

Efficiency of hospital cholera treatment in Ecuador

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ABSTRACT

This study analyzed the efficiency of cholera treatment in three hospitals representative of the Ecuadorian public health system in order to provide hospital directors and administrators and health service policy-makers with information to plan responses to future epidemics and to reduce the costs of cholera treatment in general. For the study, total and excess cholera treatment costs were calculated using hospital files and statistics and an in-hospital surveillance system of the cholera cases. The type and quantity of each input used for each treatment were analyzed, as well as the number of days hospitalized, according to the severity of the illness. With this process, excess costs were determined in relation to a "treatment norm" that would have been appropriate for each patient.

The researchers found that 45% of the cholera treatment costs were excessive. The most important contributor was excess recurrent costs (90%), including extended hospital stays, disproportionate use of intravenous rehydration solutions, and unnecessary laboratory tests. Excess capital costs, from land, buildings, and hospital equipment, represented 10% of the total excess treatment costs. No significant relationship was found between treatment costs and the severity of the illness, nor between costs and a patient's age. A patient's sex appeared to be an important variable, with the cost of treating women being notably higher than for men. An inverse relationship was found between treatment costs and the complexity of the hospital. The researchers concluded there was an inefficient use of resources in the treatment of cholera in the three hospitals where the research was performed.

The Latin American cholera epidemic spread rapidly after reaching Ecuador in 1991. That year the number of cases in the country totaled 46 284, with another 31 870 registered in 1992. While the number declined to 6 833 in 1993, there have been subsequent outbreaks, especially in the first half of

1995 (1–3). Cholera treatment in Ecuador has been principally carried out in hospitals. In 1991, 81% of registered cholera patients were hospitalized, with the figures for 1992, 1993, and the first 6 months of 1994 being 89%, 80%, and 69%, respectively (1). Nevertheless, experience in other countries has shown that a significant proportion of cholera cases can be successfully treated as outpatients or in community rehydration centers (4).

In Ecuador there have been very few cost studies of the health sector. One worth mentioning is that of Robertson et al., in which the costs of several important services in the system managed by the Ministry of Public Health

(MPH) were found to be considerably lower than costs in the rural Social Security program (5). Using cost-effectiveness analysis, Shepard et al. compared the national mass vaccination programs with the ordinary vaccination services offered by the public health system (6). An exploratory study of cholera during the height of the epidemic in Ecuador calculated the total treatment costs in two Sierra (highlands region) hospitals (2 459 cases in Ibarra and Otavalo) as approximately US\$ 65 000 (7). These figures suggest that, taking the nation as a whole, cholera treatment during the epidemic would have constituted a significant item in the MPH budget.

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This conclusion is particularly worrying if one takes into account the fact that public health expenditure has fallen in recent years, not only as a percentage of the national budget, but also in absolute terms. The reduction was on the order of 54% between 1992 and 1994 (8, 9).

The little research done on cholera treatment in Ecuador reveals that intravenous (IV) rehydration is used far more widely than oral rehydration therapy (ORT) and that hospital stays are often unnecessarily long (7, 10, 11), both of which raise treatment costs. Similar results have been found in other Latin American countries (12, 13). Nevertheless, studies in several developing countries, including Lesotho (14) and India (15, 16), have found that ORT is both highly effective and can significantly reduce treatment costs. The principal objective of this study was to calculate the level of total and excess cholera treatment costs in selected Ecuadorian MPH hospitals.

MATERIALS AND METHODS

The excess cholera treatment costs were identified, and their component elements were investigated. Such costs were calculated by subtracting from the total cost the “ideal” treatment cost—based on a preestablished treatment norm determined for each case according to the degree of dehydration. Given that it was possible that conditions specific to each hospital could lead to higher costs, regardless of whether the norm was strictly applied, the project also sought to analyze the underlying cost structure in each hospital and its effect on the cost of cholera treatment.

During the period of field research, the project team sought to answer the following questions:

1. Are cholera treatment costs in MPH hospitals significantly excessive when compared to an ideal treatment based on a diagnosis of the degree of dehydration of each patient?
2. If treatment costs are found to be excessive, is overuse of IV rehydra-

tion therapy a significant determinant of these excess costs?

3. Do treatment costs vary proportionately with the severity of each case?
4. Does the variation in treatment costs bear any relationship to the complexity of the hospital (i.e., national, provincial, or primary level) where a patient is admitted?
5. Do a patient’s sex and/or age affect cholera treatment costs?

Considering the fact that all the patients in the study left the hospital fully cured, it can be assumed that oral and IV rehydration therapy are equally effective. Since treatment effectiveness in all cases is the same, this renders a cost-effectiveness analysis redundant and the analysis effectively becomes one of cost-minimization. The research presented here centered on the analysis of the capital and recurrent costs incurred in oral treatment and in IV treatment and took into account the severity of the cases (mild, moderate, or severe), the complexity of the hospitals, and the age and sex of the patients.

The study population was made up of patients who were admitted to a hospital with a cholera diagnosis. Criteria for exclusion included the presence of blood in feces, fever, and any other associated acute or chronic illness. Patients below the age of 5 were also excluded because they were thought to run a higher risk of complications. The population was grouped by age in the following way: 5–19 years, 20–39 years, 40–59 years, and 60 years and older.

