RELATIVE VALUES IN PUBLIC HEALTH WORK

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ABOUT 1,400,000 persons die in continental United States each year. Probably a fourth or a third of these die from preventable causes. In addition, it is asserted, and recent sickness surveys seem to support the claim, that two or three per cent. of our population are, at any one time, disabled through sickness. Then there is the larger number of persons afflicted with illnesses not serious enough to disable but which cause loss of comfort and efficiency.

The task of preventing these vast amounts of sickness and death, so far as is possible, is delegated by the public to its health authorities. The latter must decide what parts of the losses are preventable, and must determine how the greatest return in prevention can be obtained with the money available. This is the problem of relative values in public health work.

If unlimited funds were at the disposal of health departments the problem of relative values would be one of merely theoretical interest. The administrator would need only to institute all the activities that seemed likely to exert a beneficial effect, and at the close of the year prepare a table of expenditures with regard to the several activities. This list would indicate the relative value attached to different activities when no stone is left unturned, but would be a tabulation of purely academic interest.

Quite different is the situation actually confronting health officials. With the scanty funds now at their disposal, and the great variation in effectiveness of different activities, the most careful discrimination must be exercised in making up the department's program. A bad distribution of funds means lives lost, and the responsibility, a heavy one, falls on the administrative official. The problem is rendered the more difficult by the lack of accurate data as to costs and results. The practical importance of an accurate appreciation of relative values can hardly be overemphasized. Professor Whipple, in discussing the subject says, "This is one of the greatest questions that a sanitarian can consider. It is today the most important of all hygienic problems because it comprehends all others."*

THE FIELD OF PREVENTION.

In attempting to determine values it seems reasonable to take vital statistics as the point of departure. Our death and sickness records suggest the opportunities that lie before us, and it is by these figures that we must judge the efficacy of our endeavors. Our

* Whipple, G. C.: "How to Determine Relative Values in Sanitation"; American City, X, 5, p. 427.

TABLE 1.

PREVENTABLE DEATHS IN ALL REGISTRATION CITIES, 1913.

Cause of death.	Number of deaths.		Per cent. of preventable deaths.
Infectious Diseases		149,600	99.0
Tuberculosis—all forms:		56,624	37.5
Lungs	48,733		
Meningitis	3,861		
Other forms	4,030		
Diarrhea and enteritis (under 2)		30,244	20.0
Bronchopneumonia		21,091	14.0
Common contagious diseases		19,058	12.6
Measles	4,517		
Scarlet fever	3,854		
Whooping-cough	3,047		
Diphtheria and croup	7,640		
Typhoid fever		5,627	3.7
Syphilis—total		4,902	3.2
Syphilis	3,422		
Locomotor ataxia	1,020		
Softening of the brain	460		
Influenza		3,000	2.0
Puerperal fever		2,825	1.9
Gonococcus infection		191	0.1
Other infectious diseases		6,038	4.0
Erysipelas	1,599		
Dysentery	1,212		
Tetanus	876		
Cerebrospinal fever	834		
Malaria	644		
Infantile paralysis	392		
Cholera nostras	140		
"Other epidemic diseases"	124		
Rabies	67		
Smallpox	44		
Intestinal parasites	30		
Mycoses	24		
Hyatid tumor of liver	13		
Anthrax	12		
Ankylostomiasis	10		
Glanders	7		
Leprosy	4		
Typhus fever	3		
Relapsing fever	2		
Plague	1		
Nutritional Diseases		1,097	0.7
Pellagra	702		
Rickets	335		
Scurvy	53		
Beriberi	7		
Poisoning by Food		329	0.2
Industrial Poisonings		124	0.1
Lead poisoning	120		
Other chronic occupational poisonings	4		
Total—preventable deaths	151,150		100.00

sickness records are, unfortunately, so fragmentary as to be of little practical value, while our death records are reliable for only two thirds of the country. Let us turn, however, to the mortality statistics for 1913, and seek to discover the opportunities for prevention.

The registration cities of the country represented in 1913 a population of 34,230,283, or 35 per cent. of the total. In Table 1 an attempt is made to show the preventable deaths occurring in these cities. This table is intended to include all infectious diseases; certain nutritional diseases, such as beriberi and pellagra; industrial poisonings; and food poisonings. Certain of the infectious diseases included, such as puerperal fever, will seem novel in connection with. health department activities. They are included on the theory that being infectious, they are preventable; that ultimately we may come to prevent them; and that the health department is the only governmental agency whose business it is to prevent them. The numbers of deaths from these diseases are, furthermore, relatively small.

