the Western Health Board area alters radically, there is no advantage to be gained by having a completely separate ambulance service dealing exclusively with emergency calls.

C VOLUNTARY SERVICE

The Knights of Malta operate a voluntary ambulance service in Tuam and Westport. Each centre receives approximately 2 calls per month. This service is not in any way linked with the Local Authority service but makes a valuable contribution at special functions, such as sporting fixtures, pilgrimages etc.

D COMMERCIAL AMBULANCES

There are no commercial ambulances in the area. Occasionally commercial ambulances from outside the area are engaged privately but this traffic is insignificant.

E HOSPITAL TRANSPORTATION

At present all the ambulances in the area are under the control of hospitals or County Homes and are used occasionally as general purpose vehicles by these institutions. Our proposals, which would place the ambulance under one central control, would, to an extent, deprive the institutions of this facility.

XVII IMPLEMENTATION

We suggest that the Ambulance Consultative Council in conjunction with the Western Health Board set up a small subcommittee to study this report. We would be available for discussions and would assist the subcommittee in every possible way.

To implement the recommendations no additional ambulances would be required but there are a number of factors which would require careful consideration. These are:

A LEVEL OF SERVICE

A decision will be required on the level of service to be provided in the area. As pointed out in Section X, the size of the ambulance fleet and its deployment depends on the level of service it is decided to provide. The scheme outlined in Section X, is for a particular level of service. A different level of service would require a different scheme.

B RADIO CONTROL AND THE LOCATION OF THE CONTROL CENTRE

The existing three separate radio control systems will have to be adapted to provide one uniform system. This problem and the problem of finding the best location for the control centre should be discussed initially with the relevant experts in the Department of Posts & Telegraphs.

C PERSONNEL

Proposals on the organisation and on the staff required are contained in Section XIII. Extra staff will have to be recruited and a decision on the staffing scheme for the ambulances made. Consultations will be required with the relevant Trade Unions and an agreement on working hours obtained.

D ACCOMMODATION

Accommodation will have to be provided for the ambulance staff at the remote locations.

XVIII CONCLUSION

Our analysis, which employed the most advanced computer simulation techniques, has produced a solution which from a common-sense point of view appears reasonable, that is, that as far as is practical the ambulances should be located as near as possible to the source of the demand for the service. When this principle is applied to the Western Health Board area, a large sparsely populated area, the drawbacks in the existing system become evident. The ambulances should be deployed more evenly throughout the area and not grouped together in relatively few locations as at present. Situations requiring ambulance service do not necessarily occur in the immediate vicinity of hospitals, yet all the ambulances in the Western Health Board area are located at hospitals, and in some cases grouped together in relatively large numbers at these hospitals. There are a number of reasons for this arrangement, the most compelling being the present staffing arrangement under which a nurse has to be obtained from a hospital to accompany the ambulance driver on almost all journeys. Our staffing proposals would overcome this difficulty and by deploying the ambulances more evenly throughout the area would ensure that practically any place in the area could be reached by an ambulance within 30 minutes of the call being received.

The model which we developed for this study is a general model and is equally applicable to any of the other Health Board areas. The ambulance service for each Health Board area could be simulated on this model once the characteristics of the area including the demand pattern for service are known. Provided we receive the same cooperation as we received in the Western Health Board area, there would be no difficulty in extending the study to each of the other Health Board areas in the country.

ACKNOWLEDGEMENTS

The Operational Research Section of the Department of Finance is grateful for the assistance received during this study. The Chairman, Members and Secretary of the Ambulance Consultative Council were very helpful with suggestions, information and comments. The Officers and Staff of the Health Authorities extended the utmost courtesy to the Section and provided all the help and facilities requested.

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APPENDIX I

CHARACTERISTICS OF THE WESTERN HEALTH BOARD AREA

WESTERN HEALTH BOARD AREA

PRINCIPAL TOWNS (POPULATION EXCEEDING 1000)

FIGURE I

WESTERN HEALTH BOARD AREA

POPULATION AND AREA

County	Area (square miles)	Population	Population density
Galway	2374.6	148,340	62.5
Mayo	2084	115,547	55.4
Roscommon	983.8	56,228	57.2

✗ National Average: 106.3 people per square mile

TABLE A

PRINCIPAL HOSPITALS

	Beds
Regional Hospitals	
Galway Regional General Hospital	567
Western Regional Sanatorium, Merlin Park, Galway ...	683
County Hospitals	
Castlebar, County Mayo	196
Roscommon	126
District Hospitals	
Clifden, County Galway	40
Ballina, County Mayo	90
Belmullet, County Mayo	22
Swinford, County Mayo	42
Boyle, County Roscommon	31
Voluntary Hospitals	
Portiuncula Hospital, Ballinasloe, County Galway ...	204
Private Hospitals	
Calvary Hospital, Galway	65
Bons Secours Home, Tuam	75
Fever Hospitals	
Galway	42
Swinford	15
Roscommon	12
County Homes	
Loughrea, County Galway	384
Castlebar, County Mayo	260
Roscommon	305
Psychiatric Hospitals	
Ballinasloe, County Galway	1527
Castlebar, County Mayo	937
Castlerea, County Roscommon	387

TABLE B

PRESENT DEPLOYMENT OF AMBULANCE SERVICES

County	Location of Ambulance Depot	Number of Ambulances	Numbers of full-time drivers	* Number of part-time drivers
Galway	Regional Hospital, Galway	5	6	0
	District Hospital, Clifden	1	0	2
	County Home, Loughrea	1	1	0
	Portiuncula Hospital, Ballinasloe	1	1	2
Mayo	County Home, Castlebar	5	6	0
	District Hospital, Ballina	1	1	0
	District Hospital, Belmullet	1	1	0
Roscommon	County Home, Roscommon	2	1	2
	District Hospital, Boyle	2	1	1

* Drivers who act as porters when not engaged on ambulance duties.

