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Susan Horton
Pierre Claquin

INTERNATIONAL CENTRE FOR
DIARRHOEAL DISEASE RESEARCH, BANGLADESH
Dacca, Bangladesh

May 1982

Working Paper No. 26

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Susan Horton[1]
Pierre Claquin[2]

INTERNATIONAL CENTRE FOR
DIARRHOEAL DISEASE RESEARCH, BANGLADESH
G.P.O. Box 128, Dacca 2
Bangladesh

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1 Research Associate

2 Field Coordinator

PREFACE

The International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) is an autonomous, international, philanthropic and non-profit centre for research, education and training as well as clinical service. The Centre is derived from the Cholera Research Laboratory (CRL). The activities of the institution are to undertake and promote study, research and dissemination of knowledge in diarrhoeal diseases and directly related subjects of nutrition and fertility with a view to develop improved methods of health care and for the prevention and control of diarrhoeal diseases and improvement of public health programmes with special relevance to developing countries. ICDDR,B issues annual report, working paper, scientific report, special publication, monograph, thesis and dissertation, and newsletter which demonstrate the type of research activity currently in progress at ICDDR,B. The views expressed in these papers are those of authors and do not necessarily represent views of International Centre for Diarrhoeal Disease Research, Bangladesh. They should not be quoted without the permission of the authors.

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ABSTRACT

In its Matlab rural research station the ICDDR,B services include a treatment centre for diarrhoeal diseases and a fleet of ambulances (speed boats). The study aimed to estimate economic resource cost of the services and to analyse their cost/effectiveness. Alternative forms of services are discussed.

Cost effectiveness and cost benefit techniques are widely used to help allocate economic resources. They are increasingly being used in health areas (1). Cost benefit studies are less frequently used for health, since they require a quantification of the monetary value of all benefits, a difficult task when considering saving life or alleviating suffering. Cost effectiveness studies use a different approach as they compare the costs of achieving a particular end and are therefore appropriate when comparing different health interventions with the same end.

The present study compares the cost effectiveness of three[1] services with the same end (treatment of diarrhoea and preventing diarrhoea related deaths) in a rural area of Bangladesh. Two criteria of effectiveness are used: the cost per patient treated, and the cost per patient of a given degree of dehydration treated. The degree of dehydration is taken as a proxy for severity of illness for watery diarrhoea. The study also uses existing estimates of the probability that a person with a given degree of dehydration will die if not treated. Thus, a third criterion can be used, i.e. cost per "death averted". The study also considers the question "who benefits" from different services. Information is provided on user characteristics such as age, sex and distance from hospital, so that cost effectiveness of treating a sub-group of particular interest, can be found.

In the past, effectiveness studies have been made twice at Matlab treatment centre (MTC) (2,3) where the present study took place. For 1969-70, Mosley *et al.*, (2) found that the treatment centre was effective when compared to an immunization programme against cholera. During the cholera outbreak in 1969-70, they estimated that the treatment centre treated 318 cases requiring treatment and averted 159 deaths, whereas a vaccine would have averted fewer than 143 of the hospital cases and hence correspondingly fewer deaths. The cholera vaccine could not have helped non-cholera diarrhoeas, whereas the treatment centre did. Mosley *et al.*, presented figures for total annual costs of a hospital and of a vaccine programme, which suggest that a hospital would be more cost effective. Their figures can be used to calculate a cost per patient of 44.6 takas and per death averted of 1,805.0 takas. This would be equal to about $14.91 and $603.48 in 1980 prices, using a World Bank price index (19).

For 1975, Oberle *et al.*, (3) calculated the cost effectiveness of the the same MTC. Cost per patient per day for hospitalization and ambulances was estimated at $11.00, which was equivalent to an expenditure of $0.14 per capita in the region served. This would be $13.83 and $0.18 in 1980

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1 Matlab treatment centre, ambulances to Matlab, Sotaki Community Treatment Centre.

prices. Cost per death averted was estimated as $38.00 to $81.00, or $48.00 to $102.00 at 1980 prices. This cost varied by age and etiology. The cost-effectiveness of an immunization programme was not explicitly calculated, but indicated to be higher.

The Oberle study (3) has been criticized for providing unrealistically low cost estimates. A figure of $11.00 for daily cost of services per patient was seen as conservative, and it was thought that items such as cost of expatriate supervision should be added. Details of the economic calculations were not included in the paper, but they were probably derived from financial records. These records may not measure actual costs very accurately, since the treatment centre exists as part of an organization with several activities such as research and field surveillance, and with activities in different geographic areas. Therefore, there is a problem in assigning certain joint costs, between different services. It is thought that the financial records somewhat understate hospital costs, by excluding some items such as cost of administration in Dacca, and the cost of expatriate supervision. The present study aims to estimate economic resource cost of services rather than the reported financial cost. In addition, an explicit cost effectiveness comparison is made with other services. The three services examined are Matlab treatment centre, the ambulances to Matlab, and a local centre staffed by paramedics at Sotaki.

BACKGROUND

Matlab thana is situated 40 miles southeast of Dacca, Bangladesh. Selected villages in the surrounding area have been under demographic surveillance since 1966, and cholera vaccine trials have been performed. Demographic and other characteristics of the area have been described in annual volumes, and periodic census information is obtained (4).

The Matlab Treatment Centre

The treatment centre is not referred to as a hospital, as patients without diarrhoea are supposed to use the government health facilities. The centre is located in Matlab bazar, and serves people from Matlab thana as well as more distant thana's and districts. About 65% of patients come from outside the demographic surveillance area, and about 40% from outside Matlab thana.

The treatment centre (TC) opened in 1963. Between September 1964 and January 1978, there was a separate outpatient department which aimed to use oral rehydration for less severely dehydrated patients (Table I). In 1979/80 the centre had five medical officers, a ward master, five nurses, and eight nursing and ward attendants, in addition to non-medical staff.

TABLE I--NUMBERS OF PATIENTS AT MATLAB TREATMENT CENTRE (MTC) 1963-79

	Admissions	Outpatients	Total
1963	(52)	-	(52)[1]
1964	804	(n/a)[2]	804
1965	887	1332	2219
1966[3]	956	1513	2469
1967	949	1873	2822
1968[4]	1960	2716	4676
1969	2223	3563	5786
1970	2893	3765	6658
1971	2331	1843	4174
1972	1391	2694	4085
1973	720	2776	3496
1974	4763	8882	13645
1975	4125	8388	12513
1976	3034	7365	10399
1977	6584	11266	17850
1978	13761	(924)[5]	14685
1979	11469	-	11469
July'79/June'80	10617	-	10617

( ) denotes not complete year

Notes: [1]Centre opens December 1, 1963

[2]OPD opens September 20, 1964

[3]Centre moved from barge to present building

[4]Ambulance system extended

[5]OPD closed January 30, 1973

Source: Matlab Admissions Books

It occupied a kutcha building and part of a pucca building. Daily admissions were on average 29. Patients stayed between 0 and 11 nights in the centre, on average 1.6 nights.

The TC had a small pathology laboratory with two staff, to perform stool, blood and other tests. In addition there was a microbiology lab with four staff who spent about 20% of their time doing routine samples on hospital patients, and the rest on more research-oriented work. The hospital building also shelters a family planning clinic and the offices of the other research activities like D.S.S., MCH-FP and special studies. A separate room in a different building shelters the productive of packets of oral rehydration salts (ORS) prepared for the hospital and field according to the WHO formula. The coexistance of services in one location, with joint use of personnel and equipment, was one difficulty in estimating costs. Treatment centre costs here include the centre itself and the pathology lab only.

For serious cases of diarrhoea with associated dehydration treatment initially starts with IV fluids. Most patients received some oral fluid. Additional medicines were used for associated complications or illnesses. At least, 50% of children had either worms, tonsillitis or respiratory problems in addition to diarrhoea.[1]

Part of the area under demographic surveillance has been involved in two research trials for homebased oral rehydration therapy in the treatment of diarrhoea. The effect of these on hospitalization has been, and is being, examined elsewhere (5,6).

Table I shows that use of the centre has increased over the years, perhaps due to increased knowledge of its activities, and improved facilities or more simply as a reflection of increased population. Certain years of especially high use, e.g. 1969, 1970, 1977 can be explained by cholera outbreaks. Outbreaks lead to increased numbers of actual cholera cases, but also to increased hospitalization of other cases due to fear of cholera. The very high continuing use since the 1974 famine is difficult to explain as major cholera epidemics occurred only in 1977/8.

Ambulance and Referral System

There are five ambulances for the treatment centre. Four are 35 hp speedboats posted at distances of 30 to 70 minutes from the treatment centre, and one jeep 9 miles away. A fifth ambulance boat at Sotaki, 90 minutes away, was withdrawn on November 30, 1979. The transport is used mainly but not exclusively for ambulance work. Patients go to the ambulance stations and request transport. There have been attempts to institute a referral system via the community workers, but the system is not fully operational as yet. Either one or two patients will come at a

1 MTC physicians' personnel communication.

patients had to come greater distances than the average hospital patient. Eighty percent come from outside the demographic surveillance area, and 60% from outside Matlab thana. There is no charge to patients using the Matlab treatment centre and ambulances.

The closure of the fifth ambulance boat, led to community efforts to obtain an alternative service for the treatment of diarrhoea: a treatment centre was opened in an ICDDR,B building at community initiative. The ICDDR,B supplied free of charge hospital and office supplies, and trained four volunteers to give oral and IV fluids, and certain drugs. A patient fee of 15 taka per course of treatment was used to cover local expenses including wages of the volunteers. A local committee administered the centre, took charge of financial management and reported monthly to the Matlab centre, giving information as to numbers of patients and stock of drugs, and making supply requests. At the Sotaki centre, an admissions book and treatment records were maintained.

MATERIAL AND METHODS

Cost information for Matlab treatment centre and ambulances has obtained from financial, supply, worker time use records, and equipment use logs. Where possible, costs were estimated directly from quantity records and price records, rather than financial amounts. This was partly to help allocate costs joint between the T.C. and other services. Cost figures are presented in two ways here. Firstly, they are presented by operationally useful categories such as wages, rent, etc., and secondly according to economic concepts of short and long run average, and average variable costs. These economic terms are explained in Appendix A.

