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MAXIMUM LIKELIHOOD ESTIMATES OF PARAMETERS OF A MODEL FOR OPEN BIRTH INTERVAL

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ABSTRACT

The purpose of the present paper is to derive a procedure for obtaining maximum likelihood estimates of the parameters involved in the above model. The asymptotic variance-covariance matrix of the estimates is obtained. Further, for a comparative study the asymptotic variance-covariance matrix obtained by method of moments is also given. For illustration, the procedure is supplied to observed distribution considered in Singh et al.

The study of. open birth interval has assumed considerable importance during the last two decades l,2,3,4. Recently, Singh et al. have derived a probability model for open birth interval taking into consideration two types of pregnancy terminations and obtained the estimates of parameters involved in the model by method of moments. The estimates are, however, obtained by method of iteration as there is no explicit solution for the estimates. Therefore, in this paper a procedure has been derived to obtain maximum likelihood estimates of parameters of a model for open birth interval.

Model

A probability model of open birth interval regardless of parity after time T from marriage as given in Singh et al. is dervied under the following assumptions.

(1) The time interval of first conception after marriage follows an exponential distribution with p.d.f.

$$f(t) = m \quad e^{-mt} \qquad m > 0, \quad t > 0$$

where m is the risk of conception.

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(2) Every conception results in a live birth and let $(1-\theta)$ be the probability that the birth results in infant death and so that 9 is the probability that the child survives at least one year.

(3) Every conception involves a period of non susceptibility comprising the duration of pregnancy and post partum amenorrhoea. Let h_1 and h_2 be the rest periods associated with two types of birth respectively.

Then the duration between the rth and (r + l) th conception follows a displaced exponential distribution with p.d.f.

$$f_r(t) = 0 \qquad 0 < t < h_1$$

$$= (1-\theta)\, m\, e^{-m(t-h_1)} \qquad h_1 < t < h_2$$

$$= (1-\theta)\, m\, e^{-m(t-h_1)} + \theta\, m\, e^{-m(t-h_2)} \qquad h_2 < t < \infty$$

and

(4) The time intervals of conception are independent. Let X denote the length of the open birth Interval and let f(x) be the corresponding p.d.f., then under the assumptions mentioned above and for large T, we have

$$f(x) = \begin{cases} \dfrac{m}{1+mh}, & 0 < X < h1 \qquad \ldots\ldots (1) \\ \dfrac{m}{1+mh}\left\{\theta + (1-\theta)\, e^{-m(x-h1)}\right\}, & h1 < x < h2 \qquad \ldots\ldots (2) \\ \dfrac{m}{1+mh}\left\{(1-\theta)\, e^{-m(h2-h1)} + \theta\right\} e^{-m(x-h2)}, & h2 < x < 8 \qquad \ldots\ldots (3) \end{cases}$$

Let Po and P1, be the probability that X lies between 0 to hi and h1 to h_2 respectively then from egh. (1) and (2), we get

$$Po = \frac{mh1}{1+mh} \qquad \ldots\ldots (4)$$

$$P_1 = \frac{m}{1+mh} \, , \, \frac{1}{m} \left[m\theta(h_2-h_1)+(1-\theta) \left(1-e^{-m(h_2-h_1)}\right)\right] \qquad \ldots (5)$$

Estimation

The proposed model involves four parameters, m, θ, h_1 and h_2. We assume that h_1 and h_2 are known, then the other parameters m and θ can be estimated.

a. *Method of Maximum Likelihood*

Let $X_1, X_2, \ldots\ldots\ldots X_N$ be a random sample of size N from the population with density f(x) and let N_o and N_1 be the number of observations in the interval $(0, h_1)$ and (h_1, h_2) respectively. Then the logarithm of the joint density of $X_1, X_2 \ldots\ldots\ldots X_N$ is given by

$$\begin{aligned} \log L = N \{ & \log m - \log (1+mh) \} - N_o \log h_1 - N_1 \log m \\ & + N_1 \log [m\theta (h_2-h_1) + (1-\theta) (1- e^{-m(h_2-h_1)})] \\ & + (N-N_1-N_o) \log [(1-\theta) e^{-m(h_2-h_1)} + \theta] \\ & - m \sum_i (x_i - h_2) \end{aligned} \qquad \ldots (6)$$

where summation is over $i = N_o + N_1 + 1, N_o + N_1 + 2, \ldots\ldots,$

N and $x_i > h_2$.

The M.L estimators $\hat{m}$ and $\hat{\theta}$ are obtained from the equations

$$\left.\begin{aligned} S_1 &= \frac{\partial}{\partial m} \log L = 0, \\ \text{and } S_2 &= \frac{\partial}{\partial \theta} \log L = 0, \end{aligned}\right\} \qquad \ldots (7)$$

Solving the above equations we get

$$\hat{m} = \frac{N - N_o - N_1}{\sum_i (X_i - h_2)} \qquad \ldots (8)$$

and

$$\hat{\theta} = \frac{\frac{N-No-N_1}{N}\ (1+\hat{m}h_1) - e^{-\hat{m}}\ (h_2-h_1)}{1- e^{-\hat{m}(h_2-h_1)} - \frac{N-No-N_1}{N}\ (h_2-h_1)\ \hat{m}} \qquad \ldots (9)$$

The asymptotic covariance matrix V of the M.L. estimates is given by

$$V = \begin{bmatrix} V(\hat{m}) & cov(\hat{m},\hat{\theta}) \\ Cov(\hat{m},\hat{\theta}) & v(\theta) \end{bmatrix} = I^{-1} \qquad \ldots(10)$$

where

$$I = \begin{bmatrix} I_{mm} & I_{m\theta} \\ I_{m\theta} & I_{\theta\theta} \end{bmatrix}$$

and $I_{mm} = E\left(-\frac{\partial^2}{\partial m^2}\log L\right)$,

$$I_{m\theta} = E\left(-\frac{\partial^2}{\partial\theta\partial m}\log L\right),$$

$$I_{\theta\theta} = E\left(-\frac{\partial^2}{\partial\theta^2}\log L\right).$$

From (7) it can easily be obtained that

$$\frac{\partial^2 \log L}{\partial m^2} = \frac{Nh^2}{(1+mh)^2} - \frac{N-N_1}{m^2}$$

$$+ \frac{N_1(h_2-h_1)\ [\theta^2+(1-\theta)\ \{1+\theta+m\ \theta(h_2-h_1)\}\ e^{-m(h_2-h_1)}]}{[m\theta(h_2-h_1)+(1-\theta)\ (1-e^{-m(h_2-h_1)})]^2} \qquad \ldots(11)$$

$$\frac{\partial^2 \log L}{\partial m \partial \theta} = \frac{N(h_2 - h_1)}{(1+mh)^2} - \frac{+N_1(h_2-h_1)[\{m(h_2-h_1)+1\} e^{-m(h_2-h_1)} -1]}{[m\theta(h_2-h_1) + (1-\theta)(1-e^{-m(h_2-h_1)})]^2}$$

$$+ \frac{+(N-N_o-N_1)(h_2-h_1) e^{-m(h_2-h_1)}}{[(1-\theta) e^{-m(h_2-h_1)} + \theta]^2} \qquad \ldots(12)$$

$$\frac{\partial^2 \log L}{\partial \theta^2} = \frac{Nm^2(h_2-h_1)^2}{(1+mh)^2} - \frac{N_1[m(h_2-h_1) - (1-e^{-m(h_2-h_1)})]^2}{[m\theta(h_2-h_1)+(1-\theta)(1-e^{-m(h_2-h_1)})]^2}$$

$$- \frac{(N-N_1-N_o)\{1-e^{-m(h_2-h_1)}\}^2}{[(1-\theta) e^{-m(h_2-h_1)}+ \theta]^2} \qquad \ldots(13)$$

b. *The method of moments*

From equation (1), (2) and (3),

$$E(X) = \frac{1}{m} + \frac{m(1-\theta)h_1^2 + m\theta h_2^2}{2(1+mh)} \qquad \ldots(14)$$

$$E(X)^2 = \frac{m\{(1-\theta) h_1^3 + \theta h_2^3\}}{3(1+mh)}$$

$$+ \frac{(1-\theta)(1+mh_1)^2 + \theta(1+mh_2)^2 + 1}{m^2(1+mh)} \qquad \ldots(15)$$

Equating the first two sample raw moments K_1 and K_2 to the corresponding population moments $E(X)$ and $E(X)^2$, and solving the equations for m and θ, the moment estimates of m and θ are obtained as $\tilde{m}$ and $\tilde{\theta}$.

Thus

$$K_1 = \frac{1}{\tilde{m}} + \frac{\tilde{m}(1-\tilde{\theta}) h_1^2 + \tilde{\theta} h_2^2}{2(1+\tilde{m}\tilde{h})}$$

where $\tilde{h} = (1-\tilde{\theta})h_1 + \tilde{\theta}h_2$

or $K_1 = I_1 + I_2$ ...(16)

$$K_2 = \frac{\tilde{m}\left\{(1-\tilde{\theta})\ h_1^3 + \tilde{\theta}h_2^3\right\}}{3\ (1+\tilde{m}\tilde{h})} + \frac{(1-\tilde{\theta})\ (1+\tilde{m}\ h_1)^2 + \tilde{\theta}(1+\tilde{m}\ h_2)^2 + 1}{\tilde{m}^2\ (1-\tilde{m}\tilde{h})}$$

or $K_2 = I_3 + I_4$ ...(17)

We know that for large N, $\sqrt{N}\ (K_1 - E(X))$ is $N\ (0, E(X^2) - (E(X))^2$ and $\sqrt{N}\ (K_2 - E\ (X^2))$ is $N\ [0,\ E(X^4) - \{E(X^2)\}^2]$ respectively, and Cov $(K_1, K_2) = \frac{E(X^3) - E(X)\ E\ (X^2)}{N}$

Now taking differentials on both sides of (16) and (17) and solving for $d\tilde{m}$ an $d\tilde{\theta}$, in terms of $d K_1$ and $d K_2$, it is found that $\sqrt{N}\ (\tilde{m} - m)$ tends to $N\ (0, \sigma_1^2)$ and $\sqrt{N}\ (\tilde{\theta} - \theta)$ tends to $N(0, \sigma_2^2)$ for large N, where

$$\Delta^2\ \sigma_1^2 = (I_{3\theta} + I_{4\theta})^2\ [E(X)^2 - \{E(X)\}^2] + I_{2\theta}^2\ [E(X^4) - \{E\ (X^2)\}^2] - 2I_{2\theta}\ [I_{3\theta} - I_{4\theta})\ \ [E(X^3) - E(X)\ E(X^2)] \quad ...(18)$$

$$\Delta^2\ \sigma_2^2 = (I_{3m}+I_{4m})^2\ [E(X^2) - \{E\ (X)\}^2] + (I_{1m}+I_{2m})^2\ \ [E(X^4) - \{E(X^2)\}^2] - 2(I_{3m}+I_{4m})\ (I_{1m}+I_{2m})\ [E(X^3) - E(X)E(X^2)]$$

where $\Delta = I_{2\theta}(I_{3m}+I_{4m}) - (I_{1m}+I_{2m})\ (I_{3\theta}+I_{4\theta})$ and I_{1m}, I_{2m}, I_{3m}, I_{4m} and $I_{2\theta}$, $I_{3\theta}$, $I_{4\theta}$, are partial derivatives of I_1, I_2, I_4 w.r.t. m and θ respectively.