The choice of the hospitals to be included in the study was based on three criteria:

- location in a zone of high cholera incidence during the research period
- previous admission of large numbers of cholera patients
- differing levels of complexity

Looking at different levels of hospital complexity enabled the results of the study to be extrapolated tentatively to other, similar hospitals in the

public health system. The following hospitals were selected: the “Dr. José Daniel Rodríguez Maridueña” Infectious Diseases Hospital in Guayaquil, a specialized national reference hospital with 107 beds; the Chimborazo Polyclinic Hospital in Riobamba, a provincial-level hospital with 173 beds which from the onset of the epidemic received a large number of the cases in the central Sierra; and the “León Becerra” Hospital in Milagro, a primary-level canton (municipality) hospital with 74 beds which, at the beginning of the study, had received the greatest number of cases nationally for a hospital of its complexity (17).

For the purpose of the analysis, costs were divided into recurrent and capital costs (see Annex 1). Recurrent costs included:

- the costs of medicines (including antibiotics and other medication) and rehydration salts (oral and parenteral), the equipment used for their administration, and laboratory tests
- personnel and administration costs: wages, salaries, and benefits; food, cleaning, electricity, fuel, and water; and other administrative costs.

Capital costs were determined on the basis of the present value of hospital buildings, land, and medical and other equipment.

It is worth noting that the research concentrated on the factors that affected the efficiency of in-hospital cholera treatment from the point of view of the providers of the service, in this case the MPH and the hospitals. For this reason, other costs caused by the disease, such as reduced productivity and lost wages and other effects on patients’ families, or other savings generated by treating patients out of hospital, while undoubtedly important, were not taken into account.

An essential element of the analysis was defining a treatment norm, in particular for the initial rehydration requirement and for antibiotics, in order to be able to specify an “ideal treatment” and the required hospital stay for each patient. This norm was based

on criteria established by Barua and Greenough III (4) and the guidelines laid down by the World Health Organization and Pan American Health Organization (18).

Evaluation of the initial rehydration requirement was based on an assessment the research team made of each patient's degree of dehydration at the time of admission. The maintenance rehydration requirement was not estimated, given the difficulty in ensuring an accurate monitoring of the ingestion and elimination of liquids. For this reason, the total volume of liquids administered to each patient was assumed to be correct and only the need for ORT or IV treatment was assessed. The appropriate length of hospital stay was also calculated on the basis of the treatment norm, estimating the values of necessary variables from a patient's clinical history.

Over the three months of April–June 1994 an in-hospital surveillance system of the cholera cases in the selected hospitals provided information on the type and quantity of each input used for each treatment, as well as the number of days hospitalized, according to the severity of dehydration. Nurses hired by the project and trained by the research team collected this information. An instruction manual was also prepared and distributed to the nurses. Prior to the data collection itself, the survey and its application by the nurses were subjected to a "dry run" and any problems that arose were corrected. With this procedure, it was possible to determine the excess costs in relation to the treatment norm for each patient in terms of inputs and hospital stay (see Annex 2).

The average cost of each of the medicines and rehydration inputs was assessed in three pharmacies and laboratories in the area, including those within the hospitals themselves, and this average was then multiplied by the quantity used. The information on the recurrent costs in the personnel and administrative category was obtained from MPH and hospital files and interviews with key staff in each institution.

The capital cost imputable to land and buildings was based on data from

municipal property registry and valuation departments, while the cost of hospital equipment was calculated from information in hospital inventories, balance sheets, and purchase receipts. (Given that municipal property valuations may differ from market valuations, the calculation of capital costs may not be as accurate as the calculation of recurrent costs.) Calculations were made on the basis of the percentage of the hospital area occupied by cholera patients. The percentage of general services (administration, food, cleaning services, electricity, water, and fuel) attributable to these areas was calculated according to the ratio of cholera-patient-days to the total number of patient-days for the hospital during the study period. This proportion, multiplied by the total cost for each item and then divided by the number of cholera-patient-days, gave the personnel, administration, and capital costs per cholera-patient-day. The results are presented in the tables in terms of excess costs and the ratio of excess to total observed costs for each cost category.

On the basis of these values, multiple regression analyses using dummy variables were run in order to identify correlations between the independent variables (severity of the illness, sex, age, and hospital type) and the results of the fieldwork (excess total, capital, and recurrent costs, and excess use of oral and IV rehydration salts). The results of the regressions showed that there was no significant relationship between excess treatment costs and patient age or severity of illness. The relationship between hospital type and patient sex was not included because its regression coefficients were not statistically significant.

Further details on the calculation of observed recurrent and capital costs and estimated appropriate levels of expenditure for cholera treatment are available on request.

RESULTS

On average, 45% of the observed cholera treatment costs in the three

hospitals studied can be considered excessive (see Table 1). At the rate of 2200 Ecuadorian sucres per United States dollar (US\$), the average treatment cost was US\$ 101.62 per patient and the excess costs were \$45.50. The most important contributor to these excess costs (61%) was personnel and administration costs, which corroborates the results found in other countries in studies of immunization programs and the treatment of diarrheal diseases (19–21). However, the individual cost category with the highest ratio of excess to total costs was laboratory tests and medical supplies (53%). Within this category, 63% of the total spent on IV rehydration salts was excessive. This suggests that IV rehydration therapy requires greater use of equipment and other supplies than oral therapy (see Tables 1 and 2). Correspondingly, the observed expenditure for oral rehydration salts was lower than would have been the case if the treatment norm had been followed.