Cost information from Sotaki T.C. was obtained from supply requisitions sent from Sotaki to Matlab, from estimates of local income, and from an imputed cost of the training provided. Methods are detailed in Appendix A.

In studying costs, private costs to patients are not included. These include items such as cost of transport to hospital if not by ambulance, cost of food for attendants and for patients where applicable, and opportunity cost of time of both patients and attendants spent travelling to and from, and remaining at, the hospital. It will be argued later that these costs, though possibly small in relation to the reported costs of services, are nevertheless large enough to provide a deterrent to some individuals to use of a service. The private costs differ somewhat between the services. For instance, at Matlab patients and nursing mother attendants receive free food, whereas at Sotaki they do not.

Effectiveness of a service was judged by the numbers of patients, and by the numbers within subcategories of interest, namely dehydration status, age and sex groups, and distance from centre. An estimate was also made of deaths averted. The study attempted to obtain comparable information for each of the three services, and wherever possible for the complete financial year July 1979 to June 1980, to avoid the seasonal effects of the incidence of diarrhoeal diseases on hospitalization.

For Matlab treatment centre, information on age, sex, duration of stay and means of transport was obtained from the admissions register. Information on symptoms, on treatment whilst in hospital, and on fluid intake, came from therapy sheets. Information on hospitalization rates by distance was obtained from a subsample of villages in the demographic surveillance area, for which recent population figures and distance figures were obtainable. This latter information was obtained from data coded for the ongoing oral therapy study (6) and comprises about 20% of hospital admissions.

Information about ambulance users was obtained from the Matlab admission register from October 1979 to January 1980. Prior to mid September 1979, the method of transport to the treatment centre had not been recorded.

Information on Sotaki T.C. users was obtained from Sotaki admissions register. In addition, a study of patients from villages identified as "switching" use from Matlab to Sotaki was made. This involved examining the Matlab T.C. admissions book for two years, one before and one after Sotaki's opening, from December 1978 - November 1980. A more detailed study was made using Matlab T.C. records December 1978 - May 1979, and December 1979 - May 1980, for selected patients. The study of "switch" in use is detailed in Appendix B.

Dehydration status was used as a measure of the severity of illness. This is appropriate for watery diarrhoeas but not for dysentery. As it is a rather subjective criterion, in this study number of nights spent in hospital is sometimes used as an alternative indicator. Clinical measures of dehydration such as weight gain in hospital, were not made available.

RESULTS

Costs

The economic terms, underlined the first time they appear, are defined in Appendix A. Tables II and III derive from financial records 1975/6-1979/80. Table II suggests that the real (i.e. deflated by a price index) costs of treatment per patient, fluctuate quite widely between years, with a tendency for lower costs per patient when there are more patients. This

TABLE II--COSTS OF MATLAB HEALTH SERVICES AND ADMINISTRATION FROM FINANCIAL REPORTS, 1976-77 TO 1979-80 (ANNUAL COST IN US $)

	1976-77	1977-78	1978-79	1979-80
Health services, current prices	113,674	132,723	124,704	156,938
Administration, current prices	20,243	61,066	80,080	51,042
Health services, 1979-80 prices	157,561	163,214	140,112	156,938
Health services plus Administration, 1979-80 prices	185,619	238,309	230,086	207,980
Number of patients, MTC for financial year	11,800	18,264	13,510	10,617
Cost per patient, 1979-80 prices				
- health services only	13.35	8.94	10.37	14.78
- health services plus administration	15.73	13.05	17.03	19.59

Note: Source: ICDDR,B financial records. Health services comprises hospital and ambulances. Total cost differs from cost estimates presented elsewhere here, since these are financial costs and elsewhere estimated resource costs are presented. Where financial year was not July-June, data was adjusted to July-June assuming financial costs were equal for each quarter of reported year. Price deflator used is World Bank Index for wholesale prices of agricultural and industrial products (19), to convert from current prices to 1979-80 prices.

TABLE III--SHARES OF SELECTED COMPONENTS IN MATLAB HEALTH SERVICES COSTS 1976-77 TO 1979-80 SHARES EXPRESSED AS COLUMN PERCENTAGES

	Financial Year			
Cost category	1976-77	1977-78	1978-79	1979-80
Wages				
- staff (including overtime)	26.30	28.73	34.21	49.40
- casual	1.25	1.71	1.81	0.86
Rent	0.11	0.06	0.02	0.34
Supplies				
- drugs & chemicals	23.34	16.57	10.99	8.16
- glassware & lab	1.08	0.50	0.60	0.46
- hospital	6.08	6.44	6.10	6.99
- office	4.85	1.48	0.35	0.40
- gasoline, lubricant	26.67	30.82	30.76	18.46
- food for patients	7.05	10.54	11.77	10.86
Equipment	0.11	0.92	0.78	0.34
TOTAL (%)	100.00	100.00	100.00	100.00

Source: ICDDR,B financial records. Where financial year was not July-June, conversion to July-June financial year, assumed constant cost per month within reported financial year.

might be expected since costs depending directly on the numbers of patients form only about a quarter of short run costs. When the number of patients increases, use of drugs and food increases, but the hospital is unlikely to rent more space or hire more doctors. This costs increase in smaller proportion than number of patients. This needs not mean that it is really cheaper to treat a patient. Due to pressure on space and doctors, patients may stay a shorter time in hospital, or receive less attention, hence a different kind of service is being given to patients.

Table III presents the shares of selected items in total costs. A similar tendency is observed, for user dependent costs (drugs, food, gasoline) to form a higher proportion of costs in years with more patients, and user independent costs (wages, excluding casual labour) to form a lower proportion. Other fluctuations may be attributable to differential rates of inflation.

Tables IV-VI compare the economic resource costs of the three services, as estimated in Appendix A. Table IV presents costs of the three services by economic concepts. Table V presents costs of the three services by operational categories. Cost levels differ. Comparing long run average costs it takes $3.36 to treat a patient at Sotaki, against between $15.65 and $16.77 (depending on assumptions) at Matlab, with an additional $12.85 per patient who comes by ambulance. The cost structures of the three services also differ. The Matlab centre has high short run, user independent costs (wages, rent), and therefore short run average cost is high relative to other costs. Sotaki's costs are predominantly user dependent (drugs, supplies) and short run average variable cost is high relative to other costs. The ambulances have both high user dependent costs (gasoline) and long run costs (equipment) hence both high short run average variable costs and long run average costs.

Using a shadow exchange rate (Table VI) does not affect relative rankings of the costs of services, but points out that a maximum variant estimate of the cost to the Bangladesh economy of treating a patient who comes by ambulance to Matlab, (25 - 33 US $) is 494 takas. Tables VII to IX give more detailed costs of each service. Tables IV to VI were derived from these tables.

The different economic cost concepts are presented, in order to allow the information to be used for different purposes. Suppose one wanted to consider the policy option of replacing the use of Matlab T.C. for some patients, and opening a new subcentre for them. One would then compare the long run average variable cost savings at Matlab and on the ambulances, with the long run average cost of opening a new centre. Alternatively, in making an economy-wide health plan and deciding whether to invest in new resources, one would compare long run average cost of the alternatives. In making a decision whether to replace a worn out ambulance boat or instead to

TABLE IV--ESTIMATED RESOURCE COSTS BY ECONOMIC CATEGORIES (IN US $), MATLAB TREATMENT CENTRE, AMBUALANCES, AND SOTAKI (FY 1979-80)

	Matlab V1	Matlab V5	Ambulances	Sotaki
Wages	79,509	84,009	8,896	891
Supplies	75,129	75,129	34,768	1,673
Maintenance	151	151	3,646	-
Rent	1,600	3,840	172	200
Administration	8,869	8,869	2,504	-
Equipment	922	922	6,217	302
Training	-	-	-	380
Microbiology lab	-	2,117	-	-
User numbers	10,618	10,618	4,359	891

Note: See Appendix A for derivation.

TABLE V--ESTIMATED RESOURCE COSTS (IN US $) BY OPERATIONAL CATEGORIES, MATLAB T.C., AMBULANCE AND SOTAKI (FY 1979-80)

	Matlab						
	V1	V2	V3	V4	V5	Ambulance	Sotaki
Short run average variable cost	3.91	3.91	3.91	3.91	3.91	7.98	1.83
Short run average cost	15.56	15.77	16.27	15.76	16.68	11.47	3.10
Long run average cost	15.65	15,86	16.36	15.85	17.77	12.89	3.36

Note: See Appendix A for cost derivations and explanations. FY 1979-80 is July-June ICDDR,B and December-November for Sotaki.

For Matlab, several variants are presented

V1 minimum estimate: no microbiology lab, excluding expatriate salary, replacing existing pucca building with rented kutcha one.

V2 minimum estimate, but with existing building.

V3 minimum estimate, but with expatriate salary included.

V4 minimum estimate, but with microbiology costs.

V5 maximum variant (minimum, plus expatriate, plus microbiology, plus pucca building).

TABLE VI--EFFECT OF SHADOW EXCHANGE RATE ON COSTS

	Costs at $ 1 = Tk.15 (in takas)			
	M.T.C. minimum variant V1	M.T.C. maximum variant V5	Ambulance	Sotaki
Short run average variable cost	58.65	58.65	119.70	27.45
Short run average cost	233.46	250.20	172.01	46.50
Long run average cost	234.75	251.55	193.35	50.40

	Costs at $ 1 = Tk.20 (in takas)			
	M.T.C. minimum variant V1	M.T.C. maximum variant V5	Ambulance	Sotaki
Short run average variable cost	70.37	70.37	159.52	32.80
Short run average cost	245.13	260.80	211.89	51.91
Long run average cost	246.85	266.20	228.61	55.83

Note: See Appendix A for derivation.