Application

For illustration, the model is applied to an observed distribution considered in Singh *et al*.

The observed distribution of open birth interval of 724 females with marital duration 10 to 19 years and having at least one birth prior to survey point is shown in table 1. h1 and h2 are taken as one year (9 months gestation + 3 months P.P.A.) and 1.75 years (9 months gestation + 1 year P.P.A.). On the basis of these two values of hi and h_2 and observed distribution, the maximum likelihood and moment estimators of m and B are obtained. Using these estimated values of parameters, the expected frequencies for different class intervals and the variances of estimators are calculated.

These results are given in table 1.

Conclusion

TABLE 1

THE OBSERVED AND EXPECTED DISTRIBUTION OF OPEN BIRTH INTERVALS OF 724 FEMALES WITH MARITAL DURATION 10 TO 19 YEARS AND HAVING AT LEAST ONE BIRTH PRIOR TO SURVEY POINT.

Open birth intervals (In years)	Number of Females		
	Observed	Expected M.L. Method	Moment Method
0 -0.75	168	159.13	160.63
0.75-1.75	199	207.73	209.38
1:75-2.75	153	154.79	155.33
2.75-3.75	103	87.54	86.97
3.75-4.75	44	48.83	48.69
4.75-5.75	24	28.36	27.26
5.75-6.75	13	16.15	16.26
6.75 and above	20	21.46	19.48
Total	724	724.00	724.00
		M.L. Method	Moment Method
X^2 at 5 degrees of freedom		5.35	5.49
$\hat{m}$		0.5635	0.5803
$\hat{\theta}$		0.852	0.875
$V(\hat{m})$		0.0006	0.0013
$V(\hat{\theta})$		0.0656	0.1078

Conclusion

The maximum likelihood estimates of the parameters and their corresponding covariance matrix are more easily obtained than that of moment estimates. The s. e. of the M.L. estimates are less than that for moment estimates.

Lkkjk'k

इस लेख का उद्देश्य उक्त माडल से सम्बद्ध परिमापी से अधिकाधिक अनुमान प्राप्त करने हेतु एक प्रक्रिया निकालना है। अनुमानों का अनंत–स्पर्शीय अन्तद्रव्य विभेद–सहविभेद प्राप्त कर लिया गया है। इसके अतिरिक्त, तुलनात्मक अध्ययन के लिए परिबल विधि से प्राप्त किये गये अनंत–स्पर्शीय विभेद–सहविभेद भी दिये गये हैं। दृश्टान्त के लिए अवलोकित बंटवारे हेतु अपनायी गयी प्रक्रिया सिंह,(कहीं और –5)में अपनायी गई है।

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A METHODOLOGY FOR ESTIMATING AMBULANCE REQUIREMENTS

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ABSTRACT

Provision of adequate size of Ambulance fleet is a matter of concern for any hospital. For estimating ambulance requirements queuing analysis was used in this study. In this analysis incidence of long waiting times rather than mean waiting times were taken as the basis for estimating ambulance requirements in keeping with the desired service level.

This study relates to selecting the ambulance fleet size for meeting the ambulatory care requirements of company's township and surrounding areas. In previous years, on an average, this number deployed at the hospital was around four which varied from time to time due to variations in call rates and breakdown pattern of ambulances. As per the prevalent practice, on receipt of a call, the staff on duty 'for ambulance service provides the service by sending an ambulance if directly available with him or makes alternative arrangements.

The Study Approach

Ambulance service constitutes an important element of any health care system. For improving ambulance service, a number of related factors should be considered which include transport need of patients Cyclic-scheduling of drivers and attendants travelling in ambulance, first-aid emergency equipment carried with ambulance, timely repairs or replacement of ambulances to minimise breakdowns, system of calling and dispatch of ambulances, etc. However, this study considers only the transportation aspects of ambulance service. From this angle, the effectiveness of ambulance service is

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mainly characterised by the following two performance measures, namely:

i. Response time: The period between receipt of a call at the hospital and arrival of ambulance at the scene.

ii. Round-trip-time (service time): The period between receipt of a call at the hospital and return of the ambulance back at the hospital along with the patient.

The above performance measures are shown in Fig. 1. It should be noted that the smaller these measures are, the more effective shall be rated the service. The value of these measures can be reduced by having more stricter supervision of ambulance operations and by increasing the fleet size.

In the present analysis, the multi-channel queuing model and a special queuing model which describes the probability of waiting more than a specified time is taken as the proposed description of an ambulance service in a hospital.

Let λ - the call-rate

μ - the service-rate

S - the ambulance fleet size

n - the number of callers in system awaiting service or being served

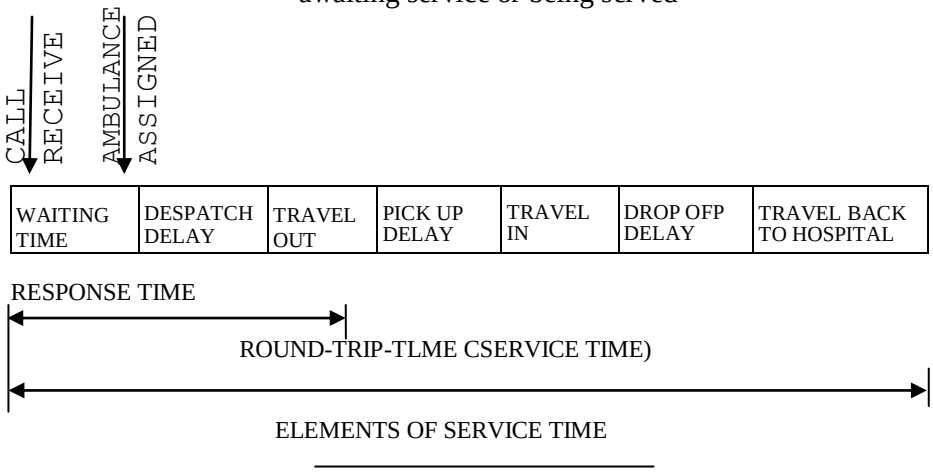


FIG. 1

In multi-channel queuing system, the probability of zero units in the system at time t is given by (1).

$$P_o = \left[\sum_{n=0}^{S-1} \frac{1}{n!} \left(\frac{\lambda}{\mu}\right)^n + \frac{1}{S!} \left(\frac{\lambda}{\mu}\right)^S \left(\frac{S\mu}{S\mu-\lambda}\right)\right] \cdots (1)$$

The average time the caller must wait before being served is (1)

$$E_t = \frac{\mu \left(\frac{\lambda}{\mu}\right)^S}{(S-1)!\,(S\mu-\lambda)^2} P_o$$

By using the appropriate results of queuing theory, the probability that an arriving unit shall have to wait *i.e.* $P_W(>0)$ is given by (2).

$$P_W(>0) = \frac{\left(\frac{\lambda}{\mu}\right)^S}{S!\left(1-\frac{\lambda}{S\mu}\right)}$$

From the same source, the probability that an arriving unit shall have to wait more than t units of time due to non-availability of servers *i.e.* $P_w(>t)$ is given by (2).

$$P_W(>t) = \exp\left[-S\mu t.\left(1-\frac{\lambda}{S\mu}\right)\right] P_W(>0)$$

$$\left(P_W(>t) = \exp\left[-S\mu t.\left(1-\frac{\lambda}{S\mu}\right)\right] \frac{(\lambda)^S}{S!\left(1-\frac{\lambda}{S\mu}\right)}\right.$$

The above results hold good only under steady state conditions *i.e.* $\frac{\lambda}{S\mu} < 1$. The performance measure $P_w(>t)$ *i.e.* the probability of delay more than t units of time is used to evaluate and compare the performance of various ambulance fleet size alternatives.

Analysis and Results

The queuing analysis of ambulance service requires estimation of call rate and service rate μ. Estimates for [and μ were made from one year records. Since the ambulance service is provided throughout the day as such the call rate was arranged in 48 half hourly intervals to determine the call variations during the day and peak demand periods. Service time covers the period between the receipt of call to pick up the patient and bringing patient to hospital by ambulance. The service time was arranged in 5 minutes intervals. Complete details of call-rates and service times are given In table 1 and 2 and shown in Fig. 2 and 3. From table 1 and 2, the average call rate per half hour and average service time were estimated at 1.26 calls and 24.85 minutes respectively. From table 1 it should be observed that call rate was maximum from 9 a.m. to 12 noon and average value during this interval was 1.9 calls which was about 1.58 times the average rate. In view of this the call rate during this interval was taken for estimation purposes. This was done on the presumption that if number of ambulances was sufficient for stress situation, for other periods it would hardly pose any problem. From table 2, the mean service rate was estimated at 1.2 calls per half an hour.