With respect to the severity of the cases being treated, in the three categories (mild, moderate, and severe), excessive use of IV rehydration salts accounts for between 60% and 69% of the excess expenditure on lab tests and medical supplies (Table 2). Of the total excess costs for each of the three severity groupings, recurrent expenditures take up between 87% and 91% and capital costs account for between 9% and 13% (Table 1). No significant differences were found between total treatment costs for cases of differing severity. It is worth pointing out that, in absolute terms, the group with the highest excess costs were the moderate cases (\$50.60), followed by the mild (\$43.50), and last, the severe patients (\$35.80).

An inverse relationship was found between hospital complexity and average total, recurrent, and capital costs. The excess costs to treat the average patient in the least-complex hospital, in Milagro, totaled \$63.60, while in Riobamba this figure was \$52.00, and in the most-complex hospital, in Guayaquil, excess treatment costs were "only" \$36.00 (Table 1). The ratio of patient-days to personnel was greater

TABLE 1. Excess and observed recurrent and capital average costs per patient for cholera treatment by severity, hospital, and sex (dollars and percentages), Ecuador, 1994

	Patients (No.)	Recurrent costs									
		Medical supplies and exams		Personnel and administrative		Total		Capital cost		Total	
		Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	Excess	Exc./obs. (%)
Severity:											
Low	37	\$14.00	62	\$25.60	42	\$39.60	47	\$4.00	43	\$43.50	47
Category/total %		32		59		91		9		100	
Moderate	35	\$14.50	56	\$31.00	43	\$45.50	46	\$5.20	44	\$50.60	46
Category/total %		29		61		90		10		100	
Grave	11	\$4.90	18	\$26.30	41	\$31.20	34	\$4.60	42	\$35.80	35
Category/total %		14		74		87		13		100	
Hospital:											
Guayaquil	46	\$16.40	61	\$17.40	33	\$33.80	43	\$2.20	33	\$36.00	42
Category/total %		46		48		94		6		100	
Riobamba	20	\$6.20	27	\$39.00	53	\$45.20	47	\$6.90	53	\$52.10	47
Category/total %		12		75		87		13		100	
Milagro	17	\$11.70	57	\$43.50	45	\$55.20	47	\$8.30	45	\$63.60	47
Category/total %		18		68		87		13		100	
Sex:											
Female:	40	\$13.40	55	\$38.80	49	\$52.20	50	\$6.40	49	\$58.50	50
Category/total %		23		66		89		11		100	
Male:	43	\$12.60	51	\$17.90	33	\$30.50	39	\$2.90	35	\$33.40	38
Category/total %		38		54		91		9		100	
Total	83	\$13.00	53	\$28.00	42	\$41.00	45	\$4.60	43	\$45.50	45
Category/total %		29		61		90		10		100	

TABLE 2. Excess and observed oral and intravenous rehydration solutions and other medical supplies, average costs by severity, hospital, and sex (dollars and percentages), Ecuador, 1994

	Patients (No.)	Oral rehydration salts		Intravenous rehydration solutions		Other medical supplies		Total		
		Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	Excess	Exc./obs. (%)	
Severity:										
Low	37	-\$0.60	-119	\$8.40	81	\$6.20	53	\$14.00	62	
Category/total %		-4		60		44		100		
Moderate	35	-\$0.80	-93	\$9.50	70	\$5.80	51	\$14.50	56	
Category/total %		-5		65		40		100		
Grave	11	-\$0.10	-7	\$3.40	22	\$1.60	15	\$4.90	18	
Category/total %		-2		69		32		100		
Hospital:										
Guayaquil	46	-\$0.80	-667	\$10.40	72	\$6.80	56	\$16.40	61	
Category/total %		-5		64		41		100		
Riobamba	20	\$0.00	2	\$4.80	40	\$1.30	14	\$6.20	27	
Category/total %		0		78		22		100		
Milagro	17	-\$0.80	-47	\$6.10	86	\$6.40	54	\$11.70	57	
Category/total %		-7		52		55		100		
Sex:										
Female:	40	-\$0.50	-62	\$8.30	72	\$5.60	46	\$13.40	55	
Category/total %		-4		62		42		100		
Male:	43	-\$0.70	-108	\$8.10	62	\$5.20	48	\$12.60	51	
Category/total %		-5		64		41		100		
Total	83	-\$0.60	-83	\$8.20	66	\$5.40	47	\$13.00	53	
Category/total %		-5		63		42		100		

in the more complex hospitals, due to the higher proportion of specialized staff in these institutions. No clear pattern emerged with IV rehydration salts; the percentage of excess costs in the total spent on them was 86% in Milagro, 72% in Guayaquil, and 40% in Riobamba (Table 2).

The differences in costs related to a patient's sex were evident in the average treatment cost, which was \$117.40 for women (50% excessive) and \$86.90 for men (38% excessive). There was little difference between the two groups in terms of expenditures on laboratory tests and medical supplies. However, for capital costs and for personnel and administration costs, the excess-to-total cost ratios were 49% in both categories for women patients and 35% and 33%, respectively, for men (Table 1). These variations were largely a result of the longer time spent in the hospital by women patients, whose average stay was more than double that of men, although there was no significant difference between the groups in terms of the distribution of cases by severity (Table 3).