TABLE C

EXISTING AMBULANCE DEPOTS

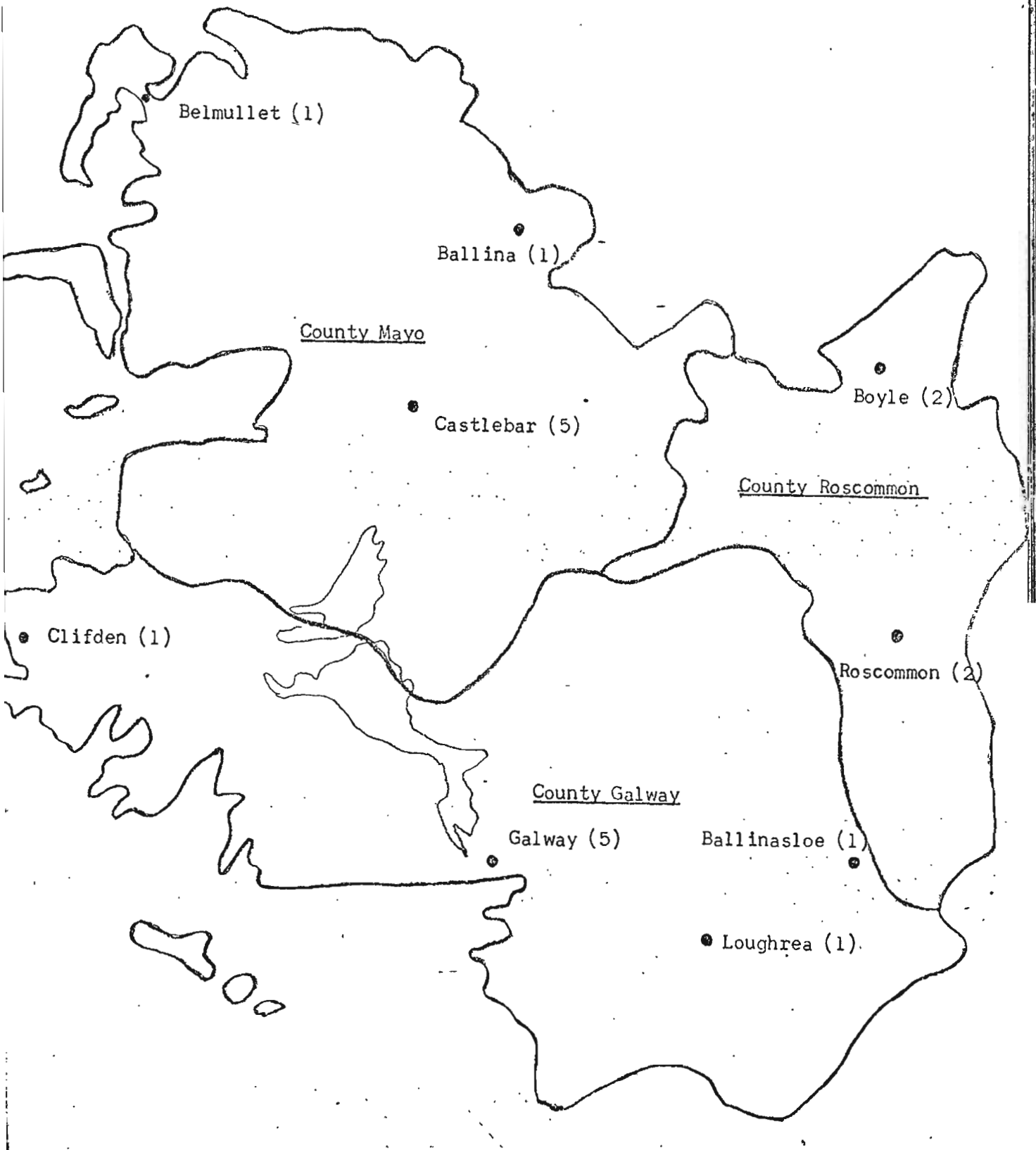


FIGURE 2

DEMAND FOR AMBULANCE SERVICES

There was a total of 9,660 Ambulance Journeys made in the Western Health Board Area during 1969. Of these, 6,380 were the result of external calls, the remainder being scheduled by the various hospital authorities.

The journeys were subdivided into 3 broad categories as follows:

Category 1: Journeys classified as urgent, usually involving either an accident, or medical emergency. Of these journeys 575 were calls to road traffic accidents, representing 6% of all calls.

Category 2: Journeys not classified as urgent, but where the use of a stretcher ambulance was nevertheless required.

Category 3: Journeys where the use of a stretcher ambulance was not essential. These frequently involve bringing discharged patients home from hospital, bringing out-patients to and from clinics, or conveying ambulant or sitting patients for admission to hospital.

The number of journeys in each category were as shown in the table below.

Category	Number of Journeys	Percentage of total
1	1640	17%
2	4733	49%
3	3287	34%
Total	9660	

TABLE D

Distribution of Ambulance calls at Regional Hospital Galway (9a.m. to 10 p.m.)

February and August 1969 (8 weeks).