For determining ambulance requirements, P_0 , E_t , P_w (> 0) and P_w (> t) were estimated. In queuing situations of this kind it is Just possible that mean waiting time with existing ambulances may be already low thereby showing that their number is sufficient whereas the demand for them may be still genuine. To alleviate this difficulty, queuing characteristics P_w(> 0) and P_w (> t) were additionally worked out. The reason for estimating P_w(> 0) and P_w(> t) is to provide more ambulances than what are necessary based on E_t. Estimates of ambulances based on P_w(>0) correspond to a case when absolutely no waiting is allowed and, therefore, represent a situation when maximum number of ambulances have to be provided. It is to be seen from the curves that for a particular t, as we Increase S, P_w(>t) starts decreasing and becomes exceedingly low after a specific value. The value of S corresponding to this small value of P_w(> t) becomes the obvious choice for ambulances to be provided- against a predecided value of waiting time 't'. Choice of 't' Is the policy matter of hospital administration. In the present exercise, fleet size (g) varied from 2 to 7 and P_w (> t) was

TABLE 1

VARIATION IN AMBULANCE CALL-RATES WITH HALF HOURLY TIME INTERVALS DURING PREVIOUS YEAR

		Occurrence in Month														
Interval		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.	Total	Prob.	Call-Rate
.00-	0.30	24	18	23	32	18	20	14	26	25	26	30	32	288	.0102	0.7890
.30-	1.00	18	17	16	23	19	27	17	21	25	21	18	19	241	.0108	0.6602
1.00-	1.30	16	19	17	21	18	18	8	15	23	19	19	18	211	.0094	0.5780
1.30-	2.00	16	15	14	14	12	11	13	16	27	20	20	15	193	.0086	0.5287
2.00-	2.30	14	15	14	13	8	17	9	12	16	12	13	13	156	.0070	0.4273
2.30-	3.00	11	11	13	13	11	15	15	15	12	19	13	14	162	.0072	0.4438
3.00-	3.30	8	13	13	8	10	13	16	11	13	10	10	18	143	.0064	0.3917
3.30-	4.00	10	17	10	6	16	15	10	11	17	7	21	12	152	.0068	0.4164
4,00-	4.30	8	9	8	4	9	13	7	13	18	5	11	17	122	.0054	0.3342
4. 30-	5.00	12	11	5	10	12	8	4	15	10	11	13	14	125	.0056	0.3424
5.00-	5.30	11	12	7	14	12	11	10	14	13	15	16	12	147	.0066	0.4027
5.30-	6.00	11	5	16	21	13	8	7	23	14	13	10	9	150	.0067	0.4109
6.00-	6.30	13	12	14	19	13	15	14	18	14	20	16	15	183	.0082	0.5013
6.30-	7.00	49	44	40	57	28	25	24	44	45	48	54	55	513	.0230	1.4054
7.00-	7.30	48	39	35	45	29	27	31	39	49	46	47	39	474	.0213	1.2986
7.30-	8.00	45	40	41	45	40	32	21	47	57	46	54	39	507	.0227	1.3890
8.00-	8.30	36	35	36	38	31	30	22	29	48	47	50	40	442	.0198	1.2109
8.30-	9.00	42	54	53	61	41	49	34	29	58	47	51	48	567	.0254	1.5534
9.00-	9.30	65	64	65	80	43	43	43	48	62	48	56	55	672	.0302	1.8410
9.30-	10.00	77	68	70	85	39	58	43	47	60	55	68	67	737	.0331	2.0190
10.00-	10.30	71	75	72	89	51	50	50	48	51	48	64	71	740	.0332	2.0273
10.30-	11.00	74	65	65	72	47	62	43	43	51	52	67	61	702	.0315	1.9232
11.00-	11.30	75	65	60	78	45	42	40	44	48	57	66	57	677	.0304	1.8547
11.30-	12.00	.81	51	58	70	47	51	45	53	52	41	63	61	673	.0302	1. 8438
12.00-	12.30	72	47	50	44	37	36	37	39	62	41	51	47	563	.0253	1.5424
12.30-	1.00	67	62	55	60	44	49	38	44	62	63	53	44	641	.0288	1.7561
1.00-	1.30	82	61	65	73	50	37	31	45	58	65	63	59	689	.0309	1.8876
1.30-	2.00	71	56	61	84	53	48	36	54	61	61	76	59	720	.0323	1.9726
2.00-	2.30	78	50	66	S3	43	40	35	48	51	53	53	56	655	.0294	1.7945
2.30-	3.00	69	61	59	82	48	58	42	47	56	45	52	50	669	.0300	1.8328
3.00-	3.30	67	60	50	79	53	33	42	43	61	55	46	69	658	.0295	1.8027
3.30-	4.00	58	55	65	70	43	34	37	47	51	60	39	63	622	.0271	1.7041
4.00-	4.30	56	45	46	65	50	48	37	40	52	50	47	45	581	.0261	1.5917
4.30-	5.00	56	51	46	54	44	38	34	50	50	51	41	53	568	.0255	1.5561
5.00-	5.30	53	36	40	57	33	40	29	43	62	36	46	55	530	.0238	1.4520
5.30-	6.00	(6	46	49	60	42	45	32	30	52	41	46	54	563	.0253	1.5424

(Cotd. on page 16)

(Table 1 contd.)

Interval	Occurrence in Month												Total	Prob.	Call-Rate
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.			
6.00- 6.30	57	28	39	43	33	41	29	45	55	43	53	50	516	.0231	1.4136
6.30- 7.00	43	34	31	41	37	34	30	39	60	44	50	51	494	.0222	1.3534
7.00- 7.30	37	25	31	39	39	42	31	38	55	44	35	31	447	.0200	1.2246
7.30- 8.00	47	31	29	53	37	34	35	38	57	46	40	51	498	.0223	1.3643
8.00- 8.30	51	34	39	56	40	40	33	29	45	41	36	80	494	.0222	1.3534
8.30- 9.00	62	42	57	70	43	34	39	55	61	42	48	71	624	.0280	1.7095
9.00- 9.30	74	48	47	69	38	50	39	53	59	51	34	64	626	.0281	1.7150
9.30-10.00	40	34	33	48	34	33	37	49	57	39	33	43	480	.0215	1.3150
10.00-10.30	40	28	38	44	38	35	35	31	40	37	39	31	436	.0196	1.1945
10.30-11.00	43	29	47	49	42	26	33	36	44	43	37	37	466	.0209	1.2767
11.00-11.30	36	26	30	46	33	36	27	27	37	35	42	33	408	.0183	1.1178
11.30-12.00	27	20	17	31	26	23	21	31	29	32	38	23	318	.0142	0.8712
Total	2187	1783	1855	2318	1592	1594	1359	1682	2085	1850	1948	1990	22243	1.0000	60.936
Prob.	0983	.080	.083	.010	.071	.071	.061	.075	.093	.083	.087	.089	1.000		
Call-Rate/ Day	70.5	61.4	59.8	77.2	51.3	53.1	43.8	54.2	69.5	59.6	64.9	64.1	730.0553		
Call-Rate/ Half Hr.	1.46	1.28	1.24	1.60	1.06	1.10	0.91	1.13	1.44	1.24	1.35	1.33	15.2088		