TABLE VII--RESOURCE COSTS, MATLAB TREATMENT CENTRE, FY 1979-80

	Paid in Taka	Paid in US $	Total[1]
Wages	1,192,636	(7,500)[2]	79,509
Supplies	n/a	n/a	75,129
Maintenance	n/a	n/a	151
Rent	24,000	-	1,600
	(57,600)[3]	-	-
Administration	133,040	-	8,869
Equipment	n/a	n/a	922
Microbiology lab	(149,409)[4]	-	-

	Costs of variants, in $				
	1	2	3	4	5
Total, user-variable costs	41,547	41,547	41,547	41,547	41,547
Total, short run costs	165,258	167,498	172,758	167,376	177,116
Total, long run costs	166,181	168,421	173,681	168,298	178,038
Short run average variable cost[5]	3.91	3.91	3.91	3.91	3.91
Short run average cost	15.56	15.77	16.27	15.76	16.68
Long run average cost	15.65	15.86	16.36	15.85	16.77

User numbers = 10,618

Notes: 1 excludes bracketed items
2 added in variants 3 and 5
3 replaces lower figure in variants 2 and 5
4 added in variants 4 and 5
5 additional costs in variants are assumed to be user, independent, and affect only average costs, not average variable costs

TABLE VIII--RESOURCE COSTS, AMBULANCE SERVICE, FY 1979-80

	Paid in		
	Taka	US $	Total
Wages	133,443	-	8,896
Supplies	-	34,768	34,768
Maintenance	54,687	-	3,646
Rent	2,580	-	172
Administration	37,566	-	2,504
Equipment	-	6,217	6,217
Total, user variable costs	-	34,768	34,768
Total, short run costs	198,376	34,768	49,987
Total, long run costs	198,276	40,985	56,204

Short run average variable cost	$ 7.98
Short run average cost	11.47
Long run average cost	12.89

	Car	Boat	Both
Number of users	891	3,468	4,359
Number of trips	547	2,749	3,296
Cost gas per user (SRAVC)	$ 2.47	$ 9.39	$ 7.98
Cost gas per trip (SRAVC)	$ 4.02	$ 11.85	$ 10.55

TABLE IX--RESOURCE COSTS, SOTAKI TREATMENT CENTRE, DECEMBER 1979-NOVEMBER 80

	Paid in Taka	Paid in US $	Total ($)
Wages	13,365.00	-	891.00
Supplies	10,721.01	958.27	1,673.00
Rent and maintenance	3,000.00	-	200.00
Administration	-	-	-
Equipment	3,841.65	46.12	302.23
Training	5,706.42	-	380.43
Total, user-variable costs	10,265.58	947.84	1,632.21
Total, short run costs	27,086.00	958.27	2,764.00
Total, long run costs	30,268.69	973.64	2,991.55
Short run average variable cost	-	-	$ 1.83
Short run average cost	-	-	$ 3.10
Long run average cost	-	-	$ 3.36

User numbers = 891

contribute to a local centre, the decision would be based on long run average cost of the centre, and long run average cost of ambulance, plus long run average variable cost at Matlab. The logic is, that if fixed outlays are being made, one must consider long run average costs. If the fixed outlay has been made, one should use long run average variable costs. If the time horizon were very short, say one year, one would use short run costs.

Effects and Cost-effectiveness

Tables XI and XII provide information on the total numbers of users of the three services, and on the total numbers with a given degree of dehydration. From these, Table X was derived. The simplest measure of cost-effectiveness, is long run average cost per patient treated. A further calculation is made of cost per user with severe dehydration, and using Chen's (7) assumption that 50% of these patients would have died, cost per "death averted" is calculated. The latter estimate should be treated with caution and deserved comments. It seems that at Sotaki and at Matlab dehydration categories are noncomparable, and at Sotaki the relative numbers of severe cases is overstated, giving a comparatively low figure for cost per death averted at Sotaki. The 50% criterion is arbitrary (although probably not far from reality), since there is an ethical problem in obtaining information as to the probability of a severely dehydrated patient dying if untreated. Oberle (3) uses a more precise criterion based on clinical information on fluid loss and weight gain in hospital. This might improve information on likely numbers of deaths averted, but his criterion remains rather arbitrary. The informatio necessary for a calculation similar to Oberle's was not available for the present study. The level of costs for deaths averted is quite high when analysed in the context of the Bangladesh health budget. At Sotaki, the cost of a "death averted" is $187.19. At Matlab it is $1,262.10 to $1,352.40 plus an additional $357.10 if the patient came by ambulance.

Detailed Study of Effectiveness

When providing a heavily subsidized service, a question frequently considered is not only how many people benefit, but who benefits. There is usually some target population, for a service which presumably for a treatment centre would be the most sick patients. It is of interest to see how many of the target population are reached, as compared to how many non-target beneficiaries. The more non-target users there are, the higher is the cost per target user. There is also an equity issue, in that treating a patient who comes by speedboat is equivalent to a 491 takas income transfer (maximum estimate), and it is of interest to see whether there are biases.

TABLE X--SUMMARY COST-EFFECTIVENESS FIGURES, IN US $

	Matlab TC V1	Matlab TC V5	Ambulance	Sotaki
Long run average cost per patient	15.65	16.77	12.89	3.36
Long run average cost per severe patient[1]	631.04	676.21	178.53	93.59
Long run average cost per "death averted"[2]	1262.10	1352.40	357.06	187.19

Note: 1 Patients for whom severe dehydration was recorded on admission

2 It is assumed 50% of severely dehydrated patients would have died in absence of treatment, following Chen (7)

TABLE XI--AGE-SEX COMPOSITION, AND TOTAL NUMBERS OF USERS OF THREE SERVICES, JULY 1979-JUNE 1980

	Age categories, Years										All Male	All Female	Total
	Male					Female							
	0-4	5-14	15-44	45-59	60 +	0-4	5-14	15-44	45-59	60 +			
Census Area[1] Population	14075	23379	36121	11032	3558	13362	21825	38680	9980	2934	88165	86781	174946
Matlab TC, Total[2]	3424	1115	1115	398	186	1885	292	1593	265	106	6238	4114	10618
Speedboat, Total[3]	1425	503	342	113	73	746	342	645	82	37	2481	1877	4339
Sotaki, Total[4]	346	76	76	44	19	163	32	110	24	1	560	330	891
Matlab TC, Census[5] Sub-sample	731	186	223	91	39	454	137	295	83	16	1270	985	2255
				Row Percentages									
Census Area Population	8.04	13.26	20.65	6.31	2.03	7.64	12.47	22.11	5.70	1.67	50.39	49.60	100
Matlab TC, Total	32.25	10.50	10.50	3.75	1.75	17.75	2.75	15.00	2.50	1.00	58.75	38.75	100
Speedboat, Total	32.68	11.54	7.84	2.59	1.69	17.12	7.85	14.79	1.88	0.84	56.93	43.06	100
Sotaki, Total	38.20	8.54	8.54	4.83	2.13	18.31	3.60	12.36	2.70	0.11	62.92	37.08	100
Matlab TC, Census Sub-sample	32.40	8.25	9.80	4.04	1.73	20.13	6.07	13.08	3.68	0.71	56.32	43.68	100

Notes: 1 Census area is under demographic surveillance
2 Age-sex composition obtained from sample of 400 records, 100 per month (October 1979 - January 1980)
3 Obtained from sampling all patients coming by ambulance for 4 months (October 1979 - January 1980 x 3)
4 Year December 1979 - November 1980 (Sotaki opens December 1, 1979)
5 Census sub-sample area represents 75% of Census area

TABLE XII--PERCENTAGES OF USERS BY DEHYDRATION STATUS (ROW PERCENTAGES)

	Dehydration level						Average dehydration level
	0	1	2	3	4	N	
Matlab TC[1]	19.42	50.91	21.33	5.85	2.48	2255	1.21
Sotaki[2]	-	11.00	55.22	30.19	3.59	891	2.26
	Matlab users, by method of transport						
Speedboat	13.0	38.4	32.6	9.4	6.5	138	1.58
Car/jeep	17.8	39.3	25.0	7.1	10.7	15	1.54
Countryboat	18.6	50.0	25.5	5.9	0.0	102	1.19
Rickshaw	27.3	37.9	22.7	9.1	3.0	66	1.44
Foot	12.5	60.0	17.5	7.5	2.5	40	1.28
Launch	25.0	75.0	0.0	0.0	0.0	4	0.75
Babytaxi	0.0	31.8	10.7	10.7	7.1	15	1.36
Don't know	42.9	28.6	28.6	0.0	0.0	7	0.86

Matlab users, dehydration status compared to "representation ratio"

	Age, years											
	Male						Female					
	0-2	3-4	5-14	15-44	45-64	65+	0-2	3-4	5-14	15-44	45-64	65+
Average dehydration	0.88	1.02	1.47	1.40	1.59	1.44	0.95	1.19	1.62	1.68	1.72	1.39
"Representation ratio"[3]		4.03	0.62	0.48	0.64	0.85		2.64	0.49	0.59	0.65	0.43

1 All patients from census subsample.

2 The classification systems for dehydration on admission differ in Matlab and Sotaki. In the latter there is no category for zero dehydration. Thus category 0 in Matlab may be comparable to category 1 in Sotaki, and 3 and 4 in Matlab to 4 in Sotaki. Categories are 0-none (Matlab only), 1-mild, 2-moderate, 3-moderate-severe, 4-severe.

3 "Representation ratio" is derived by dividing percentage share of a particular age and sex group of Matlab TC admissions, by it, percentage share of population, from Table II.

Source: Matlab: 400 sample patients October 1979 - January 1980, 100 per month.

Sotaki: admissions book.

Tables XI-XVI provide more details as to who uses the services. From Table XI, it is seen that children less than 5 form a higher proportion of treatment centre users than of the population, and males more than females. Expressing the relative percentages as a "representation ratio" in Table XII, shows that males are over represented relative women in all age groups except 15-44, and at 45-64 where the ratios are almost equal. The most under-represented age groups are males 15-44, and females 5-14. Table XI also shows that males (except those 15-44), and especially those less than five, form an even higher proportion of hospital cases at Sotaki T.C. than at Matlab T.C.

Table XIII shows the effect of distance on hospitalization rates, which, for Matlab decline from 31.7 users per year per thousand population at distances less than a mile, to 7.34 at distances of 8 or more miles. Usage similarly decreases when expressed as hours of travel, for both Matlab and Sotaki. Use rates for Matlab are higher than for Sotaki at a given distance from the appropriate treatment centre. The table shows that even if one subtracts out all ambulance patients however, the rates remain higher for Matlab. This suggests the fee at Sotaki may deter some patients, and particularly those closest to the T.C. Another explanation might be the local community's perception of the quality and appropriateness of the care given there.