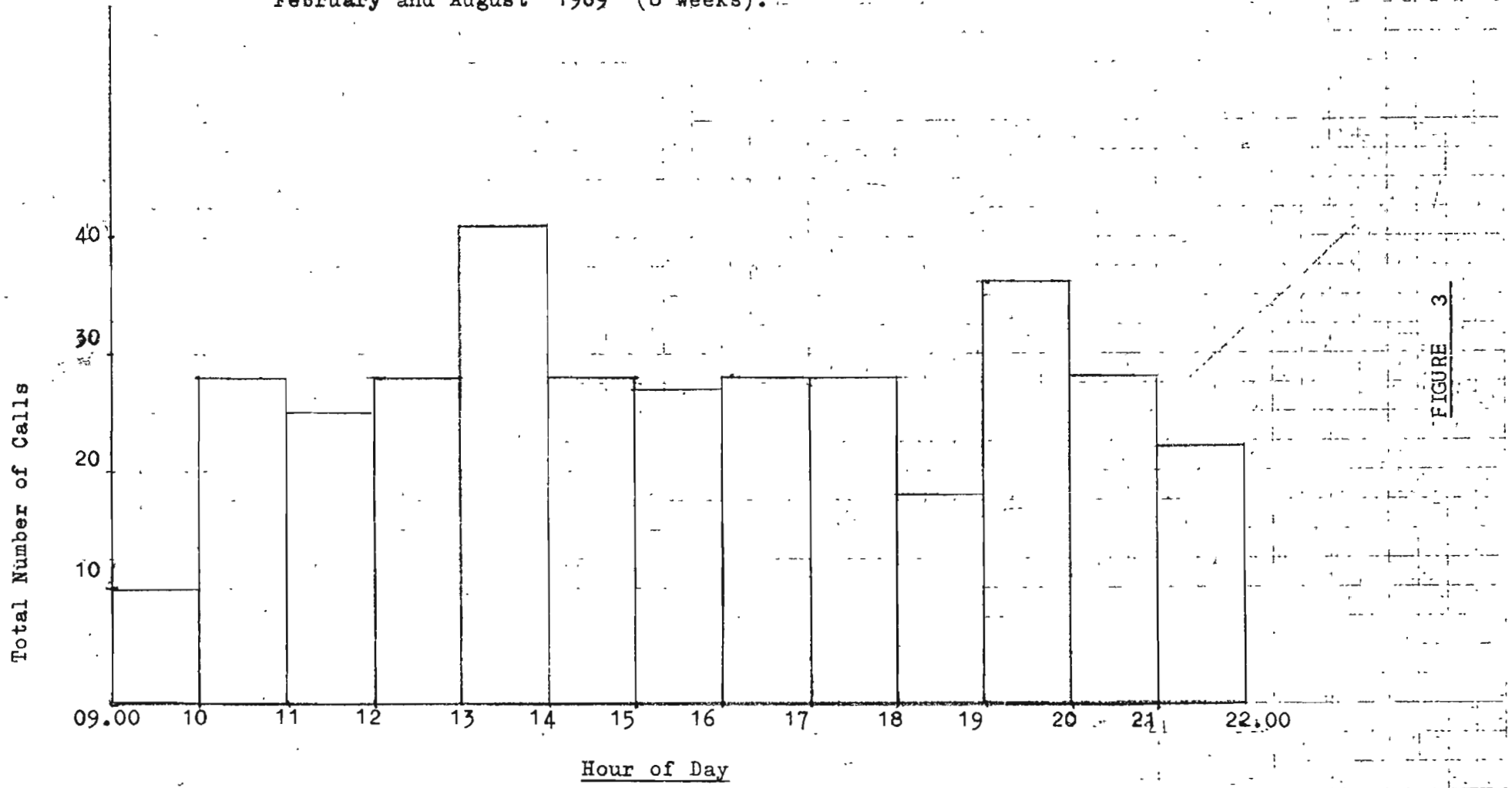


FIGURE 3

Distribution of Ambulance Calls throughout night (10 p.m. to 9 a.m.)
at Regional Hospital Galway, February and August 1969.

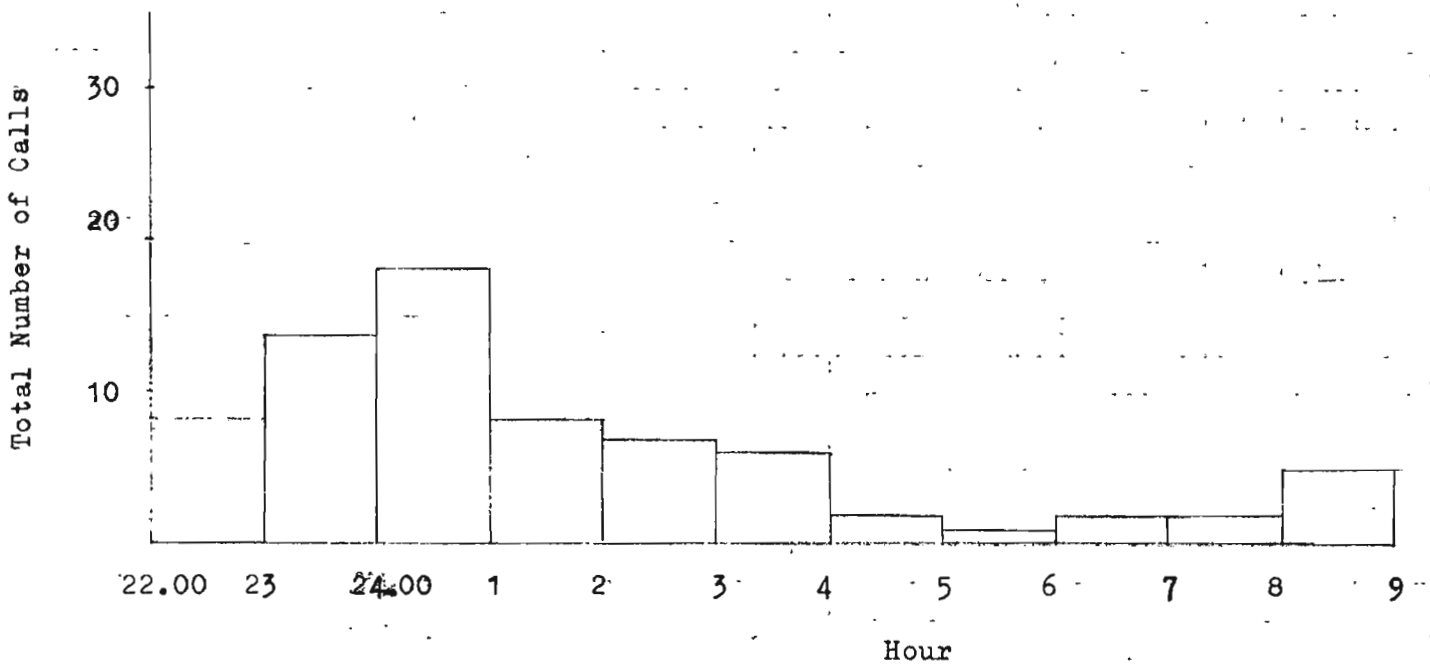


FIGURE 4

Total number of calls per day of week : February & August 1969 - (8 weeks)

Regional hospital Galway.