There are conspicuous omissions from the list. Cancer is a striking example. No one doubts that many deaths from cancer may be avoided through early operation, and allowance must be made for this disease in making up relative values; however, it has seemed better to omit cancer from this list, and to lump it in with the degenerative diseases of middle age. Allowance will be made for this group of diseases under the heading of health education. Again, the list disregards the great group, Diseases of Early Infancy, from which something certainly can be saved. In addition, bronchopneumonia is included entire and placed in the infant group, while all other forms of pneumonia are omitted. Finally, the list seriously understates the losses caused by the venereal diseases, making no effort to include the deaths that may be due to syphilis but that are registered under diseases of the arteries and other organs, although it does include deaths from locomotor ataxia and softening of the brain. The list also disregards deaths from such causes as salpingitis—deaths in which gonorrhea may play a part. An attempt to make due allowance for these inclusions and omissions will be made later in the paper.

It is worthy of note that this list of preventable deaths, although conservative, totals 151,150, or 29 per cent. of the deaths from all causes.

Damage Done as a Criterion.

When we come to compare the different diseases in the list it becomes evident that relative importance cannot be tested adequately by any single criterion, but that several of fairly equal importance must be considered. One of the most obvious tests is the number of deaths caused by each disease. On this basis tuberculosis, responsible for 56,624, or 37.5 per cent. of the whole preventable list, is the most important. Second in importance comes diarrhea and enteritis among children under two, responsible for 30,244, or 20.0 per cent. Next comes bronchopneumonia, with

14.0 per cent.; followed closely by the four common contagious diseases of children—diphtheria, scarlet fever, whooping-cough, and measles, responsible as a group for 12.6 per cent. of the deaths.

But the number of deaths is not an adequate measure of the damage done. For one thing, it fails to take account of non-fatal illness. Perhaps the extreme example of this failure is gonorrhea. In the table this disease is represented by only 191 deaths, about 0.1 of one per cent. of the total; yet we know that gonorrhea is one of the commonest of communicable diseases, and that its public health importance is far in excess of the figure just given. Other examples of diseases with low fatality rates, and whose importance is inadequately represented by the death test are hookworm and malaria. In measuring the loss due to any preventable disease we must consider not only the number of deaths but the number of cases of non-fatal sickness, the duration of attack, and the seriousness of secondary effects or impairments. Unfortunately, our knowledge of these things is imperfect.

Another factor comes into the estimate of damage done—the relative value of the lives lost or temporarily disabled. The economic value of an infant is of course not as great as that of a wage-earner. On the other hand, we realize that economic value is an unsatisfactory measure of the value of life, and is one the public is inclined not to accept. Most of us would put the humanitarian side—the anguish caused those near and dear—above economic value; and on this basis the loss of an infant may be as important as that of an older person. The argument that the loss of a wage-earner may have a serious effect on a greater number of persons is one deserving more consideration.

Preventability as a Criterion.

Passing from damage done,we come to another criterion of the first importance—preventability. Certain of our "preventable" diseases are much more preventable than others. Smallpox is, by vaccination, almost absolutely preventable. Typhoid fever is another disease we are prepared to attack with great confidence if the necessary funds and powers are at our disposal. Infantile paralysis, on the other hand, is much more difficult to curb; and measles, with its period of infectivity principally before the appearance of symptoms, is largely independent of our efforts. Similarly, we expect quicker and more sharply defined results from infant hygiene work than from that directed against tuberculosis.

Attention must be given not only to the general preventability of the disease, but to the degree of prevalence. It is generally easier to secure results in a virgin field. After a death-rate has been forced down to a certain level, each new unit of reduction is successively more difficult. This is the problem of residuals, and must be considered with reference to local conditions.

Cost of Prevention as a Criterion.

A third major criterion is cost of prevention. The great importance of this factor is enforced by the meagre-

ness of the funds at our disposal. In some respects cost is the most important criterion of all. It can be argued that in considering activities we should determine what line of effort will save a unit of life or health for the least money, and then prosecute that activity alone until the law of diminishing return brings the activity to a par with its nearest rival.