The age groupings showed a "U" curve in total average excess costs. The group 5–19 years old had average total excess costs of \$59.00. The figure was \$40.00 for those 20–39, \$45.00 for the group between 40 and 59 years old, and \$53.00 for the group 60 and older.

The variance analysis was done using computer software from SPSS

(Chicago, Illinois). The analysis showed (see Tables 4 and 5) the following differences between the hospitals to be statistically significant: the least complex hospital, in Milagro, had significantly higher excess capital, recurrent, IV rehydration salt, and total costs than the more complex hospital in Guayaquil ($P = 0.00, 0.02, 0.05,$ and $0.01,$ respectively). Similarly, the excess capital costs and IV and oral rehydration salt costs in Riobamba were significantly higher than in Guayaquil ($P = 0.00, 0.03,$ and $0.00,$ respectively). Finally, the excess capital, recurrent, and total costs of treating women were significantly higher than for men ($P = 0.00$ in all cases).

DISCUSSION

The results show that the overuse of IV rehydration is an important source of inefficiency, occasioning much higher treatment costs than oral hydration methods. All the patients who had vomiting as one of their symptoms received IV treatment, but the switch to oral therapy was never made soon enough. This is just one example of a clear pattern of indiscriminate use of IV rehydration therapy, regardless of the severity of the dehydration. This pattern could be due to:

- the absence of clear, adequately disseminated treatment norms, coupled

with poor diagnoses, leading to excess demand for laboratory tests and overcautious treatment. This is aggravated by the lack of supervision and well-defined communication channels, both within hospitals and between hospitals and the Ministry of Public Health. The MPH prepared and distributed a cholera treatment manual, yet when asked, many hospital staff members responded that they were unaware of it.

- the limited training given to junior residents, who are largely responsible for attending to cholera patients. Senior doctors, on the other hand, tend to eschew the treatment of "less-prestigious" ailments. During the early stages of the epidemic in 1991, nurses and auxiliary staff were given training, while many doctors in the hospitals most affected did not attend the programs, giving as reasons their lack of time and the limited status coming from basic training (11).

According to the norm, treating mild cases should be cheaper than treating more severe ones. Nevertheless, the results of this research show that excess costs were highest with moderate cases, followed by the mild cases, and lastly, the most-severe cases. This would appear to suggest that all the patients were treated similarly, regardless of the severity of their illness as indicated by their symptoms.

TABLE 3. Cholera-patient-days by severity, hospital, and sex, Ecuador, 1994^a

	Low	Moderate	Grave	Patient-day/ personnel	Excess days	Ideal days	Average excess days	Excess/ observed days (%)
Severity:								
Low	...	...	...	...	45	64	1.2	41.3
Moderate	...	...	...	...	51	69	1.5	42.9
Grave	...	...	...	...	17	24	1.5	41.5
Hospital:								
Guayaquil	23	21	2	14.5	44	88	1.0	33.3
Riobamba	5	6	9	9.7	46	41	2.3	52.9
Milagro	9	8	0	3.6	23	28	1.4	45.1
Sex:								
Female	20	15	5	...	76	80	1.9	48.7
Male	17	20	6	...	37	77	0.9	32.5
Total	37	35	11	...	113	157	1.4	41.9

^a Ellipses indicate the category was not applicable.

TABLE 4. Determinants of excessive cholera treatment cost, Ecuador, 1994, multiple regression analysis results (with intercept), dependent variables

	Excessive capital cost			Excessive recurrent cost			Excessive total cost		
	Coefficient	Standard error	P value	Coefficient	Standard error	P value	Coefficient	Standard error	P value
Sex: Female	-6 004.31	2 018.72	0.00	44 451.10	13 399.50	0.00	50 455.45	15 300.54	0.00
Age: 5-19	-3 084.82	3 716.47	0.41	-5 206.19	24 668.49	0.83	-8 290.91	28 168.29	0.77
40-59	904.10	2 366.18	0.70	4 896.14	15 705.76	0.76	5 800.49	17 934.00	0.75
60 +	2 422.80	3 032.37	0.43	20 245.43	20 127.69	0.32	22 668.36	22 983.28	0.33
Graveness: Low	1 948.31	3 648.40	0.60	18 640.45	24 216.64	0.44	20 588.58	27 652.34	0.46
Moderate	4 608.00	3 658.70	0.21	33 707.03	24 285.04	0.17	38 314.89	27 730.44	0.17
Hospital: Milagro	14 238.33	2 876.44	0.00	45 178.30	19 092.70	0.02	59 417.20	21 801.45	0.01
Riobamba	9 725.30	2 939.31	0.00	20 496.59	19 509.97	0.30	30 222.36	22 277.93	0.18
	R ² (not adjusted)	F	Significance F	R ² (not adjusted)	F	Significance F	R ² (not adjusted)	F	Significance F
	0.41	6.53	0.00	0.25	3.11	0.00	0.27	3.44	0.00

No. of observations: 83

TABLE 5. Determinants of excessive rehydration solution costs, Ecuador, 1994, multiple regression analysis results (with intercept), dependent variables