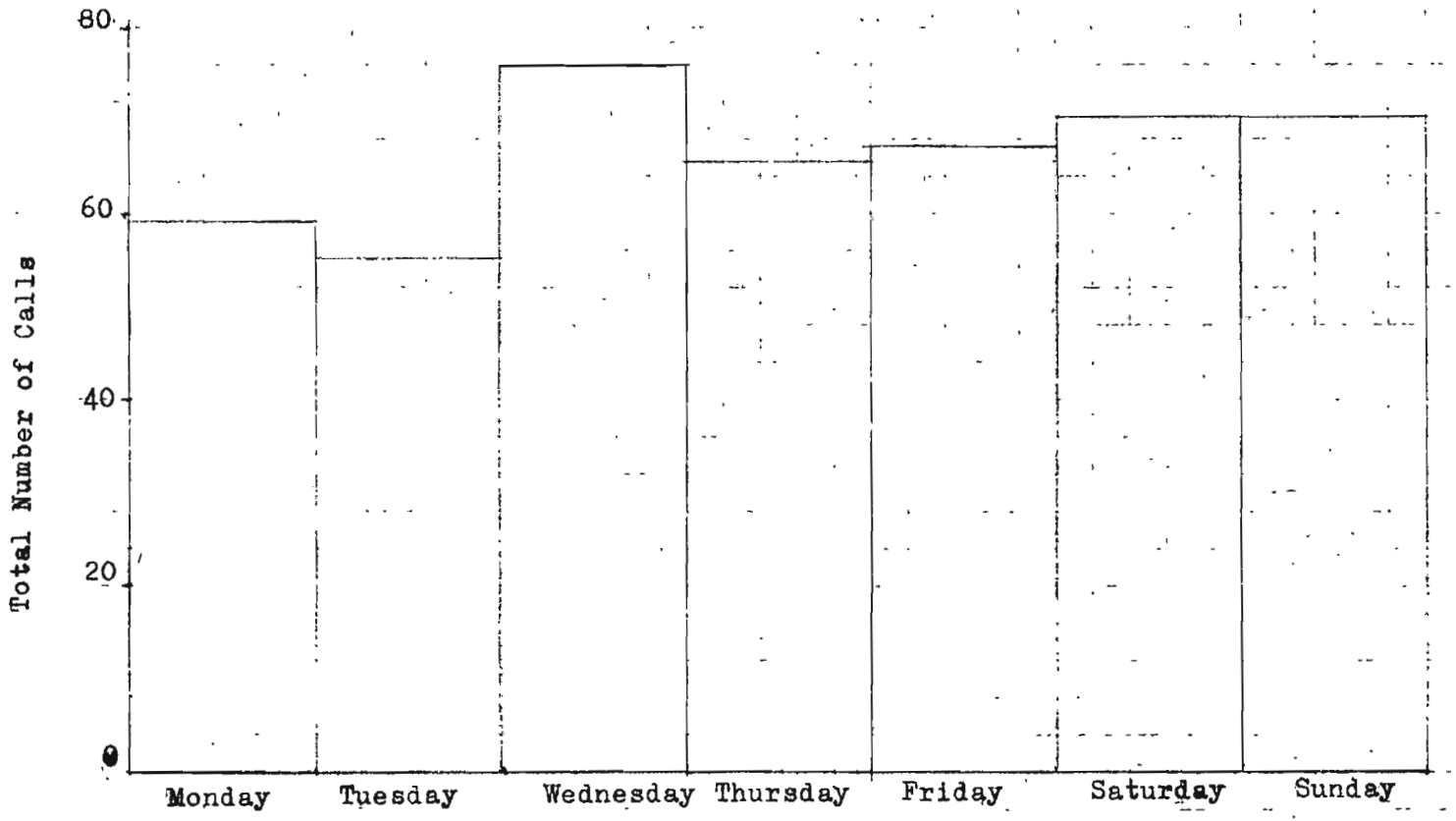
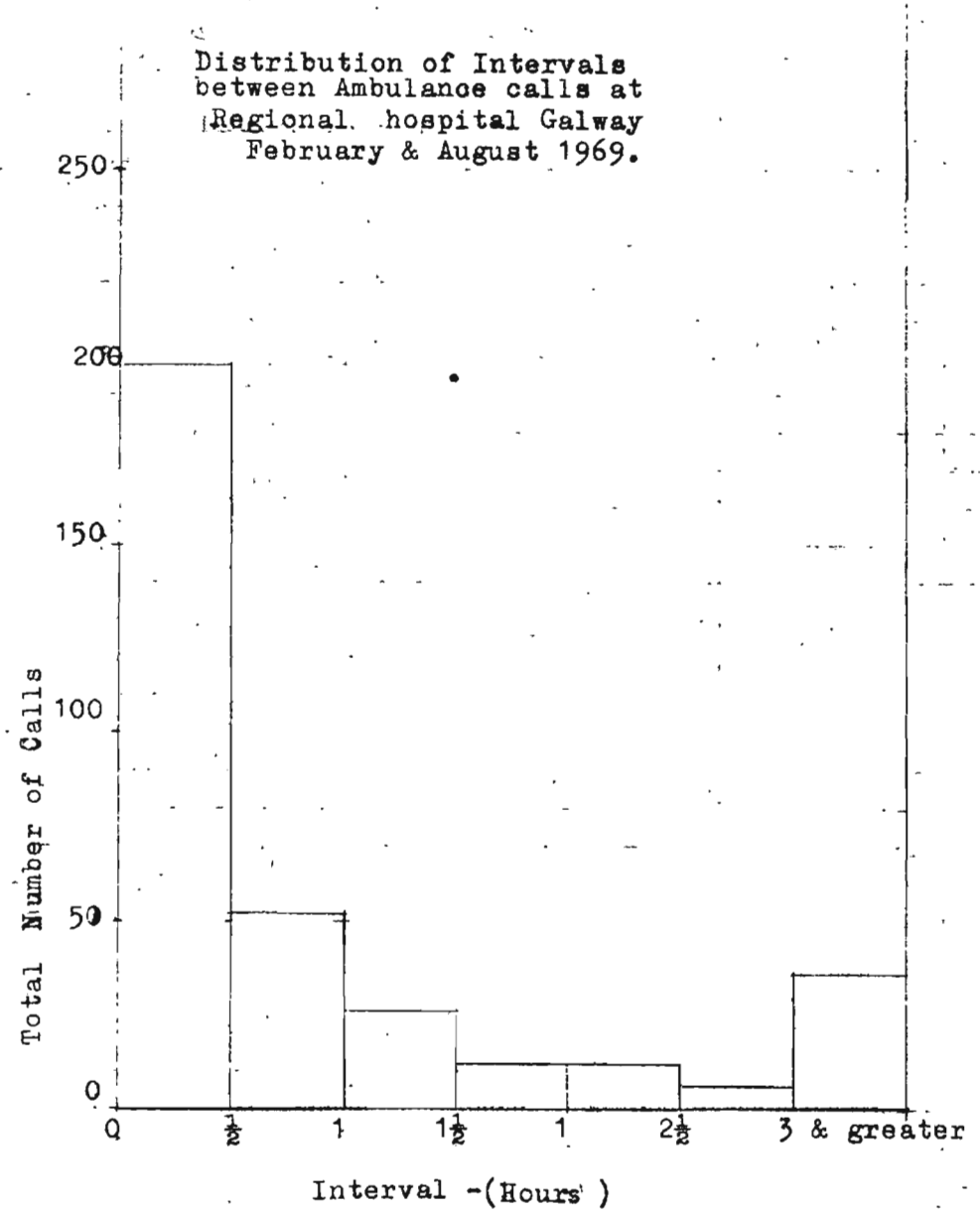


FIGURE 5


Distribution of Intervals between Ambulance calls at Regional hospital Galway February & August 1969.
250
200
150
100
50
0
Total Number of Calls
0
½
1
1½
1
2½
3 & greater
Interval -(Hours)