Table XIV presents the relative degree of dehydration of the service users. The noncomparability of classification systems at Sotaki and Matlab makes it seem as if Sotaki patients are more seriously dehydrated. If Sotaki users are compared to users at Matlab at a degree of dehydration one step less severe, however, the patterns are very similar. The table also shows as might be expected, that ambulances (speedboat and car) bring a larger proportion of seriously dehydrated patients than other means of transport. Baby-taxis and rickshaws which are quicker methods of land travel than walking, but more expensive, bring relatively more dehydrated patients than come on foot.

Table XIV also compares dehydration levels by age and sex, with the "representation ratio" calculated in Table XII. The higher dehydration level for females is associated with overall lower representation in hospital admissions, and the lower dehydration level for children under 5 especially males, with higher representation in hospital admissions.

Tables XIV-XVI crosstabulate the three variables (age-sex, distance, and dehydration) presented in Tables XI-XIII, for Matlab only. Table XIV presents the percentages of total patients of different age groups, who come from different distances. The main shift in age composition observed as distance travelled increases, is an increase in the proportion of males age 0-2, from 45.1% at less than 5 miles from Matlab, to 55.4% at 5 or more miles. Table XV shows that the ratio of males to females increases as

TABLE XIII--NUMBERS OF USERS, OF MATLAB TREATMENT CENTRE, BY DISTANCE TRAVELLED AND MODE OF TRANSPORT. NUMBER OF USERS OF SOTAKI TREATMENT CENTRE, BY DISTANCE TRAVELLED

Rate per .000 population in same distance category

	distance, miles								
	0	1	2	3	4	5	6	7	8+
MTC	31.70	29.60	19.26	17.39	17.73	16.10	17.31	8.14	7.34

% of those coming from given distance, by transport method (column %)

Ambulance	2.7	2.2	8.1	9.4	20.6	63.5	43.0	65.8	72.9
Countryboat	17.4	45.3	32.7	44.4	71.0	32.9	36.4	17.7	12.8
Foot	34.2	8.8	31.7	0.4	2.3	1.8	8.3	2.5	0.0
Rickshaw	43.6	41.2	24.7	42.2	3.8	6.5	12.8	6.3	2.3
Other/ don't know	2.0	2.2	2.9	2.9	2.3	1.8	6.6	7.6	12.8
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Rate per .000 population, in same hours category[1]

	hours travelled to treatment centre					
	0-.5	.6-1	1.1-1.5	1.6-2	2.1-2.5	2.6-3
Matlab TC	31.9	20.4	17.0	16.5	14.8	8.3
Matlab TC excluding ambulance	31.6	19.0	14.8	9.0	8.0	2.4
Sotaki	14.8	16.2	14.5	5.3	2.7	6.8

% of Matlab users coming by ambulance, by distance from ambulance station

	Miles from ambulance						
	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.6	3.6-4.0
Percentage of users coming by ambulance	75.7	48.9[2]	70.6	65.3	30.5	77.2	47.6

[1] Information is obtained from different sources, therefore results should be interpreted with caution. Hours to Matlab was calculated from water distance or land distance where no water distance available (field worker estimates) assuming (a speed of travel of) 3 miles per hour. Hours to Sotaki obtained from paramedic's estimates. Only villages with 2 or more patients were included for Sotaki, thereby biasing rates per .000 population upward slightly. Figures for Matlab represent census subsample area.

[2] Excludes one village sufficiently close to Matlab so as to not use ambulance available.

TABLE XIV--CROSSTABULATION OF DISTANCE TRAVELLED AND PERCENTAGE AGE COMPOSITION OF USERS, MALE AND FEMALE SEPARATELY, MATLAB TREATMENT CENTRE

(Row percentages)

	Age, years													
	Male							Female						
Miles	0-2	3-4	5-14	15-44	45-64	65 +	Total	0-2	3-4	5-14	15-44	45-64	65 +	Total
0	38.6	10.2	25.0	17.0	6.8	2.2	100	35.6	5.5	19.2	28.7	8.2	2.7	100
1	40.9	9.3	14.5	22.3	6.2	6.7	100	41.7	6.0	8.3	33.3	8.3	2.4	100
2	43.8	9.3	19.5	16.8	8.0	2.7	100	38.7	6.0	19.0	26.6	8.0	1.5	100
3	57.8	8.3	8.9	11.9	6.7	2.7	100	50.8	5.3	7.6	27.2	8.3	0.8	100
4.	40.0	5.0	12.0	31.0	10.0	2.0	100	34.4	6.6	9.8	32.8	14.8	1.6	100
5	54.0	7.4	11.1	21.1	4.8	1.6	100	40.8	7.7	11.5	31.5	7.7	0.8	100
6	51.9	5.9	14.6	17.8	7.0	2.7	100	40.8	5.2	11.3	33.9	7.0	1.7	100
7	70.5	2.3	4.5	6.8	9.1	4.5	100	30.3	3.0	27.2	21.2	15.2	3.0	100
8+	61.0	8.5	10.2	10.2	8.5	1.7	100	23.7	4.1	18.8	38.8	10.2	0.0	100
Summary														
0-4	45.1	8.6	15.5	19.5	7.6	3.7	100	41.2	5.8	13.0	29.4	8.8	1.7	100
5+	55.4	6.5	11.7	17.2	6.5	2.7	100	38.0	5.8	14.1	32.4	8.6	1.2	100

Area: Census subsample.

TABLE XV--CROSSTABULATION OF DISTANCE TO THE TC AND RATIO MALE/ FEMALE USERS, BY AGE GROUP, MATLAB TREATMENT CENTRE

	Ratio male/female within age group					
Miles	0-2	3-4	5-14	15-44	45 +	All ages
0	1.308	2.250	1.571	0.714	1.000	1.205
1	1.129	1.800	2.000	0.768	1.389	1.149
2	1.286	1.750	1.158	0.717	1.263	1.136
3	1.552	2.142	1.600	0.750	1.500	1.364
4	1.904	1.250	2.000	1.550	1.200	1.639
5	1.925	1.400	1.400	0.976	1.091	1.454
6	2.043	1.833	2.077	0.846	1.800	1.609
7	3.100	1.000	0.222	0.429	1.000	1.333
8	2.571	2.500	0.667	0.316	1.200	1.204
Summary						
0-4	1.364	1.838	1.488	0.828	1.071	1.246
5+	2.298	1.632	1.217	0.773	1.107	1.462

Source: Census subsample.

TABLE XVI--CROSSTABULATION OF DEHYDRATION AND DISTANCE TRAVELLED TO MATLAB T.C.

	Distance, miles								
	0	1	2	3	4	5	6	7	8
Average dehydration level	1.106	1.011	1.164	1.142	1.367	1.268	1.175	1.316	1.780

Row percentages, of users of given dehydration level, by distance

Dehydration level									
0	10.80	20.46	20.69	14.25	4.83	11.49	10.57	3.91	2.99
1	8.80	7.75	18.47	15.07	6.88	13.85	13.24	3.05	3.92
2	7.69	14.14	19.33	13.10	9.77	12.89	13.93	2.29	6.86
3	8.33	8.33	21.97	9.85	6.82	12.12	18.94	6.81	6.81
4	5.36	1.79	5.36	10.71	8.93	21.43	21.43	7.14	17.86
All	8.84	16.03	18.96	14.08	7.15	13.28	15.45	3.37	4.88

Source: Census subsample.

distance travelled to Matlab increases, from 1.25:1 at less than 5 miles, to 1.46:1 at 5 or more miles. The increase is due to the zero to two age group where the ratio increases from 1.36:1 to 2.29:1.

Table XVI crosstabulates distance and dehydration level, and shows that as user rates decrease with distance, average dehydration increases, and (reading down columns) the likelihood of coming from a higher dehydration class increases.

DISCUSSION

The above results on costs and cost effectiveness have fairly clear implications as to the relative cost-effectiveness of a simple local centre for treatment of diarrhoeal disease, as against a hospital whose size can only be justified by a highly expensive transport system.[a] The relative costs are likely to widen if relative price of gasoline continues to rise as expected.

With regard to foreign exchange burden, ambulances cost $10.56 per user in foreign exchange, Matlab TC $2.30 (minimum estimate), and Sotaki $1.13, using long run average costs. Reduction in dependence on foreign exchange is frequently a desirable aim in developing countries where foreign exchange is scare. In health areas reduction of such dependence may be difficult if drugs are not locally manufactured, although there are moves to use local production. (The ICDDR,B already produces oral and IV fluids locally). Again, a local treatment centre would be the preferred option if reduction of foreign exchange requirements were part of government policy.

The level of cost of treatment of diarrhoea seems high. Individual health expenditures in Bangladesh were about 37 takas per capita per annum in 1978 (8). Government expenditures were 7.66 takas in 1975-76 (9), which would be equivalent to about 11.3 takas in 1979-80. If one assumes that the average population-attendance ratio for Matlab is 20 per 1000 per year (representing the rate at 2 miles distance in table XIII), then the cost per person covered by the service is $15.65 to $16.77 divided by the population-attendance rate, which works out at about 5 takas or $0.33 per person per year. Therefore, few individuals would be willing to pay for treatment at Matlab or for the ambulances since the cost per patient is several times as large as annual expenditure on health. Nor could the government afford the cost per person even though it is relatively low, since it would absorb about half the health budget. Diarrhoeal disease may

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a It should be noted that the present ambulance system is a legacy from vaccine trials started 18 years ago and was introduced for ethical reasons rather than as a model component of a rural delivery system of primary health care. The qualificative "expensive" refers to its costs in the Bangladeshi health budget context.

be very important in Bangladesh, but it is not obviously sufficiently important to merit the necessary expenditure. However, if it were possible to replicate centres like Sotaki, at a cost of 1 taka per person covered per year, this might be more feasible.[a] The cost of treatment at Matlab is also high compared to reported alternative costs of diarrhoea treatment. Claquin *et al.*, (9) report the costs of office and home visits for diarrhoea treatment as 4.5 and 9 takas respectively for *Palli Chikitsoks*. Claquin (10) quotes figures of 14.15 takas for qualified allopaths, and 6 and 4.5 takas for ayurvedic healers. These figures do not include the cost of medicine to the patients.