Such a one-sided program is of course impracticable. Even if theoretically desirable, which is questionable, such a course would not be tolerated by public opinion. Great weight must, however, be given to the factor of cost. The figure used should include only that to the health department, and not that to society as a whole. Otherwise we shall become entangled in questions of other standards of value, such as comfort, convenience, and aesthetics; and these seem to be matters to be interpreted by the demographer, and evaluated by the people themselves.

Communicability as a Criterion.

Another factor that seems to deserve consideration is the communicability or contagiousness of a disease; in other words, its tendency to become epidemic. On account of this property, certain diseases, such as smallpox, must be suppressed immediately upon appearance, almost without regard to cost and, it may be, quite without regard to the amount of damage they may have done in the community during the last year, or the last ten years. Such diseases, if neglected, may quickly cause extremely abnormal damage. Communicability appears not to be correlated with the other three factors. Infant mortality, for example, which receives high ratings with regard to damage done, preventability, and cost, receives a relatively low rating for communicability. Accordingly this factor seems to qualify as a separate criterion.

Solution for Relative Values.

In general, then, the relative value of a disease, or of an activity to prevent a disease or diseases, would seem to depend on four prime factors: first, amount of damage done; second, preventability; third, cost of prevention; fourth, tendency to become epidemic. As a formula this might be expressed:

Value = Damage × Preventability × Cost × Communicability.

Certainly these seem to be the main criteria. Perhaps weights should be assigned to the four factors, but this is a refinement one hesitates to attempt. It should be noted that in the formula, cost is in the nature of an inverse factor.

One other point deserves attention. Certain activities are indispensable to a health department. For example, nothing is more important than the registration of vital statistics, yet it is obviously difficult to assign any number of deaths prevented by this work. Similarly it is difficult to measure the results of health education, although we feel sure it is an important part of the program. Perhaps activities of this kind should be regarded as in the nature of "overhead" charges. At all events, they should be assigned a liberal value.

Relative Value of Different Causes of Death.

The task of applying these criteria and of deriving a set of values is a difficult one. In offering the following values no claim is made for a high degree of accuracy. It is believed, however, that the values derived permit a considerable margin for difference of opinion without altering the general conclusions which the figures suggest. The method may, moreover, suggest ways in which more accurate values eventually will be derived. The calculations involved appear in Tables 2 and 3.

Starting with the original list of preventable deaths (Table 1), an estimate has been made of the damage done by the different causes. This estimate is intended to give due weight to non-fatal illness, and the other damage factors already mentioned. The proportions of damage done assigned to the diseases are, arranged in order of magnitude, as follows: tuberculosis, 25 per cent.; infants' diseases, 25 per cent.; venereal diseases, 20 per cent.; the four common contagious diseases of children, 15 per cent.; typhoid fever, 5 per cent.; other infectious diseases, 8 per cent.; nutritional diseases, 1 per cent.; and poisoning by food, 1 per cent.

These values have been multiplied by what seem appropriate factors representing preventability, cost of prevention, and tendency to become epidemic, the various steps of the computation appearing in Table 2. The resulting values, which relate to causes of death and not to lines of activity are, when reduced to per cents and arranged in order of magnitude, as follows.

TABLE 2.

CALCULATION OF VALUES FOR DIFFERENT CAUSES OF PREVENTABLE DEATH—AND ADJUSTMENT TO INCLUDE VALUES ARBITRARILY ASSIGNED.[a]

Cause of death.	I. Per cent. of deaths.	II. Estimate of damage done.	III. Factor[b] for preventability.	IV. II times III.	V. Factor for cost.[c]	VI. IV times V.	VII. Per cent.	VIII. Factor for communicability.	IX. VI times VIII.	X. Per cent.	XI. X times 0.73.
Tuberculosis	37.5	25.0	6	150	4	600	14.5	5	3,000	16.9	12.3
Infants' diseases	34 0	25 0	8	200	10	2,000	48.4	3	6,000	33.9	24.7
Diarrhea and enteritis	(20 0)										
Bronchopneumonia	(14 0)										
Contagious diseases of children	12 6	15 0	6	90	6	540	13.1	10	5,400	30.5	22.3
Venereal diseases	3 3	20.0	5	100	4	400	9.7	4	1,600	9.0	6.6
Typhoid fever	3.7	5.0	9	45	8	360	8.7	3	1,080	6.1	4.5
Other infectious diseases	7 9	8 0	5	40	5	200	4.9	3	600	3.4	2.5
Nutritional diseases	0 7	1.0	6	6	5	30	0.7		[e]30	0.2	0.1
Poisoning by food	0.2	1 0	1	1	1	1	0.0		[e]1	0.0	0.0
Industrial poisonings	0.1	[d]	[d]	[d]							
Total	100 0	100 0				4,131	100.0		17,711	100.0	73.0