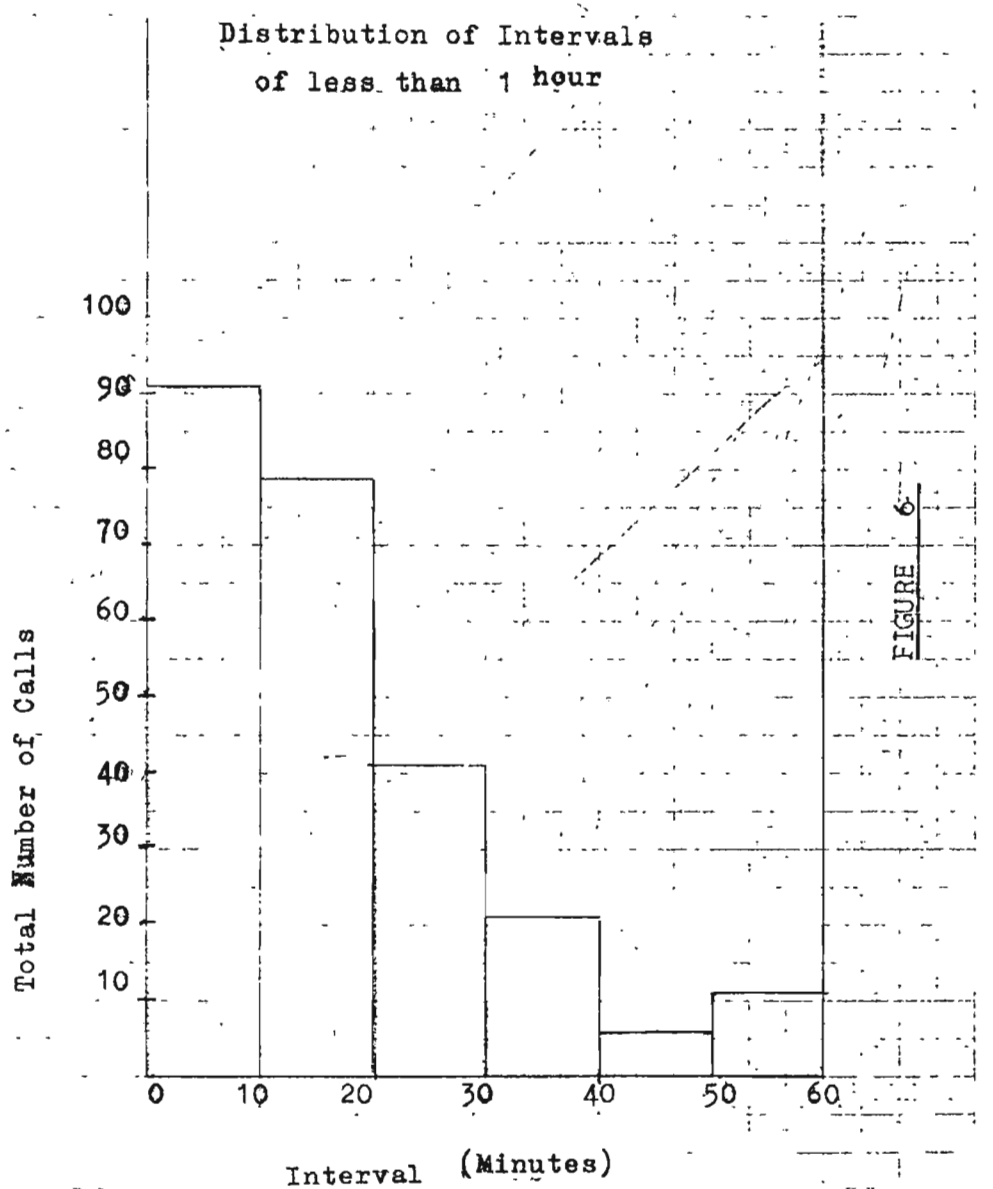

Distribution of Intervals of less than 1 hour
100
90
80
70
60
50
40
30
20
10
Total Number of Calls
0
10
20
30
40
50
60
Interval (Minutes)

FIGURE 6

ORIGIN OF CALLS

There were 6,380 external calls made on the ambulance service in 1969.

95% of these were made by doctors.

3% were made by lay people, and 2% by the Gardaí.

Almost all the calls not made by doctors were emergency cases.

The counties of origin of the calls were as follows:

County	Population	Number of calls	Number of calls per 1000 people
Galway	148,340	3150	21.2
Mayo	115,547	2345	20.3
Roscommon	56,228	885	15.7
Total	320,115	6380	19.9

TABLE E

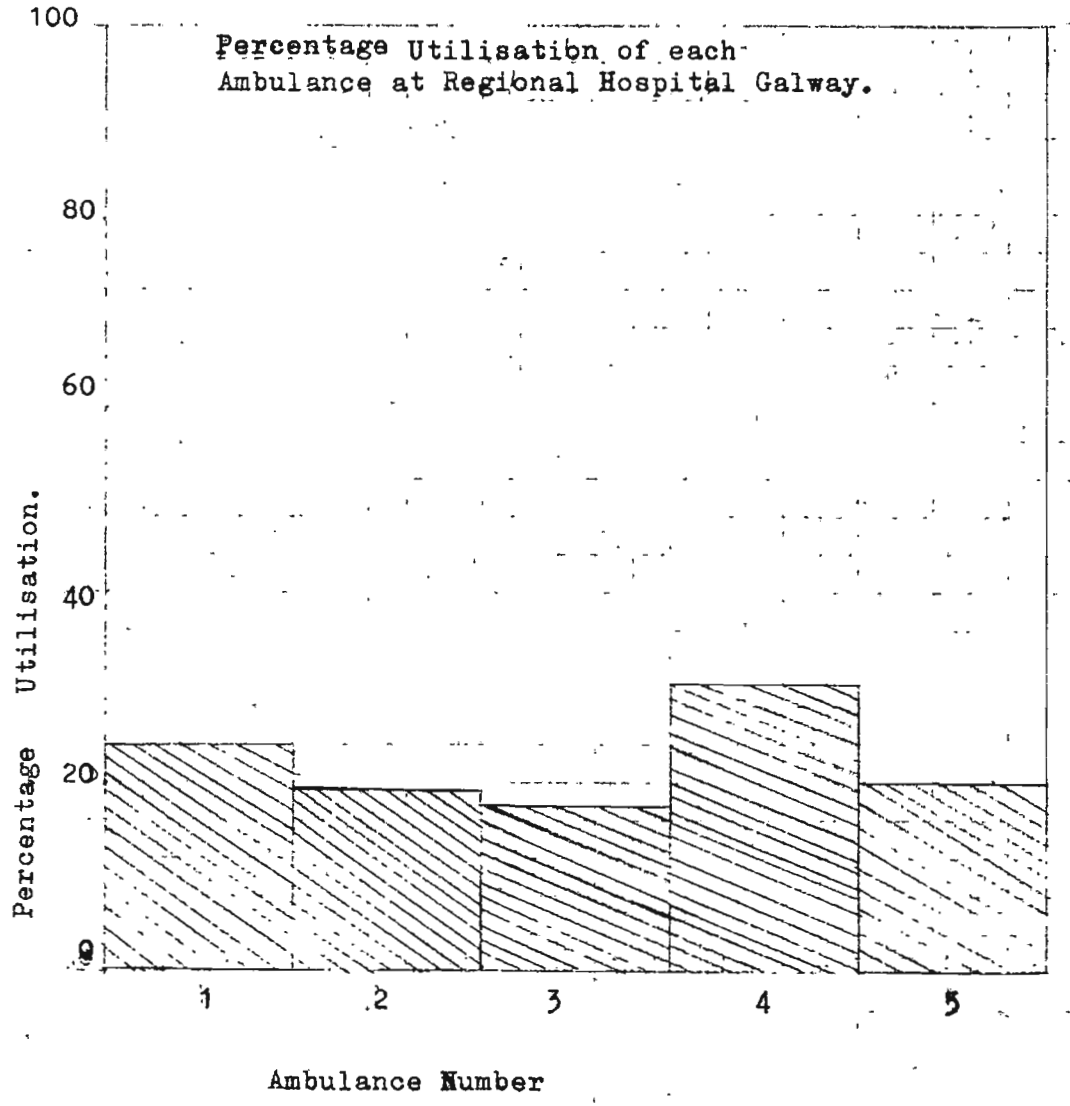

Percentage Utilisation of each Ambulance at Regional Hospital Galway.
100
80
60
40
20
0
Percentage Utilisation.
1
2
3
4
5
Ambulance Number