The costs per death averted should be used with caution, as stated before. However, they also seem very high. The cost at Matlab, of $1,262 to $1,352, seems comparable to that reported for hospitals elsewhere. Barlow (11) reports that the cost per death averted for a small hospital in Morocco in 1971 was $2,360, and $2,637 in a large hospital. However, there is a widespread opinion that Western-style hospital based care is not highly appropriate for developing countries. It might be more useful to make a comparison with other medical interventions. As an illustration, Barlow (11) estimated the cost per death averted, again for Morocco in 1971, was $126 for vaccination against TB, and $190 against diphtheria, tetanus and whooping cough.

The figures obtained for cost per patient at Matlab TC in this study ($20.81 to $21.93) are similar to those of Oberle ($23.51) and Mosley ($14.91) when converted to 1979-80 prices. The costs here per death averted are much higher ($1,262 to $1,357, versus $48 - $102 and $603.48). This is because of the subjectivity of estimates of mortality averted. Oberle's figure implies that between 1 in 2 and 1 in 5 of patients would have died, which seem extremely high. His figure for expenditure per capita ($0.18, at 1979-80 prices) is also much lower than the one here ($0.33) and would seem to reflect a very high estimate of population-attendance rate.

The study does not take into account benefits derived from the research made possible by the existence of Matlab TC. In 1963, the treatment centre was set up for research purposes, and for ethical reasons cost effectiveness had not been an overriding consideration. However, as far as is possible this study has tried to eliminate the costs of the research component at Matlab. A study of the costs and benefits of the research there, would be a totally separate question.

Although the costs of curative measures for diarrhoea are high, there may not be a more cost effective alternative. Immunization is not highly effective even for cholera alone, and water and sanitation improvements are expensive and often require major behavioural modifications. Home based

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a The need of local treatment centres must be understood as a second line strategy in the control of diarrhoeal diseases for patients failing to improve after administration at home of ORT.

oral rehydration is currently being tested, and may in future be shown as a viable alternative. However, as far as curative measures are concerned, a structure like Matlab treatment centre with its speedboat network is obviously more costly than local sub-centres staffed by paramedics similar to Sotaki. And whilst no clinical study has been done, Sotaki's treatment record, with one death out of 891 patients per year, indicates that rehydration techniques can be fairly simply taught to, and successfully used by, paramedical personnel.

As for using the results as a policy model, there are caveats. Sotaki may not be replicable exactly as at present. The Centre obviously has unusual community support which provides the local administration. Moreover, the ability to obtain volunteers for a token payment of 150 takas per month, may be a temporary phenomenon. However, even with more realistic costs, local centres are relatively inexpensive. Operating Matlab TC without ambulances would not seem viable at present scale. The ambulances bring about 40% of patients. Replacing speedboats by cheaper countryboats would not seem viable, since for some diarrhoeal patients, especially if cholera is suspected, the time taken to reach hospital is a crucial factor.

Perhaps in the long run, a better alternative as far as cost effectiveness is concerned, would be local centres staffed by paramedics, trained not only to treat diarrhoea but also other illnesses. Sotaki's example suggests that people are willing to pay relatively high fees for a service. The provision of other treatment would enable fixed wage costs to be spread, and would not seem to overload the paramedics. Sotaki's experience suggests that workers in other health programmes could be trained in rehydration techniques.

There is a final question as to cost-effectiveness, which the present study cannot answer. That is, given that even the most cost-effective methods of prevention or treatment of diarrhoea are quite costly, is it appropriate to use scarce health resources to treat diarrhoea? This question could only be answered if cost-effectiveness data for other health interventions, were available.

There is an alternative method for assessing the Matlab treatment centre's effectiveness. This would be to compare the usage rates at a given distance, with those elsewhere. The population-attendance rates are less than half those reported for a similar centre at Teknaf, in the far South-East of Bangladesh (12). The rates are also lower than for treatment centres in Africa.[1] However, it is the case-attendance rather than population-attendance rates which are of interest, and these were not available for Matlab. One would in any case expect a centre treating only patients with diarrhoea (as well as possibly other illnesses), to have a lower population-attendance rate than one treating a range of complaints.

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1 Oscar Gish, personal communication.

Who Benefits?

The question "who benefits?" from a highly subsidized service might seem superfluous here, since Matlab TC is open free to anyone with diarrhoeal illness, and use would seem to depend only on individual willingness. However, if one accepts that use of a hospital also involves private costs which may be non-trivial to the patients, then it is possible that use of the hospital depends on factors other than the degree of illness.

For instance, to rent a countryboat for 3 miles might cost 10 takas, and for a whole day 20-25 takas. Cost of a rickshaw might be 1 taka per mile, more for a baby-taxi. Bringing a seriously ill adult to hospital by land might require several people to help carry a stretcher.

Also, the cost of food for an attendant purchased at the local bazar, might be 15 takas a day, certainly more expensive than eating at home. Patients stay on average 1.5 to 2 days, and although patients receive food from the hospital attendants, other than nursing mothers, do not. Most patients have at least one attendant, usually the mother for small children, a female relative for girls, or a male relative for boys and adults. The attendant's time has an "opportunity cost" even in a country with underemployment, especially at certain seasons. Women have to find someone to attend to household tasks, and men may lose a day's employment.

At Sotaki, patients have to buy their own food, as well as pay the 15 takas admission fee. These costs compare to an agricultural wage in 1980 of about 12 to 15 takas per day.

Thus although private costs are small relative to total cost of the service, they may be non-trivial in relation to income, average expenditure on health, or cost of other types of treatment. The frivolous case is sometimes made that patients come to hospital because of a free ambulance ride or free meals. This would seem an exaggeration judging by the steady numbers of patients who either abscond from hospital, leave against medical advice, or request to be discharged.

There are also social obstacles to use of a treatment centre. For women there are social barriers against travel and coming into contact with non-family members. Matlab treatment centre is large and possibly seems impersonal, and this may deter patients who prefer more traditional medical practitioners.

One can use the notion that there are private financial and social costs, which weigh against treatment benefits, to suggest why use patterns at Matlab treatment do not entirely correspond to disease severity and incidence.

One would need to know a little about age-sex disease incidence patterns, to explain those observed in hospitalization. Khan *et al.*, (13) found for the Matlab area between 1966 and 1975, that cholera attack rates were high for children below 9. Attack rates were also higher for males than females, especially below age 9, except in the 20-39 age group where the attack rate for females was higher. However, attack rates for cholera and non-cholera diarrhoeas may differ.

Rahaman *et al.*, (14) found that the attack rates for all diarrhoeas in two Bangladesh villages, varied with age. The rates per 1,000 person-years in each village were 323 and 2-7 at age less than 1, 226 and 241 at ages 1 to 4, 91 and 100 at ages 5 to 9, 94 and 83 at ages over 10. Thus age patterns of hospitalization may partly be explained by incidence.

The relatively high use of the treatment centre by women aged 15 to 44, would accord with expectations that women of this age have high incidence because they are in closest contact with children in the household, who also suffer high incidence. However, the overall higher use by males, especially boys aged two or less, would seem to reflect societal preference rather than disease incidence. Incidence data by sex was not available to confirm this hypothesis. Sex preference has been noted elsewhere for Bangladesh, in differential mortality rates (15), and in feeding practices (16) where a recent survey found that female diets were less adequate than male. Aziz (17) found from death forms, that prior to death, females were less likely to have consulted the more expensive allopathic practitioners, and were more likely to have received no treatment. A study of the pattern of medical care of users of the ICDDR,B Dacca treatment cente, prior to their coming to the centre, found patterns similar to those observed at Matlab. Khan *et al.*, (18) looked at the proportions of patients who had received treatment prior to their using the Dacca clinic, and their average expenditure. They found that more had been spent on male children below age 9, but in the 20 to 49 age group, more had been spent on women. Contrary to the pattern of preference for small children at Matlab, however, more was spent for adults than for those aged less than 9.

Rahaman *et al.*, (12) present case-attendance data for a treatment centre at Teknaf. They find that at distances over one mile, the case-attendance rate for females was lower than for males at all ages. However, high usage by children did not imply that the case-attendance rates were higher, and in fact the case attendance rates for children were relatively low, and the highest ones were for prime working age men.

There was no incidence data for Matlab to allow case-attendance rates to be calculated. One can however use dehydration levels by age and sex, to estimate whether there are groups which receive preferential access to treatment. One would expect preferred groups to be less dehydrated.

The results in Table XII, showing relative dehydration by age and sex, confirm that the seeking of treatment is not solely determined by disease incidence. The groups with relatively greater hospital use, namely males, children less than two and especially boys, are in fact relatively less dehydrated. The most dehydrated group for males is those 15-44, presumably wage earners who can least afford to miss work whilst seeking treatment. Similarly from Table XI, comparing a free and a fee paying service, Matlab TC and Sotaki TC, the fee paying one has more males, and more males two or less. Tables XIV and XV show the same pattern of preference, that as distance from hospital increases, it is especially boys less than two who are brought to hospital.

The above can then be interpreted as hospital use imposing private costs which are more willingly borne for males and especially small boys.

The effect of increased distance reducing utilization can similarly be interpreted. Travel costs increase with distance, and other dis-benefits also, e.g. travelling long distances may be disliked per se. Table XIII shows that very few people travel more than 2 miles on foot, and other methods of transport are likely to involve charges. Distance also decreases the likelihood of personal or proximate experience of hospital use, which might increase unwillingness to use the hospital. From admissions records it is noted that there is a high frequency of repeat hospitalization, by the same bari. However, one cannot say how significant such repeat visits are without knowledge of correlation of incidence for individuals, with families or within baris. An economic argument concerning the increased costs as distance from a hospital rises, can explain why dehydration also increases with distance. As costs increase, or personal knowledge decreases, the benefits to hospitalization have to be perceived as greater, and thus only the more sick (dehydrated) or more preferred family members come to the treatment centre. There is an alternative explanation however. The patient has probably travelled for longer, often in hot weather, probably drinking less fluid, and travel has thus increased dehydration.

From the above one can infer that a large hospital as compared to a series of small treatment centres, will disproportionately benefit males and especially small boys. It also favours those in a more limited geographic area, and possibly those people with higher income, able and willing to pay the costs of travel to a more distant hospital.