$$\text{Average Call-Rate per half-hour} = \frac{60.936}{48} = 1.26$$

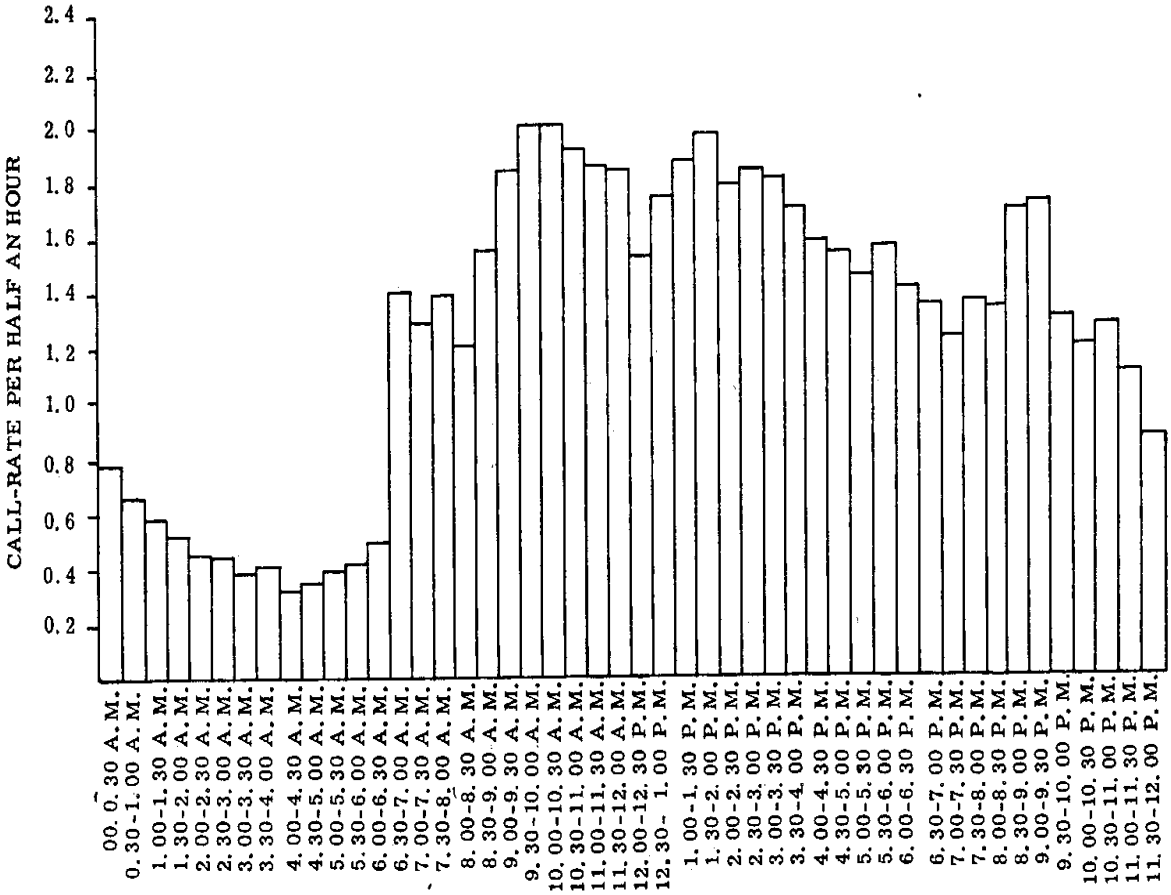
$$= \frac{15.208}{12} = 1.26$$

TABLE 2

MONTH-WISE AMBULANCE SERVICE TIME DISTRIBUTIONS DURING THE PREVIOUS YEAR

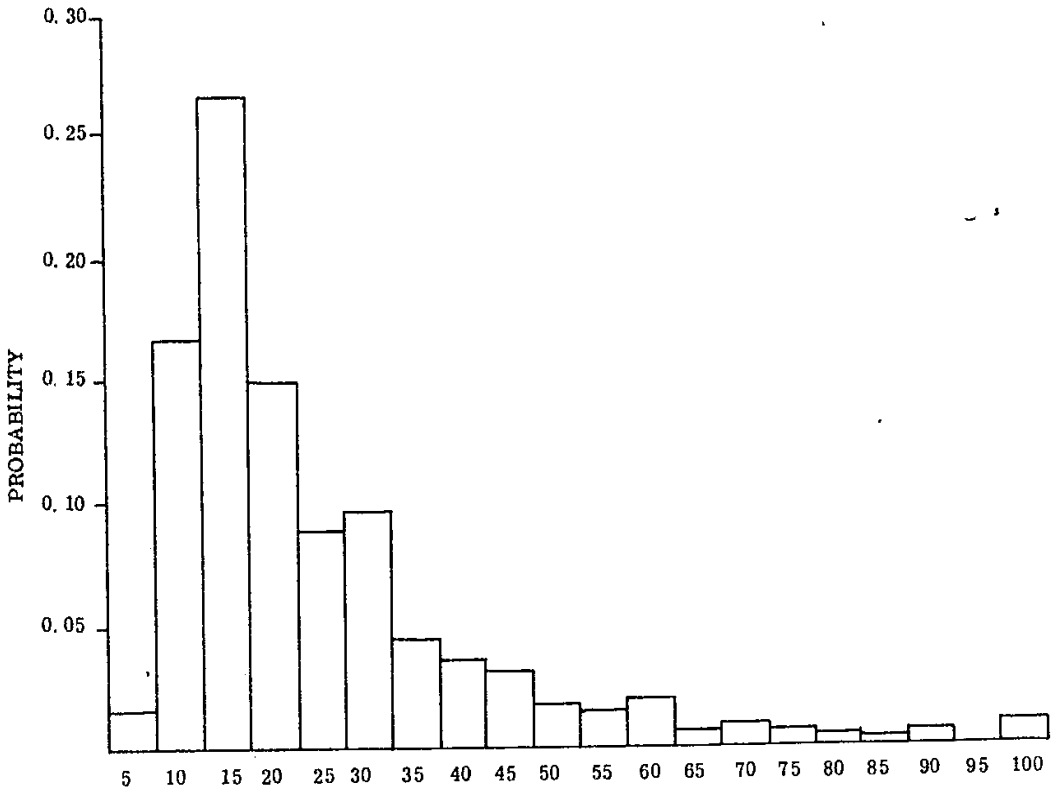
Service Time	Occurrences in Month												Total	Prob.	Product (Col.1x14)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
0- 5	19	19	11	21	14	19	14	10	11	29	18	39	224	.0155	1120
5-10	248	178	167	242	149	134	151	189	199	243	247	260	2407	.1669	24070
10-15	462	278	312	382	182	292	263	309	350	394	362	307	3893	.2699	58395
15-20	192	213	193	218	140	148	126	175	218	187	157	212	2173	.1506	43460
20-25	122	144	109	121	85	118	77	96	125	117	95	109	1288	.0893	32200
25-30	152	93	138	155	90	98	96	96	118	116	128	114	1394	.0966	41820
30-35	58	60	56	57	44	56	31	52	79	63	56	46	658	.0456	23030
35-40	32	43	41	63	31	38	42	47	50	50	57	39	533	.0369	21320
40-45	44	41	46	49	33	35	25	38	42	55	41	30	479	.0332	21555
45-50	28	19	24	23	13	19	10	15	33	30	28	22	264	.0183	13200
50-55	18	26	19	32	17	20	8	18	20	8	19	15	220	.0152	12100
55-60	39	25	24	33	22	18	15	18	30	28	27	24	303	.0210	18180
60-65	12	3	5	15	7	10	9	3	9	8	8	3	92	.0063	5980
65-70	9	6	8	6	10	6	5	10	12	6	8	11	97	.0067	6790
70-75	9	5	5	10	9	8	5	7	5	7	12	6	88	.0061	6600
75-80	4	4	4	6	3	1	4	3	3	0	5	4	41	.0028	3280
80-85	2	3	2	1	3	2	1	6	4	1	2	4	31	.0021	2635
85-90	8	7	7	8	11	1	5	2	10	3	3	13	78	.0054	7020
90-95	1	1	0	4	1	2	2	0	1	1	1	2	6	.0011	1520
95-100	10	12	6	17	15	6	14	10	14	7	14	16	147	.0097	14100
Total	1469	1150	1177	1463	879	1031	903	1104	1333	1353	1282	1276	14420	1.0000	358375
Prob.	.101	.079	.081	.101	.069	.071	.062	.076	.092	.093	.088	.088	1.000		

$$\text{Average Service Time} = \frac{358375}{14420} = 24.85 \text{ minutes}$$



VARIATION IN AMBULANCE CALL RATES AGAINST HALF HOURLY TIME INTERVALS

FIG. 2



AMBULANCE SERVICE TIME DISTRIBUTION

FIG. 3

TABLE 3

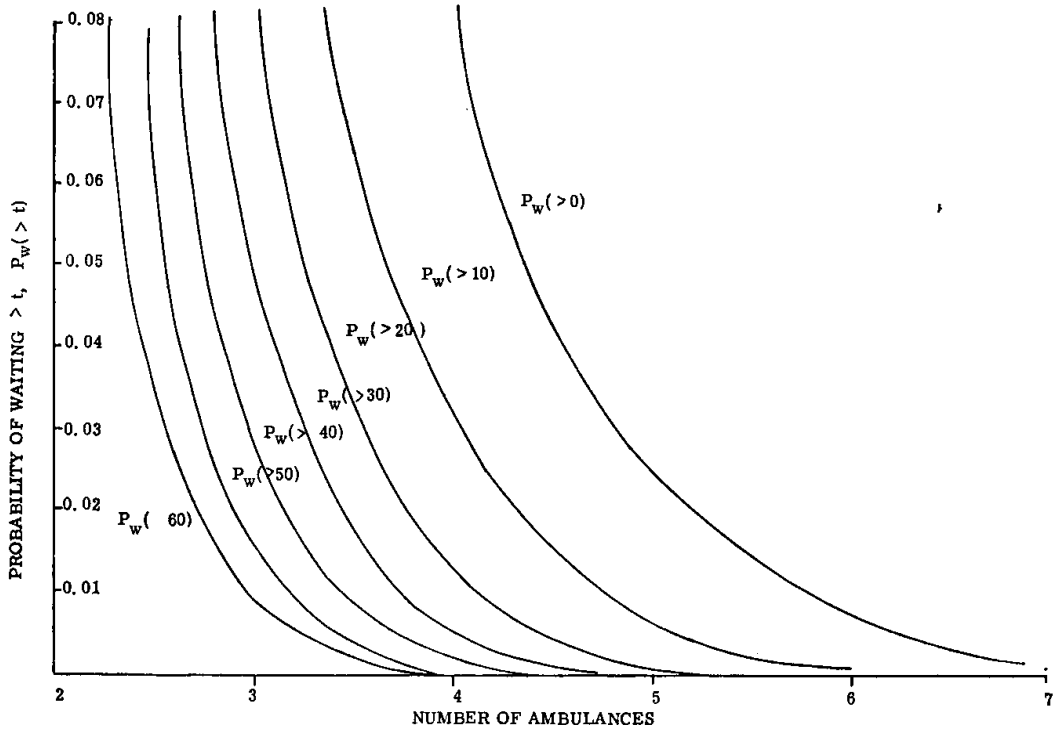
ESTIMATES OF QUEUING CHARACTERISTICS $P_w(>t)$ AND P_o WITH VARYING AMBULANCE FLEET SIZE

No. of Ambulances	P_o	Et Hrs.	Et Mts.	Prob. of Waiting > t minutes, $P_w(>t)$ At t = 0	At t = 10	At t = 20	At t = 30	At t = 40	At t = 50	At t = 60
2	0.1116	2	48	6.98×10^{-1}	5.91×10^{-1}	5.01×10^{-1}	4.24×10^{-1}	3.59×10^{-1}	3.04×10^{-1}	2.57×10^{-1}
3	0.1916		19	2.66×10^{-1}	1.51×10^{-1}	8.57×10^{-2}	4.87×10^{-2}	2.76×10^{-2}	1.56×10^{-2}	8.90×10^{-3}
4	0.2034		4	8.74×10^{-2}	3.33×10^{-2}	1.27×10^{-2}	4.82×10^{-3}	1.84×10^{-3}	6.99×10^{-4}	2.66×10^{-4}
5	0.2056		0.7	2.47×10^{-2}	6.30×10^{-3}	1.27×10^{-3}	4.10×10^{-4}	1.05×10^{-4}	2.68×10^{-5}	6.83×10^{-6}
6	0.2058		0.14	6.04×10^{-3}	1.03×10^{-3}	1.77×10^{-4}	3.03×10^{-5}	5.19×10^{-5}	8.89×10^{-7}	8.19×10^{-8}
7	0.2059		0.02	1.30×10^{-3}	1.49×10^{-4}	1.71×10^{-5}	1.96×10^{-6}	2.25×10^{-7}	2.59×10^{-8}	2.97×10^{-9}

Average Call Rate = 1.26 Calls/half hour

Average Call Rate During Peak Period (λ) = 1.90 Calls/half hour

Service Rate (μ) = 30/2 4.85 = 1.2 on half hour basis



EFFECT OF NUMBER OF AMBULANCES AND WAITING TIME ON QUEUING CHARACTERISTIC, $P_w(>t)$.

FIG. 4

estimated for each S for t - 0, 10, 20, 30, 40, 50 and 60 minutes. Results for queuing characteristics are given in table 3 and shown in Fig, 4. Against a variable t of 0, 10, 20, 30, 40, 50 and 60 minutes, corresponding desirable fleet size, were 7, 6, 5, 5, 4, 4 and 4 which were arrived after necessary rounding. Following this analysis, 6 ambulances based on desired values of t=10 were deployed in hospital to meet the ambulatory care needs of company's township and surrounding areas.