FIGURE 7

APPENDIX II

RESULTS OF EXPERIMENTS

Percentage of Emergency Cases reached within various time periods for different numbers of Ambulances

(Day-time)

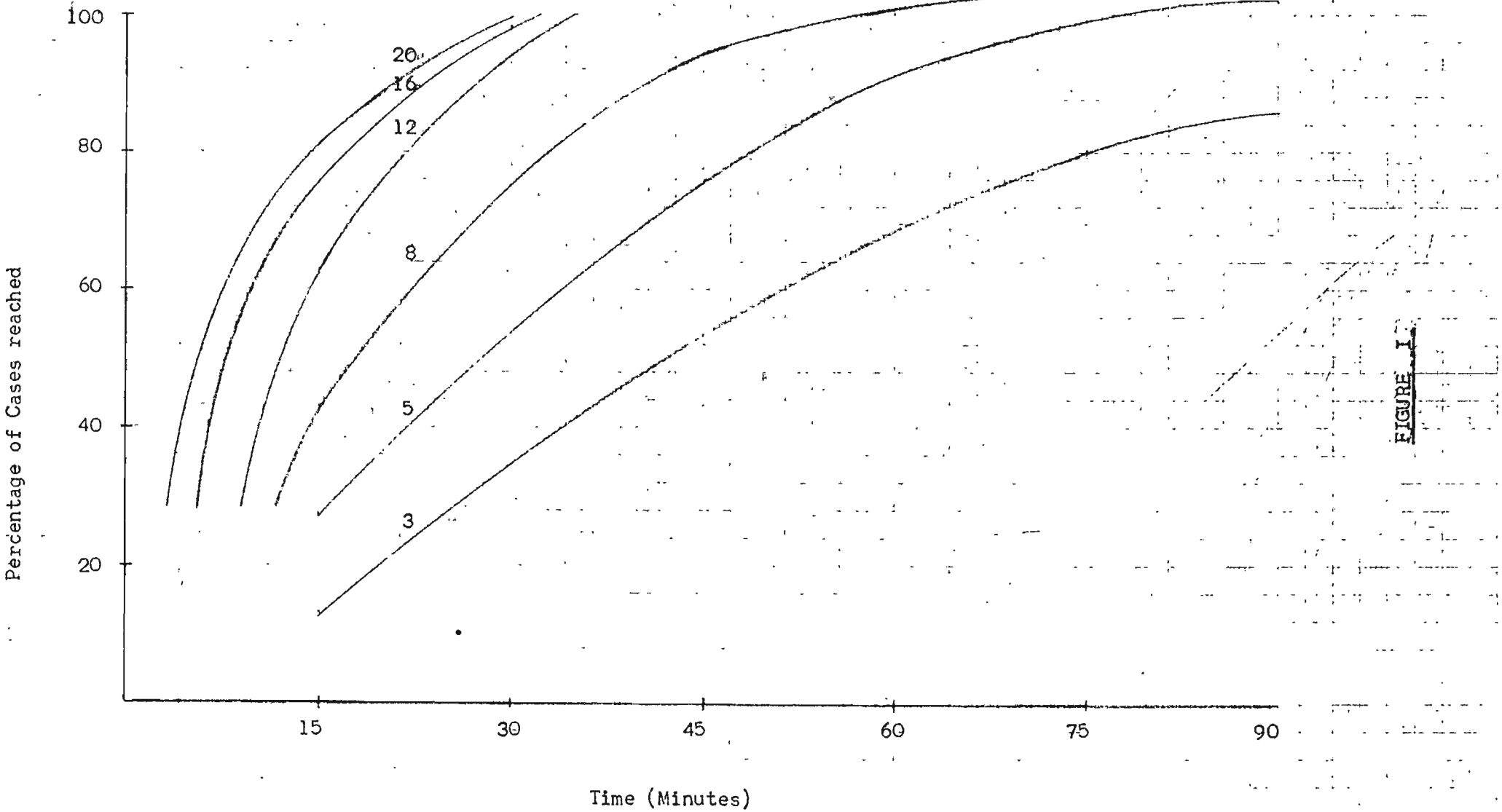


FIGURE I

Percentage of emergency cases reached within various time periods for different numbers of ambulances