Similarly, a local centre with a fee, as against one without, is likely to benefit males and especially boys, more.

One can also hypothesize other effects. Larger centres, or those charging a fee, would seem more likely to be used by those with higher incomes, unless the effect of income on household hygiene or behaviour has an offsetting effect by decreasing incidence of diarrhoea.

Education would be expected to increase hospitalization, by making people more aware of the benefits of treatment, although again education might change household behaviour in ways decreasing incidence and having an offsetting effect decreasing hospitalization.

Order of child in a family would be expected to affect hospitalization. One would expect older or only sons to be favoured. Previous diarrhoea related deaths in the household might affect willingness to seek treatment.

One might wish to take these kinds of factors into account when designing services. One would usually try to avoid increasing the advantages to already favoured groups, that is, one would avoid regressive policies. The discussion above would suggest that smaller, more local treatment centres, would have fewer regressive effects. However, a small, fee-charging centre might be more regressive in effect than a large, free one.

CONCLUSIONS

This study shows that the cost of curative care for diarrhoea is high relative to the resources available in a developing country like Bangladesh. Earlier studies showed that preventive measures such as immunization and environmental improvement, may be no more cost-effective. Comparing the types of curative services studied here, a local treatment centre staffed by paramedics, is more cost effective than a larger and more elaborate centre. The study also shows that there are patterns in use of curative services, not wholly dependent on disease incidence and severity. It may be possible to design services appropriately, so as minimize biases in use. A series of local centres would seem preferable to a single large centre on these grounds too. There remains the wider question as to the emphasis which should be placed on curative treatment for diarrhoea, as against other health interventions.

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APPENDIX A

CALCULATION OF COSTS

This Appendix gives details of the cost calculations. The first section defines various terms used in the text. The second gives details of the calculations, and the third gives some of the figures.

DEFINITIONS

1. Financial Costs and Economic Resource Costs

This study aimed to find the economic resource costs of three services, namely Matlab TC, ambulances and Sotaki TC. These do not necessarily correspond to the reported financial costs. For instance, Matlab uses a building provided rent-free by the government. Thus whilst there is no reported financial cost, there is an economic resource cost, since a rent could obtained from the building in another use.

2. Joint Inputs

Joint inputs are inputs such as workers or equipment, with more than one current use. In order to divide the cost of such inputs between uses, one needs to measure how the use is shared. The methods used in the study are explained in the second section, below.

There is another theoretical problem related to joint inputs. There are some indivisible resources such as stand-by generator (where indivisible means that the hospital either possesses or does not possess one, and cannot possess half of one) which a hospital could own, but reduce costs by sharing it with another user. In this study, there are other users who share the joint costs, such as the family planning clinic, the research operation, and the field operation. Thus the costs of Matlab treatment centre estimated here, may be lower than if an identical centre were set up elsewhere, in isolation. An illustration of this, is the cost of medical officers. To man shifts at Sotaki, there are four paramedics, who need not be fully occupied for all the time. At Matlab, there are five doctors to man shifts. The doctors, however, work

part time in research and in the family planning clinic, as the hospital workload permits. Thus the hospital is not assigned the cost of a resource (a doctor) being available but unused, as the cost is partly assigned to the other uses.

3. Prices Used

The prices used were prices paid in the financial year 1979-80. Where there was no market transaction (e.g. rent at Matlab TC, IC solution prepared in Dacca) some estimate of the market price was made. In the former case, this was the rent of an equipment building, and in the latter, the ICDDR,B's accounting prices. The equipment price used was current replacement cost.

Economists assume that the prices paid represent resource costs. There are exceptions, such as monopoly power, government intervention, taxes, subsidies or minimum wages, which distort prices. It is sometimes possible to adjust prices actually paid to remove these distortions, and to estimate the actual resource cost.

In this study the only such adjustment made, was for the price of foreign exchange, where a shadow exchange rate was used to calculate the figures in Table VI. Arguably, Bangladesh overvalues its currency for policy reasons, which makes imports artificially cheap. By doing this, which cheapens the costs to the hospital of imported drugs, the hospital thereby imposes hidden economic costs on other sectors of the economy. By using a shadow price, that is, the estimated free market exchange rate, the true cost of the resources to the whole economy is found. Thus in this study, cost is first estimated at the current exchange rate ($ 1 = Tk.15) and secondly at the shadow rate used by the World Bank, Dacca ($ 1 = Tk.20).

4. Equipment Costs

In estimating resource costs, one needs to include an estimate of the cost of tying up resources in equipment. It is necessary to include equipment costs to provide a fair comparison between equipment-intensive services such as the speedboats, and non-equipment-intensive ones such as Sotaki TC.

The appropriate cost to include, is not expenditure on equipment in the current year, as this could vary widely between years, but the cost of having the use of the equipment for that year. The

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cost used here, is the current replacement cost divided by the expected lifetime. This is equivalent to assuming straight line depreciation. This means that if a speedboat hull is expected to last for eight years, that each year it loses one-eighth of its original value, or alternatively that Matlab TC could have 16 speedboats and expect to replace two each year. There are of course alternative procedures possible, such as using historic costs, and there are different depreciation methods in use.

5. Cost Concepts

Several cost concepts are used in the text. These different concepts, have different uses, as was explained in the text. The study distinguished between variable and fixed costs, and between user-dependent and user-independent costs. This distinction exists, because there are differing degrees to which it is possible to adjust the use of inputs, as number of patients varies. Some inputs, such as drugs and food for patients, can vary almost perfectly with the number of patients. Thus costs of these inputs also vary in proportion with the number of patients. These are termed user-dependent costs or variable costs. Some inputs, have to be acquired in advance of the treatment centre knowing how many patients there will be. Thus the cost of these inputs does not depend exactly on the number of patients. These are termed user-independent or fixed costs.

Within these fixed inputs, some of the items can be varied more easily than others. For instance, one might not hire another doctor or rent more space if the number of patients went up for a week, but one might do so if this happened for a whole year. However, it might take several years to decide that it was necessary to buy a very durable input such as a speedboat or a generator. Thus economists divide costs into short run and long run costs.

Short run costs measure the cost of providing a service for another year, assuming that all the durable equipment has been bought and is available at no cost other than maintenance.

Long run costs include equipment costs, calculated as explained in section (4) above.

The other costs presented here, are:

Short run average variable costs. These are the variable costs (drugs, food) per patient.

Short run average costs. These are the variable costs plus the costs of those user-independent inputs which can be varied in the short run, which economists might define as one year. The latter includes items such as cost of employees, and rent on the building. These costs are averaged per patient.

Long run average costs. These include the items in short run average costs, plus equipment costs, as an average per patient.

METHODS

1. Included and Excluded Costs

The Matlab treatment centre is not a treatment centre in isolation, but has a function in research. Thus some hospital procedures may have a research function, and would not necessarily be followed in another treatment centre.

Thus several variants are provided for cost estimates, including and excluding items, which might be deemed necessary more for the research function of the treatment centre. These items are: a pucca building, expatriate supervision, and a microbiology lab. The treatment centre occupies one kutcha building (about half of total hospital area), and part of the pucca building. Arguably the pucca building could be replaced by a kutcha one, and a pucca building is used instead because offices and labs occupy the same building. Similarly local supervision would be less costly than expatriate, and there are hospitals without expatriate supervision. Expatriate involvement is partly due to research interests. Similarly there is a microbiology lab where only about 20% of work is for hospital patients (estimated from number of tests performed). Analogous treatment centres in Bangladesh would be unlikely to possess such a lab, yet it might be standard in the US. The purpose of such a lab is mainly to facilitate research. Since expatriate supervision, rent, and microbiology lab have relatively high costs, it is worth presenting separate estimates, including and excluding these additional three items.

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2. Allocation of Joint Costs

Several methods were used to allocate joint costs. Some workers were asked directly, e.g. medical officers. In some cases, a suitable proxy was used, e.g. to allocate the time of cooks between cooking for hospital patients, clinic patients, and visitors, the shares used were shares in cost of ingredients. The cost of Drivers' time was allocated in the same proportion as gasoline usage amongst different purposes.

For rent, allocation was by area occupied. For equipment, either time of use, or a proxy such as gasoline usage for boats or miles travelled for cars, was used. For equipment maintenance, it was assumed each boat and car cost an equal amount to maintain.

Allocation of administrative costs was difficult. Administration costs were defined as the cost of wages, office supplies and rent of rooms. It was assumed that the work is mainly to administer employees and supplies, and that an appropriate proxy for the hospitals share of administrative costs is its share in wages and supply costs administered.

The costing of the work of supply, controller's and financial offices in Dacca was difficult. It was assumed that cost in Dacca, of administering the Matlab field station, was roughly equal to the cost at Matlab, of administering field work for Dacca-based research protocols. Hence no actual estimate of the level of these costs was made.

3. Cost Categories

The cost categories used were chosen for operational usefulness namely wages, supplies, rent, maintenance, administration, equipment. It would be possible to subdivide both maintenance and administrative costs among the other four categories. The four categories would then correspond to economic concepts of factor costs, namely wages (labour), costs of supplies (working capital), rent (land), and costs of equipment (fixed capital).

The method of costing each category was:

(a) Wages. The personnel office's figures for wages were used, plus 50% overhead for benefits.

(b) Supplies. Where possible, supply quantities and controller's prices were used directly. Otherwise the controller's financial records were used.

Appendix A (Contd.)

(c) Maintenance. Financial records were used.

(d) Rent. A market rent was estimated for the existing buildings. A lower, alternative rent figure was obtained, by estimating the rental cost of a kutcha building of equivalent size, to replace an existing pucca building used by the treatment centre. Where buildings were shared between uses, rent shares were allocated according to relative floor area used.

(e) Administration. Costs of office staff, office supplies and rent were included. Maintenance and equipment costs were neglected.

(f) Equipment. For Matlab hospital, an average of the 5 previous years equipment costs was used, updated by a price index (all goods, all Bangladesh, (19)). For Sotaki and amublances an inventory was made and costed either at current prices if available, or at the actual price paid updated by a price index (industrial products, all Bangladesh, (14)). The average lifetime for equipment at the treatment centres, is thus implied to be no longer than five years. Direct estimates of vehicle lifetimes were used for the ambulances.