सारांश

उपयुक्त प्रकार के रोगिवाहन बेड़े का प्राविधान होना किसी भी अस्पताल के लिए विचारणीय मामला है। रोगिवाहन आवश्यकताओं के अनुमान हेतु इस अध्ययन में पंक्ति विश्लेषण किया गया है। इस विश्लेषण में रोगिवाहन आवश्यकताओं के अनुमान हेतु इच्छित सेवा स्तर के अनुरूप मध्य प्रतीक्षित समय के विपरीत लम्बे प्रतीक्षित समय की घटनाओं को आधार बनाया गया है।

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HEALTH ECONOMICS - CONCEPTS AND CONCEPTUAL PROBLEMS

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ABSTRACT

Awareness of the economic manifestation of health and diseases and the limited resources allocated to health care services has brought to the focus a new discipline - health economics- Cost accounting, cost benefit, cost effectiveness methods etc. are increasingly becoming an integral part of the health management and evaluation of health programmes. Various concepts and problems relating to health economics are discussed in the present paper. More efforts should be made to conduct health economic studies in hospitals and health centres by which, the process of stan-dardisation of the concepts, would be easier. Health economics should also find its due place in the medical curriculum.

The importance of the economic manifestation of health and disease and the financial limitations restricting the provisions or procurement of adequate health care are well recognised. Day by day, health is becoming all the more valuable and disease all the more expensive. This course of events has brought together two of the applied sciences-Medicine and Economics. As a result a new discipline 'Health economies' has emerged with the task of regulating the relationship between the health objectives oh one hand and the available resources on the other.

Evolution of health economics dates back to the late 17th century, when Sir William Petty, the so-called father of

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'political economy' first instigated the economic appraisal of health services. Since then many research studies on various aspects of health economics have been published e.g. cost-analysis or cost accounting studies, cost effectiveness and cost benefits of different health programmes and cost of diseases etc. 4,18,25,26. These techniques are increasingly becoming an integral part of health planning, budgeting, management and evaluation of health programmes. Concepts of health economics are, however, still under process of standardisation and conceptual problems there too do exist. The present paper discusses the concepts developed and various conceptual problems related to health economics.

What is Health Economics?

Health economics has been defined by various authors in different terms. Analysis of some of the definitions suggest that health economics is the discipline that determines the quantity and price of scarce resources devoted for the care of the sick and promotion of healthl9. It ecompasses the medical'industry as a whole and extends to such fields as the economic analysis of the cost of diseases, benefit of health programmes, returns from investments in medical education, training and research? The definition laid down by the WHO inter-regional seminar seems to be more comprehensive. It defined health economics as 'that which seeks inter alia-to quantify over times, the resources used in health service delivery, their organisation functioning and the efficiency with which the resources allocated and used for health purposes and the effect of preventive curative and rehabilitative health services on individual and national productivity'.

Concepts and Conceptual Problems of Health Economics

The concepts and various problems thereto is discussed under two headings: (1) Health Concepts; and (2) Economic Concepts.

1. Health Concepts

i. How healthy is a given individual or community?: Health has been defined by WHO as 'a state of complete physical, mental and social well being and not merely the

absence of disease or infirmity. This definition although well accepted does not lend itself to direct measurement of health of a given individual or coramunity20. it is argued that health cannot be defined 'as a state (but a process) and there is no satisfactory definition of the term 'well being'. Unless we are able to measure (in some quantitative terms or indices) the health status of the people, we cannot assess the benefits of health services. However, to measure the level of health, some comprehensive and some specific indicators have been advocated by a WHO study group and many more indices have since been developed21. There is also no satisfactory definition of disease. It has been well conceptualised that multiple factors e.g. biologic, genetic, nutritional, physical, chemical, mechanical environmental, social, cultural human behaviour, psychological and economic play a role in the health or disease status of the individuals and the community. Further health and socio-economic progress are very much inter-dependent and health has been accepted as one of the component welfare. These imply that other developmental sectors have a role to play in determining the health status of the people. This makes the task more difficult to identify and quantify the impact of each developmental sector on the health status and vice~versa.

ii. Concept of health services: In all civilised societies the State has assumed the responsibility for the health and welfare of the citizen. Provision has been made in the constitution of most of the governments including India about the health services. Consequently the concept of health services has come into being. For better health care of the people, concepts of comprehensive health care, primary health care, health care for all by the year 2000 A.D., health insurance etc. have been developed and implemented.

The purpose of health service is to promote health, to prevent, diagnose and treat disease and rehabilitate people incapacitated by disease and injury. This general statement does not indicate precisely what the term health services include. The field of health services is a continuous spectrum and it is extremely difficult not only to define the field of health services but also to break it down into clearly defined categories. But for the purpose of economic analysis it must be identified that what activities should be considered as health service activities. According to Abel Smith activities with primary intention to improve health of

the people should be considered as health services. For example, programmes like water supply and environmental sanitation are primarily public utility activities and they should not be considered totally as health services. Only supervisory and regulating activities like disinfection etc. should be considered as part of health services.

For economic analysis purpose, it has been suggested that health service can be classified into22.

a. Medical cave: includes all services for diagnosis, treatment and medical rehabilitation wherever provided and can be further classified into ambulatory, inpatient and domiciliary care.

b. Public health services: Personal public health services - nutritional, antenatal, postnatal and other such personal health services, health examination of pre-school and school children and of workers, immunization and vaccinations services provided to individuals are personal public health services.

c. Environmental public health services: Services like disinfection, spraying, oiling etc. are carried out primarily to protect human health and benefit the community in general and can be grouped as environ- mental public health services. Collection and notification of health statistics are considered as public health services.

iii. Medical Education, training, and research: While computing the cost of health services it is suggested that the cost of training in medical and nursing schools and similar other training institutions directly involved in the training of health manpower should only be included. Similarly, research expenditure which is financed by specifically allocated funds or which can be separately identified should only be included.

2. Economic Concepts

i. Concept of cost: The concept of cost "of providing health services arises from the fact that goods and manpower are absorbed in the health services which could be used to

meet other needs. In case of health and health services, costs are incurred both by the producers of health services, through their use of staff, buildings, equipments, materials and supplies etc. and by the consumers who use transport to the health centres, drugs and special foods etc. Overall health service costs should include opportunity costs on both sides.

ii. Concept of capital and recurring expenditure: In all accounting work it would be useful to distinguish between capital and current costs. The general principle of distinction is that current costs are incurred for benefits immediately obtained while capital costs are incurred for benefits which go on accruing after the end of the accounting period. In theory, any goods with a life of more than a year could be regarded as a capital goods though in practice such strict definition is seldom applied.

iii. Concept of depreciation: As the capital goods have economic life for more than a year, their economic value diminishes with passage of time. Therefore, the concept of depreciation has come into being. Depreciation rate is the rate of diminution in the value of a fixed asset due to use and/or lapse of time23. Whether depreciation should be based on original cost to replacement cost of asset is still a matter of controversy. Further, there is no agreement amongst economists as to the depreciation rate to be used for calculating the annual depreciation cost of capital establishment. Alexander et al and Satpathy et al. used 1-1/2 per cent of depreciation rate for the building cost and 10 per cent for equipment, furniture and vehicle costal McCaffree has added to the depreciation rate a A per cent interest for the money locked up in the capital goods. Sen used only 15 per cent interest rate to calculate the annual capital depreciation expenditure.

iv. Cost of sickness: In calculating cost of sickness, a distinction must be drawn between the cost of health care which may or may not be borne directly by the patient and other costs including loss of earning by the patient and his family and additional costs of special foods, clothes and other articles which usually do fall on the patient and his family. To these may have to be added the disability or rehabilitation costs for such items e.g. appliances or equipments or repairing for more suitable employment.

Various conceptual problems have been brought forward by different workers in calculating cost of sickness. All the health economists have differentiated the direct and indirect cost of the disease. Direct costs includes cost of prevention, detection, treatment, rehabilitation, research, training and capital investments, whereas loss of output to the economy because of illness, disability and premature death forms the indirect cost.

v. Measurement of health service benefits: Although some health programmes require no economic justification, there is need to quantify the benefits of health programmes, so as to enable a fair appropriation of financial resources to be obtained for them. The problems associated with the quantification of the benefits of health services are: (a) Health problems are often strongly influenced by the general socio-economic conditions prevailing; (b) the impact of health services depends on their utilisation and maintenance by the population and cooperation of the patient. It is, therefore, hardly surprising that only in a few and highly specific cases estimation of the impact of health services on the reduction of health risks and problems have been possible; (c) there has been no successful and agreed index of population health status in any country; and (d) medical specialists and others value a given health impairment differently.

The WHO Seminar on health economics has opined that although certain types of benefits are measurable directly in terms of money or incomes but most of the benefits of health programmes, however, cannot or should not be measured in monetary yardstick. Putting a monetary value on human lives is not considered as a satisfactory procedure.

vi. Cost trends: It is generally believed that better health services would reduce the total volume of sickness in the nation and consequently the need for health services would decline. The state of health service is, thus, seen not only as a wealth producing service, but also as a partially self-liquidating service. It has been, however, observed that expenditure on health is consuming the national income at an increasing rate and if, this trend continues several countries may be spending some 10 per cent of their national income on health services before the year 2000 A.D..

The reasons for such increasing trend are: (a) rapid population growth in developing countries; (b) frequent and more costly demands of ageing population in the developed countries; (c) labour intensive nature of health services; (d) advances in costly medical technology; (e) increasing demands for^ higher standards of health care facilities; (f) as communicable diseases are brought under control, cost of detection or prevention of a case Increases. Moreover chronic and digenerative diseases with their high cost of care dominates the pic ture; and (g) b ad management and multitude of agencies financing and delivering parallel and uncoordinated health services.

vii. Definitions and use of cost analysis procedures: (1) Cost accounting: Cost accounting is a set of procedures for determining the cost of a product and various activities involved in its manufacture and sales and for planning and measuring performances.

The functions of cost accounting are: (a) determination and analysis of cost which help in evaluating the operating efficiency of each division; (b) accumulation and utilisation of cost data for purposes of controlling costs; (c) as an aid to management it helps arrive at the cost of production of every unit job, work order, processes etc. and indicate Inefficiencies to the extent of various forms of waste viz, material, labour and administration etc.