	Intravenous			Oral		
	Coefficient	Standard error	P value	Coefficient	Standard error	P value
Sex: Female	2 662.17	3 399.96	0.44	65.04	285.78	0.82
Age: 5-19	-291.96	6 259.32	0.96	-283.31	526.12	0.59
40-59	-2 497.88	3 985.14	0.53	334.39	334.97	0.32
60 +	3 651.72	5 107.15	0.48	93.58	429.28	0.83
Graveness: Low	5 389.06	6 144.67	0.38	123.95	516.49	0.81
Moderate	7 948.65	6 162.02	0.20	-373.72	517.95	0.47
Hospital: Milagro	-9 562.63	4 844.53	0.05	201.71	407.21	0.62
Riobamba	-10 809.86	4 950.41	0.03	1 793.22	416.11	0.00
	R ² (not adjusted)	F	Significance F	R ² (not adjusted)	F	Significance F
	0.18	2.07	0.05	0.34	4.71	0.00

No. of observations: 83

The inverse relationship found between hospital complexity and excess treatment costs could be the result of greater demand for cholera treatment and better-qualified staff working in the more-specialized hospitals, in turn contributing to a more efficient use of resources (Tables 1, 4, and 5).

The least-complex hospital, in Milagro, had a higher cost of land, buildings, and equipment per patient-day, \$6.20, versus \$2.30 in Guayaquil and \$3.00 in Riobamba. That may be in part the result of remodeling carried out in Milagro over the last five years. While the Milagro hospital may not be comparable with other primary-level hos-

pitals due to these higher capital costs, it could be argued that the Milagro hospital suffered from lower occupancy rates or excess capacity of facilities, resulting in excess treatment costs. For this reason, in the future it will be important to analyze carefully the value of expanding the canton-level hospitals if patients can be more efficiently treated in the larger hospitals where economies of scale can reduce costs and increase efficiency.

The Riobamba hospital had a greater proportion of severe cases (45%), coupled with the previously noted tendency to treat all patients similarly, regardless of their severity. This in part

explains its relatively lower excess expenditure on laboratory tests and medical supplies, especially IV rehydration salts (Table 2), even though in absolute terms the excess days of hospitalization are higher than in the other hospitals (Table 3). This suggests that, in spite of having a greater proportion of severe cases, the hospital was more efficient than the hospitals in Guayaquil and Milagro in terms of excess use of IV rehydration therapy.

The Guayaquil hospital, the busiest and most complex in the sample, had the lowest recurrent, capital, and total costs per patient (Table 1). Although its ratio of excess to observed costs was lower than in Milagro, it had a higher per-patient expenditure on IV therapy (Table 2) which, in view of the fact that it received a particularly large number of cholera patients, would have made a significant contribution to the hospital's overall costs. This would be especially worrying if there were a new epidemic, since the Guayaquil hospital would be the major recipient of cases in its region.

The high level of excess costs incurred in cholera treatment in all three of the hospitals studied raises the question as to the reasons why trained medical staff prescribe treatments that are inefficient and often not recommended for cholera patients. One important factor would appear to be that MPH hospital budgets are established on the basis of the previous year's oc-

cupancy rate (the ratio of occupied bed-days to total available bed-days). This provides an incentive to hospitalize patients unnecessarily and extend a patient's stay once admitted, so as to raise the occupancy rate. Additionally, hospitals have been known to close wards with this same aim of increasing the proportion of occupied bed-days and thus securing more funds in the subsequent year's budget.

It is worth underlining that the hospitals could have saved money by administering the correct treatment and avoiding unnecessary and excessively long periods of hospitalization. An example of these savings can be found in the Babahoyo provincial hospital, where the costs of cholera treatment have been significantly reduced by implementing a management system based on continuous improvement in patient care (11). Another possible solution would be to adopt the budget system many countries use, where funds are assigned on the basis of the income and specific diagnosis of each patient and hospitals receive more funding if they treat more patients. This approach provides a disincentive to prolonged hospital stays and unnecessary and expensive treatments.

In general, it can be said that if the cholera treatment guidelines of the U.S. Institute of Medicine (22) were observed, 29% of the total excess costs corresponding to medical supplies and exams would be automatically reduced. The reduction of the rest of the excess costs (personnel, administration, and capital costs) would require measures other than the correct application of treatment guidelines, such as the elimination of excess hospital beds and staff.

The higher treatment costs observed with women patients is related to their longer periods of stay in hospital, with their excess periods of hospitalization more than double those of men. This directly raises the capital and personnel and administration costs of their treatment (Table 1). Although the treatment norm specified a slightly longer treatment period for women, this distinction is not enough to explain the differences found. Nor do

differences in the severity of the cases account for the variation, since more of the female patients were among the mild cases (Table 3).

The small influence a patient's age has on excess costs is not surprising when one takes into account that around 70% of the sample population was in the 20–59 age range and that children under 5 were excluded from the study. Both the very young and the old would have been more likely to suffer complications. The exclusion of young children produced a more homogenous population and reduced the size of the "U" curve in the excess average total costs for the different age groups.

The results of this study could, with due caution about the homogeneity of the treatment facilities in the Ecuadorian public health system, be extrapolated to other, similar hospitals. Nevertheless, to corroborate the results found here and have a larger sample from which to extrapolate, further research is required in which the methodology is varied with the focus of the study. This research analyzed treatment costs from the perspective of each individual hospital, specifically highlighting the impact of different factors in the generation of excess treatment costs, in order to provide hospital directors and administrators and health service policy-makers with information to plan responses to future epidemics and to reduce the costs of cholera treatment in general. If, for example, the objective were to identify priorities for cost reductions in the public health system as a whole, it would be necessary to analyze the real demand for health care and then focus investment in those areas where demand is highest and where economies of scale can be achieved.