[a] Based on mortality in all registrations cities, 1913.
[b] Factors on a scale of 10; that number being most favorable rating, one being the least favorable.
[c] Cost—to health department.
[d] Disregarded.
[e] Factor for communicability not applied in these cases.

Values arbitrarily assigned:

Inspection of school children	7.0
Education	5.0
Vital statistics	5.0
Dispensary and clinics	5.0
Laboratory	5.0
Total	100.0

First: infants' diseases, 33.9 per cent. The two causes included under this heading, diarrhea and enteritis under two and bronchopneumonia, are responsible for 34 per cent. of the deaths in the preventable list. Bronchopneumonia, responsible for 14 per cent., includes deaths of other than infants; but the median age of the deceased is 1.5 years, and 68 per cent. of the deaths occur among children under five. To compensate for the deaths improperly included, there are the deaths of infants from several other causes which I have disregarded, —such causes as pneumonia, and the group Diseases of Early Infancy. Deaths of infants under two amount to over one fifth of all the deaths that occur, and in our list of preventable deaths this group of infants accounts for over a third of the total. In an unworked field, infant mortality offers a high degree of preventability at a low cost; if it were not for a low rating on communicability it would attain even a higher value than it does.

Second: the four contagious diseases of children, 30.5 per cent. These diseases are responsible for 13 per cent. of the preventable deaths, and are estimated to be responsible for 15 per cent. of the damage done. They are the most likely to become epidemic, a fact that contributes largely to their high final rating.

Third: tuberculosis, 16.9 per cent. Although responsible for 37.5 per cent. of the preventable deaths, its value is reduced by high cost of prevention, moderate preventability, and absence of the acute tendency to become epidemic that characterizes some of the other communicable diseases.

The fourth value falls to the venereal diseases, 9 per cent. Although only 3.3 per cent. of the preventable deaths can be definitely ascribed to these diseases it is certain that they cause many deaths that are registered under other titles. In addition, there is a tremendous number of non-fatal cases, and the indirect results of these are frequently grave. Conservative estimates have placed the number of cases in the country at two or three million. This field is almost untouched, and health department effort in the way of education, diagnosis, and treatment, should accomplish great good.

The fifth place goes to typhoid fever, with a value of 6.1 per cent. Then follow other infectious diseases, 3.4 per cent.; and nutritional diseases, 0.2 per cent. Poisoning by food registers less than 0.1 per cent.

These are values calculated for the different causes in our list of preventable deaths. It is necessary now to make allowance for certain diseases, such as cancer and the degenerative diseases of middle age, which were not included in that list; to make allowance for certain activities that are indispensable to a health department; and to express the result in terms of health department organization.

Values According to Lines of Activity.

To health education an arbitrary value of 5 per cent. in the final scale is assigned. This item will cover activities in behalf of the semi-preventable diseases just mentioned. Similarly, a

value of 7 is assigned to the physical examination of school children, and a value of 5 to each of the following activities: vital statistics, dispensary and clinics, and laboratory. As these arbitrarily assigned items aggregate 27 per cent., it is necessary to reduce proportionally the previously determined disease values to make them total 73 per cent. Table 3 exhibits the distribution of what seem appropriate parts of these reduced values among the following activities: milk control, privy and well sanitation, fly and mosquito suppression, and food sanitation. The result is the following list of final values, expressed according to lines of health department activity.

TABLE 3.

DISTRIBUTION OF DISEASE VALUES ACCORDING TO LINES OF HEALTH DEPARTMENT ACTIVITY.