Problems of cost accounting in health sector: The accounting methods currently in Use do not as a rule, permit comparison of the costs and benefits of dealing with given health problem in different ways. Situations where several programmes use some resources Jointly, such as those for teaching, research and provision of medical care, the proportional allocation of total costs among programmes is often difficult and to some degree arbitrary. The cost accounts methods need to be standardised for each programme and broken down by type of resources such as staff, machineries, drugs etc. Alexander et al. and Satpathy et al. applying work sampling and time motion study data respectively observed that cost accounting of health centre expenditure, distribution of these expenditure by PHC functions and estimation of unit costs were possible. A proper and uptodate recording system, Is however, very much essential for this purpose.

Williams has said that in costing the inputs into activities are often unclear at a conceptual level and even the data at our disposal were frequently inadequate?.

(2) Cost benefit analysis: It is a method of comparing the cost of providing service with the gain accruing or likely to accrue from it. In practice cost benefit analysis is mainly tieed to Justify a particular health service programme or action. It attempts to value all socially relevant outcomes in monetary forms. The difficulty, however, is that most benefits in terms of health and social development cannot or should not be reduced to monetary terms. Cost benefits analysis is probably most useful for health programmes that have a major impact on economic development.

Banerjee has suggested that because of the deficiency in public health statistics and inter-dependence of public health aims and achievements with those in other fields of social policy, the unit for measurement of benefit should be level of living rather than level of health.

A frequent source of confusion to readers is that cost and benefits are usually not measured at the same time and that the so-called costs of a disease being measured are really the projected benefits on the implicit assumption that the disease will be totally eliminated or eradicated.

(3) Cost effectiveness analysis: It is comparing the costs of achieving an agreed objective in different ways. Cost effectiveness and cost benefit analysis measure inputs in the same way i.e. as costs In monetary terms. They differ in their measurement of outcomes. Cost effectiveness analysis concentrates on one major desired outcome or benefit such as health improvement or reduction of the incidence of one disease as outcome in terms of effectiveness i.e. percentage reduction In the incidence of disease rather than valuing it in terms of money. The price to be paid for the simplicity of cost effective analysis is that either cost or effective- ness has to be kept constant while the different options are considered and comparative evaluation seeks to show which one of equally costly alternative policy actions is likely to be most effective or which one of equally effective policy action is expected to be least costly.

Cost effective analysis is particularly useful to evaluate different methods of attacking a single disease problem. But care should be taken, however, to ensure that lower costs do not mean loss of quality.

(4) Cost efficiency analysis: It is a method of comparing the two or more enterprises providing similar services or in a single enterprise at different times.

Conclusion

Analysis of the concepts health economics and various problems relating to it, suggest that more effort has to be made to further develop and standardise the concepts. Health economics should be made an integral part of the health management right from the peripheral level to intermediary and apex referral hospitals. Health administrators, doctors and other health personnel should be oriented to this new discipline. Thie can be achieved by including and emphasising 'health economies' in undergraduate and postgraduate medical curriculum. Refresher courses for the health administrators in health economics would also be of considerable help.

Lkkjk'k

स्वास्थ्य एवं रोगों के आर्थिक अविर्भाव के बोध और स्वास्थ्य देखरेख सेवाओं के सीमित संसाधनों के बंटवारे ने एक नई नियमानुशीलता पर ध्यान केन्द्रित किया है– वह है स्वास्थ्य अर्थशास्त्र। लेखा लागत, लाभ लागत, लागत प्रभावशालिता तरीके तेजी से स्वास्थ्य प्रबंध और स्वास्थ्य कार्यक्रमों के मूल्यांकन का गहन हिस्सा बनते जा रहे हैं। स्वास्थ्य अर्थशास्त्र से सम्बन्धित विभिन्न धारणाएं और समस्याओं पर इस लेख में चर्चा की गई है। अस्पतालों और स्वास्थ्य केन्द्रों में स्वास्थ्य अर्थशास्त्र पर और अधिक अध्ययन किये जाने के प्रयास होने चाहिए ताकि इन धारणाओं का स्तरीकरण आसान हो सके। स्वास्थ्य अर्थशास्त्र को चिकित्यकीय पाठ्यक्रम में भी यथेश्ट स्थान मिलना चाहिए।

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QUANTITATIVE ESTIMATION OF Rh ANTIBODIES IN Rh IMMUNIZED SUBJECTS AND THEIR EFFECTS IN PREGNANCY

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ABSTRACT

The study links the cases of mishaps of pregnancy with the changing Rh antibody titre value which increases with the gestation period. The author concludes that the high antibody titre in females of incompatible matings has a relationship with some of the cases of abortion, still birth and haemolytia disease of the foetus/newborn of hitherto unidentified aetiologioal factors acting together or separately to cause these mishaps.

It is a fact that mothers develop antibodies against the incompatible babies. The initial, antibody production is liable to occur anytime from early pregnancy onwards. The titre becomes higher and manifest more with the advance of pregnancy. The non-appearance of antibodies by about the thirty-fourth week reduces the probability of their production in that particular pregnancy. Antibodies detected after the thirty-fourth week tend to be of low titre and are associated with a mildly affected or clinically normal infant.

Rh immunization can only be diagnosed by examining maternal blood for the presence of antibodies. The methods of forecasting accurate antenatal prediction would help us to increase foetal and neonatal salvage.

The present study was undertaken with the following aims and objectives:

i. To study the Rh blood groups of pregnant women and their respective husbands.

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ii. To determine the incidence of Rh incompatibility.

iii. To estimate the Rh antibodies in maternal serum by doubling dilution at the time of registration and at the various intervals of gestation. Cases with high or rising titre were advised for hospitalization.

iv. To observe the effect of Rh antibodies in pregnancy.

Materials and Methods

The present study was carried out in the Post-graduate Department of Physiology in collaboration with the Department of Obstetrics and Gynaecology, S.N. Medical College, Agra. In all, 360 couples were investigated, out of which 250 belonged to the 'study group*. For purpose of comparison, 110 normal couples were also investigated and placed in the control group. Salient features like age, socio-economic status, parity, obstetric history and clinical findings of all these cases which came under observation were also recorded. The criteria for selection of study cases were as follows (Table 1),

TABLE 1

STUDY GROUP: CLASSIFICATION OF CASES INTO SUB-GROUPS ACCORDING TO PRESENTING SYMPTOMS

S.No.	Type of Cases	No. of Cases	Percentage
1.	*Abortion cases with or without history of abortion/s*	*190*	*76.0*
2.	*Non-pregnant cases with history of abortion/s with no foetal haemolytic disease*	*19*	*7.6*
3.	*Cases of normal full term confinement with no foetal disease but with history of abortion/s*	*28*	*11.2*
4.	*Still birth cases*	*3*	*1.2*
5.	*Cases of full term confinement with foetal haemolytic disease*	*8*	*3.2*
6.	*Non-pregnant cases with history of abortion along with foetal haemolytic disease*	*2*	*0.8*
	Total	*250*	*100.0*

The cases of control group were selected at random; the only criterion being that none of them had any history of abortion or foetal haemolytic disease.

Five ml of venous blood was collected from an ante-cubital vein by pre-sterilised glass or plastic syringe. Rh typing was done by rapid slide test using Anti-Rh (anti-D) serum and by 'Standard technique' for Rh typing - One stage method using saline anti D*. Rh antibody titration was done by standard technique using 30 per cent solution of bovine Albumin in various dilutions.

Results and Discussion

Rh typing was carried out in all the 360 couples. The incidence is given in table 2.

The results obtained in this study have shown a marked difference of Rh positivity and Rh negativity in the females of the two groups. As regards the males in both the groups, the difference was negligible. The findings of the present study show a little higher incidence of Rh negativity as compared to the findings of other workers. The incidence in each of the above reports was 10.0 per cent while in the present series it was 10.2 per cent (study and control groups combined). However, an incidence of 13.5 per cent has been reported in an analysis of 12,140 cases. Another study quoted a 17 per cent incidence of Rh negativity in U.K.5 However, the racial, genetic and other factors might be responsible for the incidence of Rh negativity in various regions.

The coincidence that all Rh negative females in the study group had Rh positive husbands is apparent from table 2 and 3, Further, all the eight Rh negative females of control group also happened to have Rh positive husbands (table 2 and 3). The incidence of Rh incompatible matings in the study and control group thus tallies with the incidence of Rh negativity in the females - both in the study group (17,6%) and in the control group (7.3%),

Rh antibody titration is a simple matter of serial dilution of the serum to find the end point of agglutination. A titre of 1:64 shows that dilution of the serum to 64 volumes is the highest dilution in which agglutination of a

TABLE 2

INCIDENCE OF Rh FACTOR

Sex	*Rh Factor*	*Study Group (%)*	*Control Group (%)*
Female	*Rh Positive Rh Negative*	*82.4* *17.6*	*92.7* *7.3*
Hale	*Rh Positive Rh Negative*	*92.4* *7.6*	*91.8* *8.2*

TABLE 3

INCIDENCE OF Rh COMPATIBLE AND INCOMPATIBLE MATINGS

Type of Matings	Study Group		Control Group	
	No. of cases	Percentage	No. of cases	Percentage
Rh Compatible	206	82.4	102	92.7
Rh Incompatible	44	17.6	8	7.3
Total	250	100.0	110	100.0

2 or 3 per cent suspension of red cells occurs. Rh antibody titration was carried out in all the incompatible cases at the time of their registration in the hospital and at the various stages of gestation, as for as possible. The findings are given in table 4 and 5 for the study group and control group respectively.

In the present series, out of 44 Rh incompatible cases of study group, four cases were of full term with haemolytic disease of the newborn while one case was of still birth. Three cases had a maximum Rh antibody titre 1:1024 at 36 weeks of pregnancy. Out of these, two cases terminated in full, term delivery and the infants had Rh haemolytic disease while one case terminated in a still birth. Two more cases of Rh haemolytic disease were observed. One of them had Rh antibody titre 1:512 at a gestation of 36 weeks while the other had a titre of 1:128 at the same period.