4. Summary

An estimate of resource costs such as the above, has inevitably some arbitrary elements, in costs included or omitted, in share of costs allocated, in price indices or depreciation methods used, and in imputed costs for goods not purchased at market prices. Thus estimates should be interpreted with caution. The methodology of summing separate costs, may also have an inbuilt downward bias due to unintended omissions. For this reason, estimates should be treated as lower bounds.

CALCULATIONS

1. Matlab Treatment Centre

(a) Wages. This includes 10% of time of one expatriate, 35% of time of acting head, 51% on average of time of 5 doctors, and full time work by 2 health assistants, 1 wardmaster,

Appendix A (Contd.)

4 assistant staff nurses, 6 ward attendants, 1 side nurse, 1 pathology technician, 1 laboratory technician, 6 ward attendants, 5 cleaners, and 2 laundry operators. The treatment centres share of floor area, 49%, (treatment centre plus 33% of main building) was applied to wages of 13 security guards and 2 cleaners. The treatment centre's share in food costs, 58% (where another 11% went to clinic patients, and the remaining 30% to visitors) was applied to the wages of 1 cook and 3 cook's helpers. The cost of casual labour used by the treatment centre was obtained from financial records.

(b) Supplies. Financial records were used. This included the following items:

Items	Cost in Dollar
Drugs and chemicals	12,813
Glassware and lab supplies	724
Hospital supplies	10,973
Office supplies	630
Food for patients	17,036
Material for uniforms	573
Maintenance supplies	1,134
Janitorial supplies	1,462
Miscellaneous supplies	524
Transport of supplies, clearing	280
Total	75,129

(c) Maintenance. The reported maintenance and repair costs of office and laboratory equipment were used. Some additional maintenance costs are included within other items, namely some of the casual labour costs in wages, and the cost of maintenance supplies, in supplies.

(d) Rent. Estimates are for 2,195 square feet of kutcha building (treatment centre) @ 500 taka a month, and for replacing 2,438 square feet in the existing pucca building, by another kutcha building, also @ 500 taka month. An alternative, higher, figure is given for rent in the existing buildings. This estimate was for 2,195 square feet of kutcha building @ 500 taka a month, and 33% of the 7,343 square feet of pucca building @ 33% of 12,000 taka a month.

The same fraction of total floor area that the treatment centre occupies in the two main buildings, 50%, is applied to the rent of a store, a staff welfare association building, and a room used for storage of medical records and production of oral therapy packets. This additional rent amount is @ 50% of 2,000 taka a month.

(e) Administration. This includes 54.68% of administration costs at Matlab, derived as follows:

	Paid in Taka	Paid in $	$ Total
Wages (5 office staff, 4% of 13 security guards and 2 cleaners)	228,318	-	15,221
Office supplies	n/a	n/a	651
Rent (4% of pucca building)	5,760	-	384
Total			16,220

The treatment centre's estimated fraction of administrative time, was calculated as the sum of wage and supply costs for the treatment centre as calculated above, divided by the wage and supply costs for all 8 separate budgets administered at Matlab (namely, the treatment centre, administration, two transport budgets, three maintenance budgets, and one store). It was assumed that the costs of administering research protocols by Matlab administration which were not charged to Matlab, and the Dacca costs of administering the Matlab Field Station, which seemed impossible to separate, might be roughly equal and offsetting, and hence were omitted.

(f) Equipment. The figures used were for equipment purchases 1975-1979 adjusted by a price index for all Bangladesh, all products (19).

(g) Microbiology. The figures used were for 25 specimen analyses per day each with 3 plates, plus 20% share (based on workload) of fixed costs, namely:

Appendix A (Contd.)

	Paid in Taka	Paid in $	Total in Dollar
Wages (4 lab staff, 8% of security staff and cleaners)	137,889	-	9,193
Rent (8% of pucca building)	11,520	-	768
Total fixed costs	-	-	9,961
20% of above total	-	-	1,992
Cost of plates (user-dependent cost)	1,980	-	125
Total			2,117

2. Ambulances

(a) Wages. Log books were used to find the fraction of time that boats, or miles that cars were used for ambulance duty. It was found that 4 ambulance boats were used 94% of the time as ambulances, one (withdrawn after five months at Sotaki) 41% of the time, one car 54% of miles, and one jeep 27% of miles. These fractions were used to allocate driver wage costs, maintenance costs, equipment costs, administration costs, and despatcher wage costs.

(b) Supplies. This was equal to cost of gas and diesel, neglecting oil, as calculated from log books of use. It is assumed that although the ICDDR,B pays in taka for gas and diesel, they are imported and hence represent a foreign exchange cost.

(c) Maintenance. It was assumed that cars and boats cost approximately the same amount each to maintain. Thus the share of ambulances in total maintenance costs was 4.98 out of 18. Financial amounts from financial records were allocated accordingly.

(d) Administration. This assumed that the ambulance's share of Matlab administration costs was 15.44%, where method of claculation of share and total were as detailed for the treatment centre.

(e) Equipment. Acutal purchase price of the most recent equivalent model purchased was found, and converted to 1979/80 prices using the all Bangladesh industrial goods price index (19). Equipment life estimates which were obtained from equipment personnel, were: 5 years (car and jeep), 8 years (boat hull), and 2 - 2.5 (2.25) years (boat engines).

3. Sotaki

(a) Wages. It was assumed that total income from patient fees covered wage and other small local costs.

(b) Supplies. Costs were found by multiplying records of quantity supplied, and Matlab controller's price records. Subcategories were as follows:

	Paid in Taka	Paid in $	Total in Dollar
Drugs, oral and IV fluid	6,423	902	1,330
Other hospital supply	3,842	46	302
Office supply	455	10	41

(c) Rent. The estimated rent and maintenance cost for an equivalent kutcha building were used. The actual pucca building was donated free, and would command a higher market rent.

(d) Administration. This cost was assumed to be zero, as the local committee is not paid.

(e) Equipment. Supply records quantities of cots and fluid bottles were used, multiplied by the Dacca Controller's prices. Equipment lifetime was assumed to be 3 years.

(f) Training. The cost used were the volunteers' per diem, and cost of doctor's time and nurses' time, for 18 days of training for 4 paramedics. The cost of training is included since it might be regarded as "human capital" provided by ICDDR,B. It is assumed that training lasts for 3 years before either new volunteers are trained, or a refresher course is needed. However, cost estimates for Matlab treatment centre and ambulances do not include training costs, which might be large especially for the doctors. Hence in comparisons between services one might wish to subtract out this cost. Here it is always included.

The results of the calculations are shown by service in tables 7 to 9, and in summary form in tables 4 and 5.

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CALCULATION OF COST USING SHADOW EXCHANGE RATE

Table VI shows the increase in costs in taka, when a shadow exchange rate is applied to items directly imported. Taka costs will increase from between 0%, if there are no directly imported components, to 33%, if all components are directly imported, since the shadow exchange rate for the taka is 33% above the actual rate.

In some cases it was necessary to make an assumption as to whether components were imported, if this information was not available from controller's accounts. It was assumed that gasoline and diesel were imported, and that maintenance and administration costs were wholly local. For Matlab supplies it was assumed that drugs, chemicals, glassware and laboratory supplies were wholly imported, and all other supplies wholly local. For all other items local and import components were known.

APPENDIX B

DETAILED STUDY OF THE IMPACT OF SOTAKI TREATMENT CENTRE ON THE USE OF MATLAB TREATMENT CENTRE AND AMBULANCE

INTRODUCTION

It was decided to do a detailed study of the effect of withdrawing one ambulance between Sotaki and Matlab, and of starting of local treatment centre at Sotaki, on December 1, 1979. In particular, it was of interest to find how many fewer patients came to Matlab as a result, and whether this shift in use pattern affected total costs of treatment. Also, it was found that certain patients continued to attend Matlab from the area near Sotaki, despite the fairly considerable distance (at least 12 miles by canal). Some patients began to use the next ambulance station some 4 miles from Sotaki and eight miles from Matlab, others came by country-boat or launch. It was of interest to find why such patients preferred to go to Matlab when they presumably knew of a closer centre. One hypothesis was that the most seriously dehydrated patients would still be taken to Matlab for more specialised care.

METHODS

The admissions registers for Matlab and Sotaki were used, along with treatment records at Matlab. Firstly, a detailed study of village of origin for Sotaki patients was made, from the Sotaki register, to determine catchment area of the centre. For the 10 months December 1979 to September 1980 for which data was available at the time, 66 villages were identified where at least 2 patients came to Sotaki. These villages contributed 634 of the 746 patients attending Sotaki over this period. Secondly, a study was made of patients attending Matlab from these same 66 villages, for the two 10 months period (December 1978 - September 1979 and December 1979 - September 1980), i.e. prior to, and following the opening of Sotaki TC. It was found that in the first period 406 patients attended Matlab, and in the second 242, a decrease of 164. One reason for the decline in use of Matlab TC by these 66 villages, might be that they had switched to using Sotaki TC. An alternative reason might be that disease incidence had declined.

Therefore, the correlation coefficient was obtained between decrease in attendance at Matlab, and numbers of new users of Sotaki, by village. The correlation coefficient was only 0.038. Nor did it increase when

Appendix B (Contd.)

25 of the 66 villages were excluded, i.e. those villages found not to be users of Matlab in either period. It was thought that lack of correlation between decrease in use of Matlab, and new use of Sotaki, did not necessarily mean that there was no switch in use. Rather, it was thought that use of the new centre would depend also on its distance from a particular village.

Thus a subsample of 13 villages was selected, where the use of Matlab decreased by at least 3 patients between the period before Sotaki opened, and the period after. One problem encountered was that village names are not all unique in Matlab thana. Nor is the same name in Bengali consistently transliterated into English the same way. Nor are the 13 villages concerned presently under demographic surveillance (although five previously had been). Thus there were no census numbers to allow one to check whether, for example, a Matlab patient recorded as coming from Baluchar, came from the village near Sotaki, or another Baluchar elsewhere. Two villages were excluded from the original 13, because there might be confusion with another village of the same name using Matlab. It was found that from each of the remaining 11 villages, at least 10 patients used Sotaki, and they contributed 288 out of the 746 users over 10 months.