The research did not attempt to predict the excess costs of cholera treatment or project them on a nationwide basis; this would require a different research methodology with factors not considered in the present analysis. Likewise, no attempt was made to estimate the social cost of the cholera epidemic, for which information on the real or imputed income foregone

by each patient and the opportunity costs of their treatment would have been necessary.

Finally, it is worth mentioning that a new cholera strain, *Vibrio cholerae* 0139, has been identified in Bangladesh and other parts of South Asia and to which immunity is not acquired through previous exposure to the disease (23). If this strain were to arrive in Latin America, the resultant epidemic could be as serious as the one studied in the research reported here. For this reason, and to prevent a severe drain on the resources of the Ecuadorian health system, it is vital that training programs for medical staff be developed that take into account the relative efficiency of different treatments and that strengthen diagnostic and prescription procedures. Emphasis should also be put on the use of oral rehydration therapy whenever possible. As part of this process, hospital communication and information systems need to be improved so that policies and procedures can be monitored and evaluated and treatment norms adequately disseminated, following such approaches to developing and using clinical-practice guidelines as those recommended by the U.S. Institute of Medicine (22).

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REFERENCES

1. Ecuador, Ministerio de Salud Pública. Datos sobre el cólera en el Ecuador. Quito: MSP; 1994.
2. Weil O, Berche P. The cholera epidemic in Ecuador: Towards an endemic in Latin America. *Rev Epidemiol Sante Publique* 1992;40: 145-155.
3. Sempértegui R, García L. Cólera in: Ministerio de Salud Pública/UNICEF. Panorama epidemiológico del Ecuador. Quito: MSP/UNICEF; 1992.
4. Barua D, Greenough III W. Cholera. New York: Plenum Publishing Corporation; 1992.
5. Robertson R, Castro C, Gómez L, Gwynne G, Tinajero C, Zschock D. Primary health services in Ecuador: Comparative costs, quality and equity of care in Ministry of Health and rural Social Security facilities. *Soc Sci Med* 1991;32:1327-1336.
6. Shepard D, Robertson R, Cameron III C, Saturno P, Pollack M, Manceau J, et al. Costo-eficacia de las estrategias de vacunación en servicios ordinarios y en campañas en el Ecuador. *Bol Oficina Sanit Panam* 1992;112:110-129.
7. Nieto P, et al. Análisis de costos de hospitalización en pacientes afectados por cólera en la provincia de Imbabura [unpublished report]. Quito, Ecuador; 1991.
8. Ecuador, Ministerio de Finanzas. Presupuesto del estado, 1993 [supplement to] Registro oficial, Year I, Volume II, Number 99; 1993.
9. Ecuador, Ministerio de Finanzas. Presupuesto del estado, 1994 [supplement to] Registro oficial, Year II, Volume I, Number 350; 1994.
10. Cañizares R, Valle K, Briones A. Manejo hospitalario del cólera en el Hospital de Guayaquil. In: Ministerio de Salud Pública/Organización Mundial de la Salud/Organización Panamericana de la Salud. Boletín Informativo sobre el cólera en la costa ecuatoriana. Guayaquil, Ecuador: MSP/OPS/OMS; 1992. (Boletín epidemiológico especial).
11. Hermida J, Laspina C, Idrovo F. Improving quality of cholera case management in a hospital setting in Ecuador [draft of report]. Bethesda, Maryland: Quality Assurance Project; 1994.
12. Endsley S, McCarthy D. Field-test of cost elements of revised WHO/PAHO health facility survey [trip report]. Honduras: Pan American Health Organization; 1993.
13. Phillips M. Report on the development and field-testing of a costing component in the CDD health facility survey manual. Pan American Health Organization; 1992.
14. Cost-effectiveness analysis of oral rehydration therapy. *Wkly Epidemiol Rec* 1990;36:275-279.
15. Srivastava V, Arya H, Uppal S, Rath B, Laisram N. Comparison of oral and intravenous rehydration among hospitalized children with acute diarrhoea. *J Diarrhoeal Dis Res* 1985;3:92-95.
16. Sircar BK, Saha MR, Deb BC, Singh PK, Pal SC. Effectiveness of oral rehydration salt solution (ORS) in reduction of death during cholera epidemic. *Indian J of Public Health* 1990;34:68-70.
17. Ecuador, Instituto Nacional de Estadística y Censos. Anuario de estadísticas hospitalarias. Quito: INEC; 1993.
18. Organización Mundial de la Salud/Organización Panamericana de la Salud. Guía para la prevención y control del cólera. Quito: OMS/OPS; 1991.
19. Horton S, Claquin P. Cost-effectiveness and user characteristics of clinic based services for the treatment of diarrhea: a case study in Bangladesh. *Soc Sci Med* 1983;17:721-729.
20. Creese A. Cost effectiveness of potential immunization interventions against diarrhoeal disease. *Soc Sci Med* 1986;23:231-240.
21. Creese A, Sriyabbaya N, Casabal G, Wiseso G. Cost-effectiveness appraisal of immunization programmes. *Bull World Health Organ* 1982; 4:621-632.
22. Field MJ, Lohr KN, eds. Guidelines for clinical practice: From development to use. Washington, D.C.: National Academy Press; 1992.
23. Shears P. Cholera. *Ann Trop Med Parasitol* 1994;88:109-122.