Four cases of study group were of full term normal delivery. These babies were quite healthy and none of them had any symptom of haemolytic disease although they had Rh antibodies. Rest of the cases were terminated in abortion at various stages of gestation. Some of them had Rh antibodies (2 cases of "non-pregnant state" were also included and these cases had a history of abortion) (Table 4). Five cases of -control group had a weak Rh antibody titre shortly before delivery (titre 1:4 in three cases and 1:8 in two cases) and all of them gave birth to normal infants. Rest of the cases also delivered normal full term babies (table 5).

Conclusion

Changes in the Rh antibody titre value were seen to be progressively increasing with the gestation period. Increased titre was seen to be responsible for many cases of mishaps of pregnancy. However, it was concluded that the high antibody titre in females of incompatible matings may explain some cases of abortion, still birth and haemolytic disease of the foetus/newborn of obviously unknown aetiological factors acting together or separately to cause these mishaps. Wiener, Langley and Stratton could not establish any relationship between Rh antibody titre in maternal serum at term and the severity of the disease with which the newborns were affected.

TABLE 4

STUDY GROUP: Rh ANTIBODY TITRE

S.No.	Rh Factor		Gestation (weeks)	At registration	Rh Antibody titration At various stages of gestation (weeks)									Fate of pregnancy
	Wife	Husband			8	12	16	20	24	28	32	36	38	
1.	-	+	12	A	A	1:8	-	-	-	-	-	-	-	Abortion
2.	-	+	36	A	A	A	A	A	A	1:128	1:1256	1:1024	-	H.D.N.B.
3.	-	+	12	A	A	1:4	-	-	-	-	-	-	-	Abortion
4.	-	+	12	A	A	1:8	-	-	-	-	-	-	-	Abortion
5.	-	+	N.P.S.	A	-	-	-	-	-	-	-	-	-	-
6.	-	+	36	A	A	A	A	A	A	A	1:64	1:128	-	H.D.N.B.
7.	-	+	36	A	A	A	A	A	A	A	1:4	1:8	-	F.T.N.D.
8.	-	+	12	A	A	1:32	-	-	-	-	-	-	-	Abortion
9.	-	+	8	A	1:16	-	-	-	-	-	-	-	-	Abortion
10.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
11.	-	+	20	A	A	1:2	1:4	1:8	-	-	-	-	-	Abortion
12.	-	+	38	A	A	A	A	A	A	A	1:4	1:8	1:16	F.T.N.D.
13.	-	+	38	A	A	A	A	A	A	A	1:4	1:8	1:16	F.T.N.D.
14.	-	+	12	A	1:4	1:16	-	-	-	-	-	-	-	Abortion
15.	-	+	8	A	1:16	-	-	-	-	-	-	-	-	Abortion
16.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
17.	-	+	P.S.	A	-	-	-	-	-	-	-	-	-	-
18.	-	+	12	A	A	1:4	-	-	-	-	-	-	-	Abortion
19.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
20.	-	+	8	A	1:16	-	-	-	-	-	-	-	-	Abortion
21.	-	+	12	A	1:4	1:16	-	-	-	-	-	-	-	Abortion
22.	-	+	12	A	1:4	1:16	-	-	-	-	-	-	-	Abortion
23.	-	+	16	A	A	A	A	-	-	-	-	-	-	Abortion
24.	-	+	16	A	A	A	A	-	-	-	-	-	-	Abortion
25.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
26.	-	+	20	A	A	1:2	1:4	1:8	-	-	-	-	-	Abortion
27.	-	+	16	A	A	A	A	-	-	-	-	-	-	Abortion
28.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
29.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
30.	-	+	24	A	A	A	A	A	1:2	-	-	-	-	Abortion
31.	-	+	12	A	A	1:8	-	-	-	-	-	-	-	Abortion
32.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion

(Contd. on page 40)

(Table 4 contd.)

S.No.	Rh Factor		Gestation (weeks)	At registration	Rh Antibody titration									Fate of pregnancy
	Wife	Husband			At various stages of gestation (weeks)									
					8	12	16	20	24	28	32	36	38	
33.	-	+	36	A	A	A	A	1:32	1:64	1:128	1:512	1:1024	-	H.D.N.B.
34.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
35.	-	+	16	A	A	A	A	-	-	-	-	-	-	Abortion
36.	-	+	20	A	A	1:2	1:4	1:8	-	-	-	-	-	Abortion
37.	-	+	16	A	A	A	A	-	-	-	-	-	-	Abortion
38.	-	+	36	A	A	A	A	A	A	A	A	A	-	Abortion
39.	-	+	24	A	A	1:32	1:64	1:128	1:256	-	-	-	-	Abortion
40.	-	+	36	A	A	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	-	Still Birth
41.	-	+	36	A	A	A	A	A	A	A	A	A	-	Abortion
42.	-	+	12	A	A	A	-	-	-	-	-	-	-	Abortion
43.	-	+	36	A	A	A	A	A	1:32	1:64	1:128	1:512	-	H.D.N.B.
44.	-	+	36	A	A	A	A	A	A	A	A	1:2	-	F.T.N.D.

Index: Col.2 "-" = Rh factor negative
Col.3 "+" = Rh factor positive
N.P.S. = Non-pregnant state
A = Absent
H.D.N.B. = Haemolytic disease of newborn
F.T.N.D. = Full term normal delivery

TABLE 5

CONTROL GROUP: Rh ANTIBODY TITRE

S.No.	Rh Factor		Gestation (weeks)	At registration	Rh Antibody Titration At various stages of gestation (weeks)									Fate of pregnancy
	Wife	Husband			8	12	16	20	24	28	32	36	38	
1.	-	+	38	A	A	A	A	A	A	A	A	A	A	F.T.N.D.
2.	-	+	36	A	A	A	A	A	A	A	A	1:4	-	F.T.N.D.
3.	-	+	36	A	A	A	A	A	A	A	A	1:4	-	F.T.N.D.
4.	-	+	36	A	A	A	A	A	A	A	A	1:4	-	F.T.N.D.
5.	-	+	36	A	A	A	A	A	A	A	A	1:8	-	F.T.N.D.
6.	-	+	36	A	A	A	A	A	A	A	A	1:8	-	F.T.N.D.
7.	-	+	36	A	A	A	A	A	A	A	A	A	-	F.T.N.D.
8.	-	+	36	A	A	A	A	A	A	A	A	A	-	F.T.N.D.

Index: Col. 2 " - " = Rh factor negative
Col. 3 " + " = Rh factor positive

A = Absent
F.T.N.D. = Full term normal delivery

However, the titration of maternal antibodies at 10 days post-partum also makes possible the selection of high titre donors of Rh typing serum. A high titre anti-D serum may be obtained from the Rh negative mothers with suitable antibodies (titre not less than 6A), who had recently delivered an Rh positive infant. This is not of immediate benefit to the mother and baby concerned but without such sera, freely given by mothers who have seen the effects of haemolysis on their own children, none of the antenatal Rh testing, nor the treatment of infants with haemolytic disease nor even the provision of Rh negative blood would be possible.

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Lkkjk'k

इस अध्ययन में संगर्भावस्था अनिष्टपात के मामलों को परिवर्तित होती आर. एच प्रतिरक्षी अनुमाप अर्ध्य से जो कि गर्भाविधि में बढ़ जाता है, सम्बन्धित किया गया है। लेखक का निष्कर्ष है कि असंगत समागम की स्त्रियों में उच्च प्रतिरक्षी अनुमाप का गर्भपात, मृत जन्म और गर्भ/नवजन्म की अब तक अज्ञात रूधिर–सम्बद्ध बीमारियों के लिए साथ'–साथ या अलग रूप से कार्य कर रहे हैतूकीय कारकों का आपस में संबंध है।

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TRIBAL HEALTH PROGRAMME

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ABSTRACT

In June 1978, the Department of Social Welfare, Government of Maharashtra, commissioned the Centre for Development Studies and Activities (CDSA), Pune, to prepare an. Action Programme for the Improvement of Health in 'the -. Tribal Areas of Maharashtra, The following is the ^' brief report submitted by CDSA.

The basic objective of the study was to come up with an action plan which could be incorporated with the sub-plan for the tribal areas, in Maharashtra State. The study focussed on health in a selected cluster of villages, namely Peint Block. Detailed information on nutrition, food consumption expenditure, land holdings, family size and diseases was collected. Our findings led us to an integrated and holistic approach which link aspects of land holdings, production, income, family size, consumption, nutrition and health.

Problems were identified related to poor levels of nutritional intake, inaccessibility to social services, low levels of participation, lack of coordination and monitoring of the s chemes that do exis t, low levels of economic viability of the families, poor sanitation, etc.

The existence of a traditional system of health care, though only for curative services, was observed and further it continued to enjoy the confidence of the tribal population in spite of the competition offered by the modern system. However, the two systems worked in isolation, whereas it would be possible to integrate the traditional system with the modern system, and thereby enable the latter to gain greater credibility and acceptance by the tribal population.

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Major Findings

One major conclusion drawn by the research team is that the health problem was an integrated aspect of tribal life. This also means that the health problem is closely tied up with the problem of (a) lack of development of productive potentials, arid (b) an exploitative system of work, and distribution. A model was evolved which related (1) land, (2) production, (3) income, (4) family size, (5) consumption, (6) nutrition, and (7) health. This interacts with the ecological model in which (a) poor health levels, (b) the level of infectious viruses and bacteria, (c) poor sanitary conditions and personal hygiene form a vicious circle.

It was found that 9.0.17 per cent of the people fall under the subsistency line in terms of the per capita income needed to generate a level of expenditure on food, which would meet basic nutritional levels. About 37 per cent of our sample households had no land holdings at all. But even for those who had land, the holdings were small or uneconomical to operate, due to the undulating terrain.

There Is an extensive system of 'indirect bondedness'. We use the term 'indirect bondedness[1] as it is based on a system of indebtedness and labour contracting. It works through labour contractors who are themselves tribals. This tends to conceal the system, as it operates through a layer of dominant individuals from among the tribals. People generally depend for subsistence consumption on their employers, especially during lean periods. This sort of indebtedness 'in kind' may or may not be accompanied by debts in cash. In either case, it becomes an obligatory debt, which the tribals can repay only through their own labour in
the next kharif season. Such an arrangement virtually ends up in a kind of indirect bondedness, from which the tribals cannot extricate themselves easily. The main implications of this kind of economic non-viability of the households are: (1) malnutrition, (2) ill health, (3) Inaccessibility to proper education and health care services, etc., and (4) inability to improve the productivity of their farms, which in turn perpetuates the vicious circle of poverty, indebtedness, bonded labour, low consumption and poor health.