From these 11 villages a more detailed study was done from which the results in Table XVII derive, on characteristics of "non-switchers". By comparing the characteristics of people who used to come to Matlab, with those of the smaller number continuing to come, one could test whether it was in fact the more seriously ill who continued to use Matlab, or whether perhaps other factors were responsible for their chossy Matlab.

The definition of "switchers" is as follows. It does not necessarily refer to an individual who uses Matlab one year and Sotaki the next. Rather it refers to a segment of the population with certain characteristics, such that if they sought treatment in the first year they would go to Matlab, in the second to Sotaki. The non-switcher population is those who, if they sought treatment in either year, would go to Matlab. A third group of new users is defined as those who would not have sought medical help from Matlab in the first year, but would use Sotaki the second year. It is assumed that the fourth population group of discontinued users, who would go to Matlab one year but to neither Sotaki nor Matlab the second year, is negligible, and the fifth, who would not seek treatment either year, uninteresting to this study.

We then assume that the population group characteristics determining use are stable. Thus few actual individuals actuallly use Matlab twice, or use Matlab then Sotaki, but the characteristics of potential users in each group can be obtained from actual users.

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TABLE XVII--SELECTED CHARACTERISTICS OF "NON-SWITCHERS" FROM MATLAB TO SOTAKI

Percentage with selected characteristics	Percentages		
	MTC[1]	MTC users, 11 villages[2] before Sotaki	MTC users, 11 villages[3] after Sotaki
Age 6 years	49.00	52.88	81.25
Sex, male	56.99	62.96	52.94
Sex, male, age less than 2 years	15.81	30.77	47.06
Water diarrhoea[4]	55.00	67.92	64.71
Bloody diarrhoea[4]	31.00	5.6	12.5
Vomiting[4]	55.00	86.1	87.5
Abdominal pain[4]	n/c	28.4	25.0
Fever[4]	60.00	44.3	75.0
More than mild dehydration[4]	27.00	31.11	17.65
Pulse abnormal[4]	n/c	45.37	70.59
Respiration abnormal[4]	n/c	30.56	23.53
Use of antibiotics[5]	46.00	32.41	56.25
	Average value		
Average			
IV intake, liters[5]	0.607	0.819	0.256
OT intake, liters[5]	1.386	1.908	1.694
Days in hospital	1.73	1.411	2.35
N	100	108	17

[1]Obtained from study 100 charts September 1979.

[2]Obtained from admissions records Matlab, December 78 - May 79.

[3]Obtained from admissions records Matlab, December 79 - May 80.

[4]On admission.

[5]In hospital.

Source: See Appendix B for details of how 11 villages were selected.

Appendix B (Contd.)

The 107 users of Matlab from the 11 villages studies, before Sotaki opened represent switchers, nonswitchers, and discontinued users (the latter are assumed to be negligible). Users of Matlab after Sotaki opened represent nonswitchers only. The users of Sotaki from the same villages are switchers and new users. Thus one can obtain directly the characteristics of switchers from Matlab users in the second year, and by inference the characteristics of switchers, by finding the change in characteristics of Matlab users between the two years. The characteristics of users of Sotaki cannot directly be separated into those of switchers and new users.

The analysis therefore rests on a series of assumptions, and small numbers make conclusions tentative. But the results seem interesting.

RESULTS

1. Number of "Switchers" Per Year

The 66 village study found that number of patients using Matlab fell period in 10 months, equivalent to 197 in a year. This excludes villages where only one person used Sotaki, but where use of Matlab might still have decreased. These 66 villages sent 624 patients to Sotaki in 10 months, a rate of 749 per year. This gives an estimate of 197 "switchers" and 552 new users, for the 66 villages.

The more detailed 11 village study found a decrease of use of Matlab of 91 patients in 6 months, equivalent to 182 in a year. Use of Sotaki by the same 11 villages was 228 in 10 months, equivalent to 346 in a year. This gives an estimates of 182 possible switchers, and 164 new users, for the 11 villages.

The decreased use of Matlab might not be wholly attributable to switch in use from Matlab to Sotaki, but possible to a decrease in diarrhoea incidence in the second period. An exceptional example of this was one large village out of the 66 but not the 11. Aburbidy, where there was a marked decrease in numbers attending Matlab (34) but only 4 patients went to Sotaki. However, averaging over a number of villages would partly remove the effect of disease variability. The villages are geographically contiguous, but since hospitalization rates for contiguous villages are not unduly highly correlated (using data from the census subsample), it may be fair to assume that incidence rates for contiguous villages are not perfectly correlated either.

Appendix B (Contd.)

An alternative method to estimate the decrease in use of Matlab TC, is to calculate the number of trips made in a previous year by the Sotaki ambulance. There were 159 trips in 9 of the 12 months between December 1978 and November 1979, an annual number of 212. Average number of patients per trip was calculated as 1.26 for all speedboats. Possibly some of these previous speedboat users continued to use Matlab, either coming by country-boat, launch, or the next nearest ambulance four miles away. Thus, (212 x 1.26), i.e. 267 is a likely maximum for decrease in use.

These calculations are speculative, but suggest that 182 is not an unreasonably high estimate of minimum number of switchers.

2. Cost of Switch in Use, Per Year

Short run average variable cost per patient at Sotaki	$	1.83
Short run average variable cost per patient at Matlab		3.19
Short run average variable cost of Sotaki ambulance, per trip		23.61
Same, per patient (note, Sotaki ambulance is more expensive than the average ambulance)		18.74
Change in short run average variable costs at Matlab, due to 182 fewer users		711.62
Change in short run average variable costs of Sotaki ambulance, due to 212 fewer trips which have led to 182 fewer Matlab users		5,004.42
Total long run cost of running Sotaki, per year		2,991.55
Total cost to ICDDR,B of items supplied to Sotaki, plus training, per year		2,100.55

Thus, a conservative calculation suggests costs were reduced when the Sotaki ambulance was withdrawn. Since the number of patients treated at Sotaki was greater than the number no longer using Matlab, by a factor of four, the saving per patient was even greater.

3. Effects of Switch in Use, Per Year

It might be worth running a more costly service, if the benefits outweighed costs. One (unquantifiable) benefit is that to the research at Matlab, of having extra patients for studies. The

Appendix B (Contd.)

Sotaki ambulance brought about 267 patients (out of 10,618). The other ambulances brought more, 4,192 between them, or about 40% of all patients.

Another benefit might be that the treatment at Matlab was more specialised. It might be that the difference in treatment was sufficiently desirable, as to outweigh the increased costs to patient and attendant of being away from home for longer, and the discomfort of a longer travel time to seek treatment.

Table XVII compares patients previously using Matlab, to those continuing use of Matlab. One would expect the patients who continued to come, would be a either those with high income (if cost is a major deterrent), or those who most preferred Matlab's treatment. If Matlab's facilities were seen as much superior, then one might expect the more dehydrated patients to continue to use Matlab.

However, Table VIII shows that those who continue to use Matlab are not more severely dehydrated. There are however indications that they are more likely to have complications of nondiarrhoeal infection, judging from presence of fever, use of antibiotics and abnormal pulse, which for children seems to indicate respiratory problems, tonsillitis, etc.

This tentatively suggests that the replacement of an ambulance service to Matlab by a local treatment centre, was not perceived by users as providing inferior treatment for the most dehydrated patients. Users seemed to prefer the treatment at Matlab for non-diarrhoeal complications. This is as expected, since the paramedics at Sotaki were mainly trained to treat diarrhoea.

The replacement of services may have had an age and sex biased impact. If one compares all users of Sotaki and Matlab (from Table XI), 62.9% of Sotaki users were male, and of the Matlab users 56.9%. At Sotaki, 38.2% of males were aged less than five years, as against 32.7% at Matlab. One might attribute this to a greater willingness to pay the Tk.15.00 fee at Sotaki, for males, and especially small boys. However, previous users of Matlab from the 11 villages studied near Sotaki, were even more likely to be male (63.0%) and if male, below five (48.5%). The reason may perhaps be similar, namely that travelling a longer distance to hospital involves costs which are more willingly borne for males and especially small boys. Therefore, although charging a patient fee increase age and sex biases, the bias is less than that due to distance effects, when distance is as great as 12 miles.

Thus there is no evidence either that the replacement of services was seen as inferior treatment for the more dehydrated patients, or that the cost of the new service to users unduly penalized those who already received less favourable access to medical care. It does suggest however that a local centre with a fee will favour treatment of favoured groups (males, small boys) more than a local centre without a fee.

4. Cost Effectiveness

The above shows that the total cost of Sotaki was much less than the change in average variable costs at Matlab. Evidence does not suggest that the new service was perceived as less effective, except perhaps for respiratory complications. Sotaki TC seems relatively cost-effective as regards cost per patient treated.

ICDDR,B PUBLICATIONS*

A. Annual Report:

5. Annual Report 1980. 103 p.

B. Working Paper:

25. Becker S, Mahmud S, Sarder AM. Validation study of pregnancy histories and indirect techniques of fertility and mortality estimation in Matlab, Bangladesh. Volume One. Methods and Study of Possible Contamination. Apr 1982. 59 p.

C. Scientific Report:

55. Becker S, Razzaque MA, Sarder AM. Demographic Surveillance System - Matlab. Volume Eight. Census Update 1978. Apr 1982. 31 p.

D. Special Publication:

18. Claquin P, Claquin B, Rahman S, Razzaque MA, Shaikh K, Chowdhury TR, Kanawati NH. An evaluation of the Government training programme of traditional birth attendants. May 1982. 78 p.

E. Monograph:

2. Maloney C, Aziz KMA, Sarker PC. Beliefs and fertility in Bangladesh. Dec 1981. 385 p. (Price: US$ 30.00/£ 15.00).

F. Thesis and Dissertation:

3. Shahid NS. Complicatione of measles in rural Bangladesh (Long-term complications in the under-two). June 1981. 38 p.

G. Newsletter:

Glimpse: ICDDR,B Newsletter. Vol. 1, No. 1, Jan 1979-

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* List of previous publications, such as, annual reports, working papers, scientific reports, special publications and thesis and dissertations, can be obtained on request. For further information, write to Head, Library and Publication Branch, International Centre for Diarrhoeal Disease Research, Bangladesh, G.P.O. Box 128, Dacca 2, Bangladesh.