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ANNEX 1. Methodology used to calculate recurrent and capital costs

I. Recurrent Costs

1) Personnel Costs

i) From payrolls and staff distributions, personnel were divided into three groups: [A] those whose work was exclusively confined to the pediatrics or clinical departments (Riobamba and Milagro) or infectious diseases (Guayaquil), [B] those who worked exclusively in other areas, and [C] those who worked in the hospitals' general services departments (e.g., administration, kitchens, etc.).

ii) In calculating the staff costs associated with cholera treatment, the total wage bill of the workers in group A was included, none from group B, and that part of the wages of the workers in group

C corresponding to the proportion of clinical, pediatric, and infectious disease patient-days to total patient-days in each hospital.

iii) Having summed the relevant wages for the first six months of 1994, this total was divided by the daily average of clinical, pediatrics, and infectious disease patient-days in the same period, thus producing the staff cost per patient-day.

2) Other Recurrent Costs

For the remaining recurrent costs (administration, food, cleaning, electricity, fuel, and water), the total expenditure on each item recorded in the hospital accounts was summed for the first six months of 1994, and then divided by total number of patient-days for the period, giving the average cost per patient-day.

3) Total Recurrent Costs

To obtain the total recurrent cost per patient-day, the totals from 1 and 2 above were added to the expenditure on medicines and other materials necessary to administer rehydration salts. This figure was then multiplied by the number of days each patient spent being treated, thus generating the ideal, excess, and total costs per patient.

II. Capital Costs: Land, Buildings, and Hospital Equipment

1) Land and Buildings

i) The cost of hospital land and buildings per patient-day was calculated on the basis of the commercial value used for taxation purposes by the municipal valuation and property registry office in each city.

2) Hospital Equipment

i) In order to calculate the value of hospital equipment, information was taken from hospital inventories, the items referring to equipment investments in budget statements, and details of purchases made directly by the Ministry of Public Health (MPH).

ii) The estimation of the value of the equipment whose use was associated with cholera treatment followed a procedure similar to that used to calculate personnel costs. First, the total inventory was divided into three groups: [A] those pieces of equipment used exclusively in the clinical, pediatrics, and infectious disease departments, [B] those not used in cholera treatment, and [C] those of general usage (e.g., computers, beds, desks).

iii) In the case of the equipment registered in hospital inventories, its current value was determined by taking the value recorded in the inventory as the initial value (this assumption, despite its obvious imprecision, was used due to the lack of data available on purchase prices and dates) and then depreciating that at a rate of 14% a year, up to a maximum of 70%. These values were then converted into April 1994 (the start date of the project) sures on the basis of the cumulative inflation rates in each of the cities between the date of the inventory and the beginning of the project. To calculate the total equipment costs, the total value of the equipment in group A, none of group B, and the value of equipment in group C was multiplied by the ratio of clinical, pediatrics, and infectious disease patient-days to total patient-days.

iv) To the value of equipment registered in hospital inventories as calculated above in iii were added the value of the equipment recorded in hospital budgets. However, since there was no mention of the type or use of the equipment registered, the value used was the current value multiplied by the ratio of clinical, pediatrics, and infectious disease patient-days to total patient-days.

v) Finally, of the list of equipment bought directly by the MPH (principally four contracts with overseas suppliers that together account for around 90% of the total equipment purchases made in the last five years), those pieces that were not used at all in cholera treatment and those presumably already included in the hospital inventories were disregarded. The valuation of the remaining equip-

ment involved four stages. First, the prices in each contract were converted into sucres at the date of delivery to the receiving hospital, using national price indexes. Second, each piece of equipment was depreciated, using the formula described earlier, from the hospital delivery date to the beginning of the project. Third, these values were converted into April 1994 sucres using the respective inflation rates in each of the three cities. Finally, the value corresponding to cholera treatment was calculated in the same way as already described for the other cost categories.

vi) The values obtained above were then added together to give the total value of equipment associated with cholera treatment in each hospital.

3) Total Land, Building, and Equipment Costs per Patient-day

Adding the values of land and buildings to those of hospital equipment, the total current value of the hospital was determined. An annual rental value equal to 10% of the total current value (and 5% for the six months covering the study) was assumed. The total land, building, and equipment costs per patient-day were then calculated by dividing this six-month value by the total number of patient-days during that period.

Notes to Annex 1:

a) Since inflation data were not available for Milagro, figures corresponding to Guayaquil, the nearest large city, were used.

b) In calculating the value of buildings, the value of areas totally unrelated to cholera treatment was not deducted from the total, thus leading to an overestimation of the costs per patient-day in this category.

c) With regard to personnel costs, in the case of Guayaquil the payroll for June 1994 alone was used for the calculations, due to the lack of information on the other months covered by the study.

d) In the calculations based on budget statements, in Guayaquil patient information was only available for the first five months of 1994, in Milagro there was only data on budgets and patients for the period January–May, and in Riobamba, in the absence of consolidated budget statements, other documents from the accounting department were used.