Nearly 87 per cent of the sample households spend more than 85 per cent of their income on food. But the nutritional

standards are appalling. Nearly 67 per cent of the sample population suffered from calorie deficiency. About 24 per cent of the sample population sufferred from protein deficiency.

The normal diet of the tribals consists mainly of Nagli. It may sometimes be accompanied by rice and tur/urid dal. Vegetables are eaten seasonally. Consumption of eggs, meat, fish and milk is negligible. During the summer, the survive mainly on 'Kadu Kand' (a bitter root) and a thin gruel made out of Nagli. There is no special diet for pregnant and nursing mothers, or children, and there is no special weaning diet either. Due to inadequate intake of food, especially during the lean months, they generally remain undernourished.

There is an acute water shortage for six months of the year, despite the high rainfall (100-150"). They may sometimes have to go four or five miles to fetch water. Their cattle also have to go without water for three to four days at a stretch, and are driven to a stream bed at a distance of four to five miles. About 29 per cent of the villages have acute water problem, all the year round. Only 15 per cent of the wells are perennial. Others have water only for about six months.

The incidence of water-borne diseases is quite high. As per the clinical survey conducted by us, 54 per cent of the people suffer from amoebiasis, worms, dysentery, diarrhoea, scabies and other skin infections.

Since most of the tribals work in the fields, it is hardly possible for them to carry boiled water wherever they go. Tribals refuse to drink water purified by potassium permanganate, as they do not like its taste and smell. They also believe that if milk is kept in pots washed with such water it curdles.

Over 60 per cent of the villages, covering 54 per cent of the population, are not connected by pucca roads. The terrain is difficult; it is characterised by hills and valleys. There are very few all-weather roads. Patients generally have to walk to the PHC. During the monsoon and early winter, when they are cut off completely, they may" not go to PHC at all. If a person is very ill, he will have to

be carried to the PHC. Even the sub-centres are often cut off from the more interior villages, due to landslides and heavy rains, during the monsoon.

Many times the doctors at the PHC run out of medicines. They are then asked to buy the required medicine with their own money, and charge for the same. This creates an imbalance, as some people get the medicine free while others have to pay for the same. This leads to a lack of confidence among the tribals regarding the doctor and the government facilities.

Following administrative problems were also identified:

a. There is often an inordinate delay regarding payments to the staff at the field level. Their salaries are received late, sometimes by one or two months. Their bills submitted for reimbursement may take upto an year for reimbursement.

b. The budgetary provisions need to be made more flexible at the PHC level, so that whatever money is allocated is used efficiently and does not lapse.

c. The doctors are forced to do too much of administrative paper work, due to the lack of properly trained secretarial help.

d. No food is provided to the patients; nor is there any cooking facility available for people coming from faraway places, so that they can cook their own food and supply the patients their needs.

e. There is no provision for visits by specialists from the district level. The tribals are thus forced to go to the district headquarters for the services of specialists like dentists, ophthalmologist etc.

Action Programme

The proposals that emerged as a result of the study are outlined below. A programme of action which focusses on health, nutrition, environmental improvement and family viability is suggested for the predominantly tribal areas of Nasik district.

The strategy is to use health as an entry point for development of the area. The long term goal is to break into the cycle of low productivity, poor consumption levels and, poor health.

The social structure of the area is based on a pyramid with traditional land owners and money lenders at the top. Next come dominant tribal clans, and then the masses of tribal population. At present, a vast majority of the people depend on the top tier for doles of grain, etc. during the lean months. Thus culturally the bottom tier feels emotionally indebted to the top tier. Some additional livelihood is made by the bottom tier through their small land holdings, foraging in forests and forest-related work.

Such a situation makes it imperative that our strategy should include some economic inputs, if changes are to be brought about in the existing system. Thus, a strategy of basic human needs (health, nutrition and sanitation) combined with schemes for wage employment and self-employment has been taken.

More explicitly, the strategy includes:

a. Linking health and nutrition inputs to wage and self- employment activities, exploiting local resources and potentials In a low-skill and labour-intensive manner.

b. Creating an institutional basis for the improvement of health, and overall development, penetrating to the smallest level of settlements, and integrating plans and actions initiated by beneficiary groups.

c. Increasing the economic viability of the poorest families, so that they can participate in the social and economic activities and achieve basic consumption
levels.

The programme objectives have been spelt out in terms of physical targets (inputs) and in terms of beneficiaries (coverage).

At the programme formulation stage, several factors, which may act as constraints to the success of the programme, were considered.

a. Existing poor levels of grass-roots participation may considerably reduce the effectiveness of the programme. Our political system encourages a spirit of inaction in the people, through promises of free gifts. Even our social workers have created dependency by 'giving' things rather than sponsoring self-reliance. People expect things to be done by others and to be done free. They will not maintain or manage what is p rovide d. The re fo re, it is essential to get the beneficiaries to help identify problems, set priorities, and commit funds for maintenance.

b. Lack of confidence in the administrative system is another major constraint. Unfortunately, the experience of the tribal population with the government officials has been one of exploitation. This is even more true in the case of functionaries at the lowest echelons of the bureaucracy. The injection of a participatory element and the involvement of non- government organisations (voluntary agency) will therefore be critical factors.

c. Coordinating the inputs will be a major problem in implementing an integrated programme, which depends on various government agencies, and different levels of bureaucracy. For example, a gobar gas plant without a cattle shed, or a cattle shed without cows, or cows without foddeiT will not work. Timing, phasing, and the locations of inputs will be critical.

d. Adapting the programme to the local conditions is another important problem. The implementing staff must learn and respect the variations from area to area, or even from village to village.

e. Finding the necessary staff is likely to become a major bottleneck in implementing the programme. If the work is managed by conventional techniques it is likely to result in apathy on the part of the super -

visory and contact officials. Therefore, motivated managers and social workers will have to be directly recruited. Unless dedicated workers, from the community itself, are found, trained and motivated, the programme will not gain momentum. The involvement of voluntary agencies will help, as the government need not create permanent posts, and the voluntary agencies can hire motivated young people on a contract basis.

f. Exploitation of the various schemes by the privileged and powerful classes and individuals in the area is a very real problem. Involvement of the beneficiary groups in the decision-making processes, and adequate monitoring are the two most crucial factors in this regard.

The proposed action programme links together positive, preventive and curative elements for improvement of health. Six action areas have been identified:

a. Nutrition

b. Family viability

c. Training and institutional development

d. Environmental hygiene

e. Health

f. Social and economic infrastructure

The action areas are mutually supportive and interlinked. The resources for the programmes are concentrated on central villages which presently have PHCs and Sub-centres. The per capita investment suggested is Rs.175 over a period of two years. As the programme is integrated and include needed facilities and infrastructure for other sectors also, it would not make sense to compare the per capita investments directly with other health programmes. Many of the proposed inputs will merely begin to bridge the gaps of decades of neglect.

The action area of nutrition includes the following schemes:

a. The infant food supplement scheme (Peint mix).

b. Food supplement scheme (milk) for pregnant and lactating mothers.

c. Community cooking-cum-bakery units.

d. Nursery-cum-demonstration garden.

e. Shala garden scheme.

f. Distribution of fruit-hearing trees (saplings).

g. Fresh water fish scheme (breeding and demonstration tank).

h. Distribution of fish- to he raised in the paddy fields.

The action area of family viability includes the following schemes:

a. Artificial insemination of indigenous cows.

b. Distribution of pregnant Indigenous heifers crossed with exotic bulls.

c. Sale of indigenous heifers (loan) schemes.

d. Handicrafts development scheme.

e. Poultry scheme.

The action area of training and institutional development provides a vertical and horizontal link in the development effort. It includes the following schemes:

1. Training for village bhagats.
2. Training for local dais.
3. Training for primary school teachers.
4. Orientation sessions for PHC staff.
5. Establishment of Nasik Foundation for Development.
6. Training of the sub-centre staff and Sanchalikas.
7. Transport for participants in orientation courses.

8. Printing monthly newsletter on health, environment, nutrition and other schemes.
9. Support for a voluntary organisation.
10. Providing audio-visual unit.
11. Functional education for skill development.
12. Initiation of women's groups.
13. Appointment of Sanchalikas in each village centre.

The action area of environmental hygiene includes most of the preventive measures. It includes the following schemes:

1. Communal haud for bathing.
2. Bore wells with hand pumps (210);
3. Overhead tank with electric pump (37).
4. Disinfecting of wells.
5. Smokeless Chulhas.
6. 2 Sandas each in every village.
7. Goborgas plants (37).
8. Cattle sheds (37).
9. Mini-cattle sheds (555).

The action area of health deals directly with the health care system, and supplements the activities of the primary health centres. It includes the following schemes:

1. Upgrading health sub-centres (32).
2. Health card system.
3. 100 per cent immunisation.

4. 100 per cent health check-up.

5. Supplementary medicine grant.

6. Medicine department in Advasi Co-op. Society shops (37). .

7. Equipping bhagats in each village (419).

8. Equipping dais in each village.

9. Printing posters and other publicity.

10. Walkie-talkie in each health centre (37).

11. Trained chemist at the PHC (5).

12. Supplementary medicine grant to the PHC.

13. Enhancement of petrol allowance to medical officers.

14. Additional rooms in PHC.

15. Accounts clerks in PHC.

16. Additional doctor's quarters at PHC

17. Quarters for pharmacist, accounts clerk and programme staff.

18. Food for patients at PHC.

The action area of social and economic infrastructure includes the following schemes:

1. Improving roads to the sub-centres.

2. Bunding work, to support community nursery.

3. Postal substations in central villages.

4. Housing for contact officials.

5. Open-air meeting places in central villages.

6. Village centre buildings (37).
7. Creches (37).

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सारांश

जून १९७८ में महाराष्ट्र सरकार के समाज कल्याण विभाग ने महाराष्ट्र के जनजातिय क्षेत्रों में स्वास्थ्य कार्यक्रमों को बढ़ाने के लिए पूना स्थित विकास अध्ययन एवं गतिविधियां केन्द्र को कार्य योजना के लिए आज्ञप्त किया था । यह उक्त केन्द्र द्वारा प्रस्तुत रिपोर्ट का संक्षिप्त सार है ।