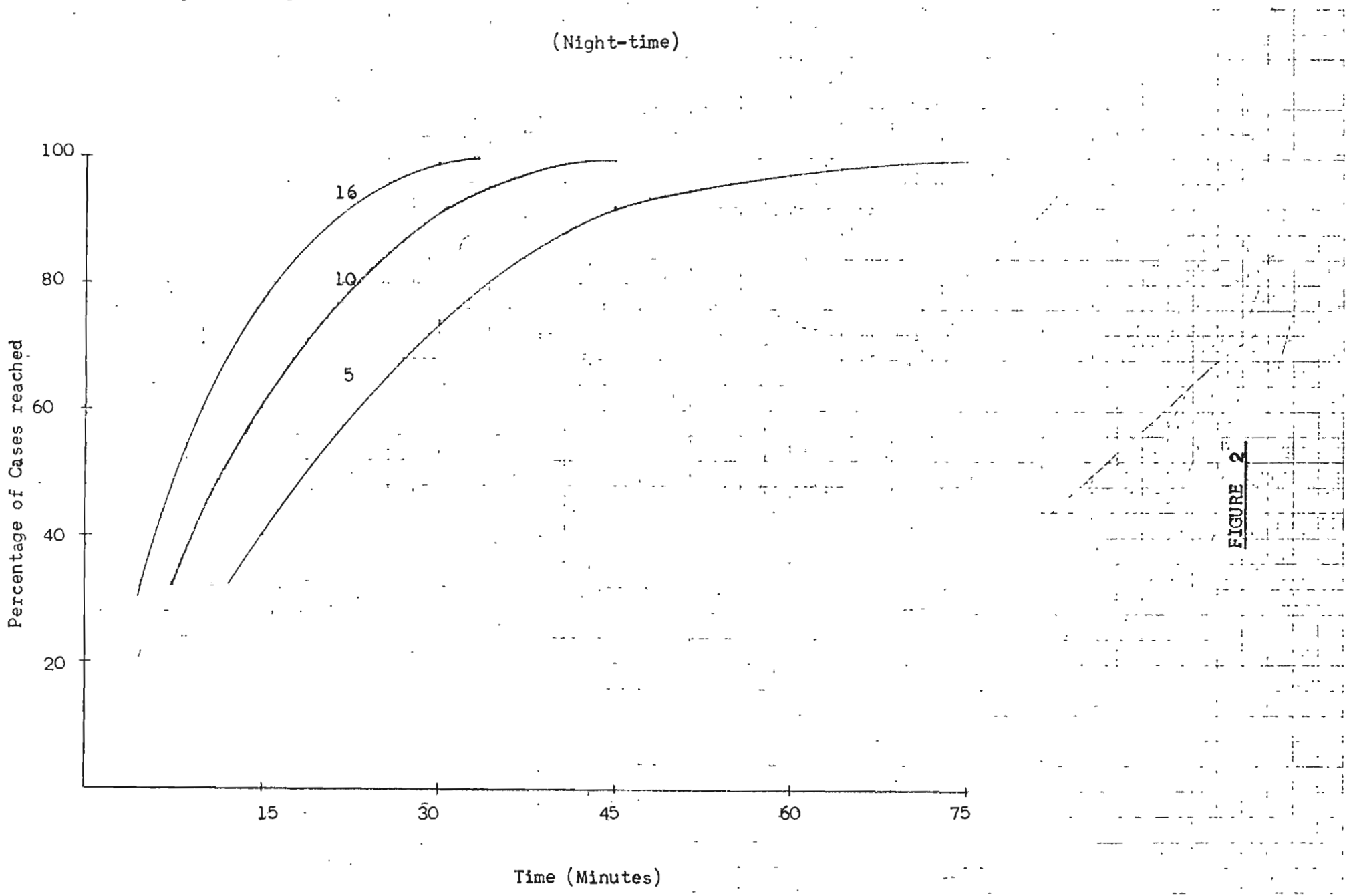


FIGURE 2

AVERAGE TIME TO REACH BOTH EMERGENCY AND NON-EMERGENCY PATIENTS

Number of ambulances	Average pick-up time (minutes)		
	Day-Time		Night-time
	Emergency	Non-emergency	Emergency
3	60	240	
5	36	43	25
6			23
7			22
8	24	30	20
10	20	23	17
12	17	19	14
14	15	16	
16	13	15	12
20	11	13	

TABLE A

Average time to reach an emergency case for different numbers of ambulances

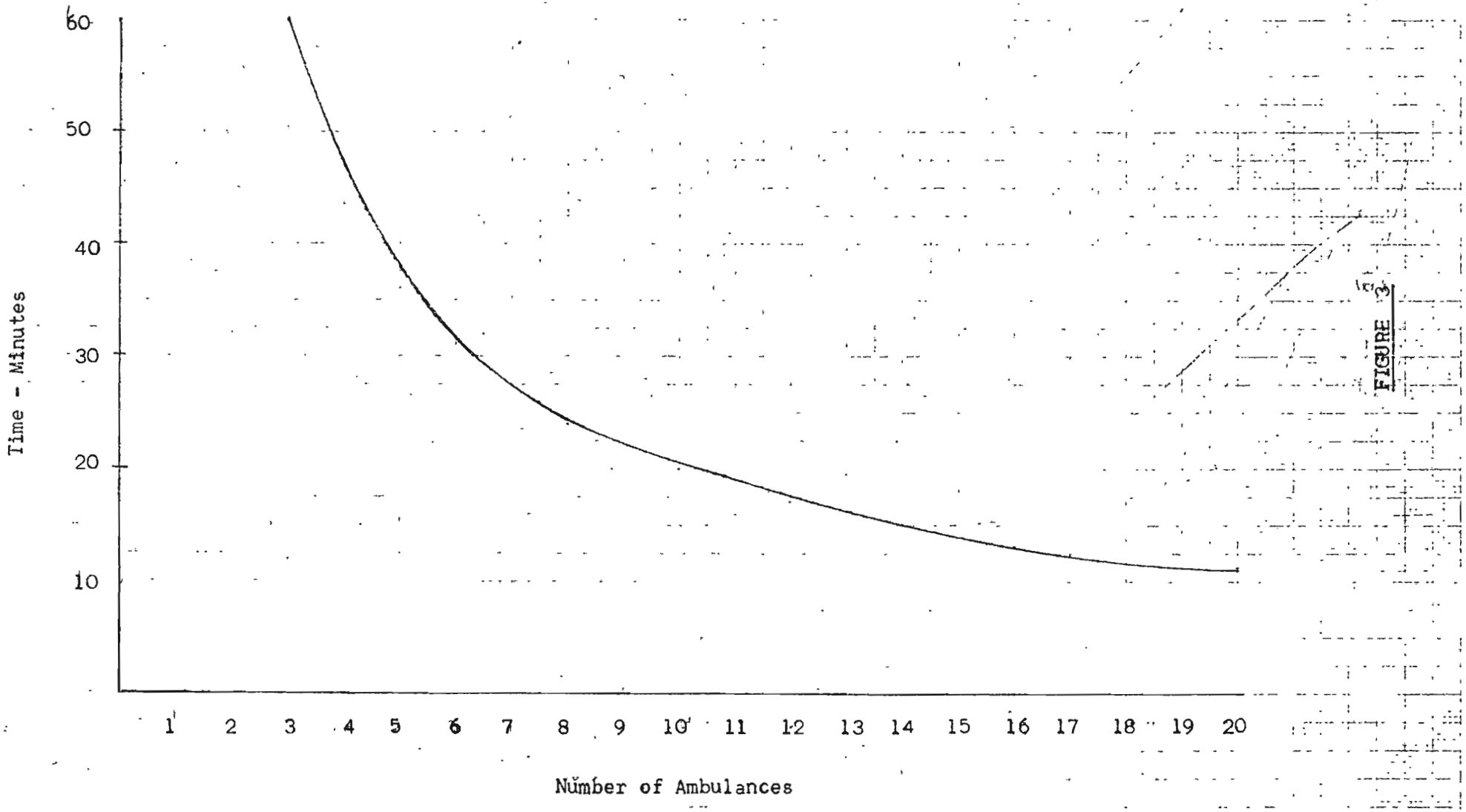


FIGURE 3

MAXIMUM WAITING-TIME FOR AN AMBULANCE

Number of Ambulances	Maximum waiting-time (minutes)		
	Day-time		Night-time
	Emergency	Non-emergency	Emergency
3	330	700	
5	180	400	165
6			
7			75
8	90	215	60
10	75	105	60
12	45	75	45
14	45	75	
16	45	60	45
20	45	45	

TABLE B

ANALYSIS OF THE NUMBER OF TIMES PATIENTS HAD TO QUEUE FOR SERVICE

DAY-TIME EMERGENCY CASES

Number of ambulances	Proportion of cases which had to queue	Proportion waiting for specified periods in queue (minutes)				
		< 16	16-30	31-45	46-60	60
3	17. 2%	4.6%	5. 2%	3. 7%	1. 8%	1. 9%
5	1.34%	0.29%	0.64%	0.29%	.62%	

TABLE C

For 8 ambulances or more no queues formed.