ANNEX 2. Norm used for estimating correct cholera treatment

1. Loss of liquids: Estimate loss of liquids using the following formula:
(weight in kg) × (degree of dehydration expressed as a proportion) = liters of liquid lost
2. Initial rehydration requirement: Evaluate the initial rehydration requirement as follows:
 - Severe cases: IV—50% during the first hour, the rest during the subsequent 2–4 hours
 - Moderate cases with uncontrollable vomiting: treatment as per severe cases, followed by oral rehydration
 - Mild cases with uncontrollable vomiting: IV until the vomiting has passed, followed by oral rehydration. When vomiting is not present and liquids are tolerated: oral rehydration from the outset.
3. Maintenance rehydration therapy: Maintenance rehydration therapy should at all times be administered orally, except when uncontrollable vomiting is present. As soon as the vomiting has passed, oral therapy should be adopted.
4. Quantity of liquids administered: It is to be assumed that the quantity of liquids the relevant health unit administers as part of the maintenance rehydration is correct.
5. Type of liquid administered: The types of liquid to be administered are as follows:
 - For the initial rehydration only hypertonic liquids (lactates, dextrose in water plus electrolytes, and oral rehydration salts) are taken into account. For the subsequent maintenance therapy, to counteract losses due to diarrhea and vomiting, only hypertonic solutions are considered. In the case of other losses, other hypotonic liquids, such as mineral water, are accepted. Due to the impossibility of precisely controlling ingestion and excretion, it is assumed that while diarrhea or vomiting are present, both hypertonic and hypotonic liquids should be administered. Once these symptoms have been controlled, only hypotonic liquids should be used.

- When a patient stays less than one day in hospital and the initial rehydration has not been completed, the remaining rehydration salts should be given to the patient for oral administration at home.
 - When a patient has spent more than one complete day in hospital and is sent home with oral rehydration salts, even if the initial rehydration is deemed adequate, these additional salts are considered appropriate but not obligatory.
 - When a patient receives less than the required initial rehydration therapy, the initial rehydration administered is considered to be equal to the ideal treatment.
6. Hospital stay: The length of the hospital stay depends on severity:
 - Mild cases without uncontrollable vomiting should not be admitted to hospital.
 - Mild cases with uncontrollable vomiting should be hospitalized while they receive intravenous therapy, and then until they have fewer than three diarrheal depositions within 24 hours.
 - Moderate and severe cases should remain in hospital during the initial rehydration and until they have fewer than three diarrheal depositions within 24 hours, are not vomiting, and their vital signs are stable.
 7. Antibiotics: Antibiotics should be administered as follows:
 - Tetracycline – adults: 500 mg every 6 hours for three days
 - Erythromycin – adults: 250 mg every 6 hours for three days
– children: 30 mg/kg three times a day for three days
 - Sulfas – adults: 160 mg/kg trimethoprim and 800 mg/kg sulfamethoxazole twice a day for three days
– children: 5 mg/kg trimethoprim and 25 mg/kg sulfamethoxazole twice a day for three days
 8. Laboratory exams: The test considered appropriate is a Gram's stain to identify *Vibrio cholerae*, although it is not considered necessary for diagnosis. All other tests are considered excessive.
 9. All other medication is considered excessive, with the exception of those necessary for the treatment of passing symptoms, such as migraine.
 10. Medications to treat parasites are not taken into account.

RESUMEN

Eficiencia del tratamiento del cólera en hospitales en el Ecuador

En este estudio se examinó la eficiencia del tratamiento del cólera en tres hospitales representativos del sistema público de salud ecuatoriano, a fin de ofrecer a los directores y administradores de hospitales y a las autoridades que dictan las políticas de los sistemas de salud información de utilidad para planificar la respuesta frente a futuras epidemias y reducir los costos del tratamiento del cólera en general. Para los fines del estudio se calcularon los costos totales y excesivos del tratamiento del cólera usando como fuente los archivos y estadísticas de hospitales y un sistema intrahospitalario para la vigilancia de casos de cólera. Se examinaron el tipo y la cantidad de los recursos usados para tratar a cada paciente, así como el número de días de hospitalización, de acuerdo con la gravedad de la enfermedad. Mediante este proceso se determinaron los costos excesivos en relación con la "norma terapéutica" que hubiera sido la apropiada para cada paciente.

Los investigadores encontraron que 45% de los costos del tratamiento del cólera eran excesivos. El componente que más contribuyó al exceso fue el de costos recurrentes (90%), entre los cuales se contemplan las hospitalizaciones largas, el uso desproporcionado de las soluciones rehidratantes para uso intravenoso y las pruebas de laboratorio innecesarias. Los costos de capital excesivos, desde el terreno y los edificios, hasta la indumentaria del hospital, representaron 10% del total de los costos excesivos en tratamientos. No se halló ninguna asociación significativa entre los costos del tratamiento y la gravedad de la enfermedad, ni entre estos costos y la edad del paciente. El sexo del paciente fue una variable de importancia, ya que el costo de tratar a las mujeres fue notablemente mayor que el de tratar a los hombres. Se encontró una relación inversa entre los costos en tratamientos y la complejidad del hospital. Los investigadores llegaron a la conclusión de que en el tratamiento del cólera se hizo un uso ineficiente de los recursos en los tres hospitales donde se realizó el estudio.