DAY-TIME NON-EMERGENCY CASES

Number of Ambulances	Proportion of cases which had to queue	Proportion waiting for specified periods in queue (minutes)						
		<16	16-30	31-45	46-60	61-90	91-120	120
3	7.2%	2.6	4.6	4.1	3.7	6.9	6.6	43.5
5	16.8%	2.4	3.7	2.9	2.4	2.3	1.2	1.9
8	4.4%	1.0	1.2	1.9	0.2	0.1		
10	1.8%	0.6	0.7	0.5				

TABLE D

For 12 ambulances or more, no queues formed.

No queues formed at night.

NON EMERGENCY AMBULANCE JOURNEYS DIVERTED TO SERVICE

EMERGENCY CALLS

Number of ambulances	Percentage of non-emergency journeys re-routed to emergency calls
3	22%
5	7.7%
8	3.0%
10	1.9%
12	1.4%
14	0.9%
16	0.66%
20	0.31%

TABLE B

The performance of sixteen ambulances operated for the whole area as one unit, compared with their performance if operated as three separate independent units one in each county. Seven ambulances were allocated to Co Galway, six to Co. Mayo and three to Co. Roscommon.

	Percentage of cases reached within each specified time period (minutes)				
	15	30	45	60	
One Unit	76%	98%	100%		
Three separate Units	66%	91%	98%	100%	

TABLE F

APPENDIX III

PROPOSED AMBULANCE BASES

SUGGESTED LOCATIONS FOR AMBULANCES

(Underlined locations denote new depots)

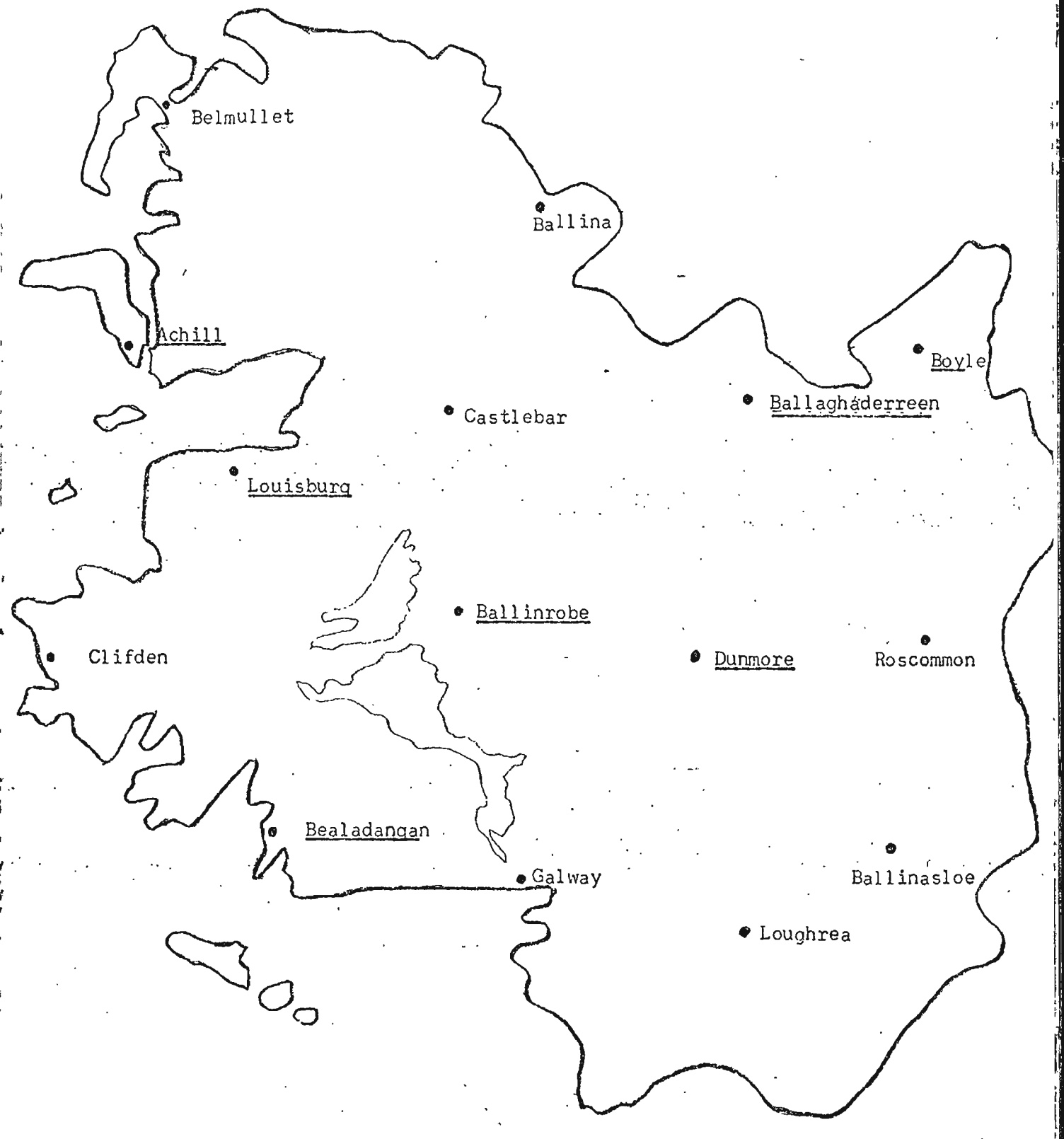


FIGURE 1

APPENDIX IV

NUMBER OF STAFF REQUIRED PER AMBULANCE

CALCULATION OF THE NUMBER OF STAFF REQUIRED PER AMBULANCE

1 ambulance staffed by 2 men for 12 hours per day requires

$$12 \times 2 \times 365 = 8760 \text{ man hours per year}$$

Each man works a $42\frac{1}{2}$ hour week, has 3 weeks annual leave, one week of public holidays and allow, on average, 1 week sick leave

$\therefore$ each man works on average $42.5 \times 47 = 1998$ hours per year.

$\therefore$ each ambulance requires $\frac{8760}{1998} = 4.4$, say 4.5 men per year.

Annual salary = £1252 (including allowances)

$\therefore$ staff costs per ambulance per year = £1252 X 4.5 = £5634.