Disease.	Relative value.	Milk control.		Food sanitation.		Privy and well sanitation.		Fly and mosquito suppression.		Tuberculosis.		Infant hygiene.		Control communicable diseases.	
		Fraction.[a]	Value.	Fraction.	Value.	Fraction.	Value.	Fraction.	Value.	Fraction.	Value.	Fraction.	Value.	Fraction.	Value.
Tuberculosis	12 3	.02	.25							.98	12 05				
Infants' diseases	24 8	.06	1 49			.06	1 49	.06	1 49			.82	20 34		
Diarrhea and enteritis		(10)				(10)		(10)				(70)			
Bronchopneumonia		b		b	b							(10)			
Contagious diseases of children	22 3	.02	.45											.98	21 85
Venereal diseases	6 6	b	b	b	b										
Typhoid fever	4 5	.10	.45	.01	.05	.40	1 80	.10	.45					.39	1 76
Other infectious diseases	2 5	.02	.05	.02	.05	.10	.25	.20	.50					.66	1 65
Poisoning by food	0 0			1 00	00										
Total	73 0		2 69		10		3 54		2 44		12 05		20 34		25 26

[a] "Fraction" indicates fractional part of disease value estimated preventable by activity.
[b] Not distributed.

TABLE 4.

Final values* as applied to activities directly concerned with:

Control of Communicable Diseases—	
Tuberculosis	12.1
Venereal diseases	6.6
All others	25.3
Infant hygiene	20 3
Privy and well sanitation	3 5
Milk control	2.7
Fly and mosquito suppression	2.4
Food sanitation	0 1
Inspection of school children	7.0
Vital statistics	5 0
Education	5.0
Dispensary and clinics	5.0
Laboratory	5.0
Total	100.0

* For a more detailed subdivision of values see, Chapin, C. V.: "Effective Lines of Health Work," *The Providence Medical Journal*, January, 1916. Persons interested in relative values should consult also, "How Should Spend the Health Appropriation," by the same author, American Journal of Public Health, Vol III, No. 3, page 202.

The value 25.3 for communicable diseases other than tuberculosis and the venereal diseases may seem high as compared with the values for those specific diseases and that for infant hygiene. On the other hand, this 25.3 per cent. must cover the work against the common contagions of

children, as well as that against typhoid fever, smallpox, and others of the more unusual diseases. It must take care also of the possibilities in connection with pneumonia. In addition, infant hygiene is represented by 4.5 per cent. in the allowances for milk control, privy and well sanitation, and fly suppression. It is assumed that control of communicable diseases will be carried on with modern epidemiological methods, public health nurses, and emphasis on bedside disinfection of discharges.

The list of final values does not consider industrial hygiene; not because the work is unimportant, but on the theory that state authorities will meet the need. Plumbing inspection does not appear, partly because of lack of evidence to justify its insertion, and partly because this is considered work for the building department. Nuisance abatement is intentionally omitted; it is realized, however, that health departments commonly must carry this largely police function. The privy, well, fly, and mosquito work, for which allowance has been made, cover the important sanitary parts of what is generally understood by nuisance abatement.*

Before leaving these values it seems wise to utter a few words of warning. The values are based on the rates of mortality existing in registration cities as a whole in 1913, and thus represent certain average conditions. Local conditions will of course modify any values, as will the passage of time and the development of sanitary science. Similarly, the importance of different health measures in any one city will be different at different times. It must be confessed that the existing data for the determination of relative values is seriously inadequate. What we need for better values is better vital statistics and better cost-keeping. Probably nothing would be a greater help to the progress of this subject, and perhaps of sanitary science in general, than for our health officers to form the habit of keeping careful records regarding new procedures, together with statements of the results and the costs. These could be published in the departments' annual reports; and thus there would be accumulated a mass of data comparable to that in the handbooks now existing in the fields of civil and mechanical engineering.

Some health officers, of course, do this already; none more admirably than Doctor Chapin of Providence. On this occasion one is tempted to express one's admiration of Doctor Chapin's reports and other writings, and say what models of scientific work they are, and say how much we all owe to him. But one hesitates to do so, from fear that he would dislike it. At all events, when we have more reports like Doctor Chapin's we shall be in a fair way to get our judgments of relative values onto a definite quantitative basis.

Making liberal allowance for inaccuracies in the values here presented,

* For a vigorous exposition of existing inconsistencies see, Armstrong, D. B., "Public Health Values—A Few Modern Fallacies," Proceedings of the Fifth Annual Conference of Mayors of New York State; 25 Washington Ave., Albany, 1914. For an excellent critical discussion of the relative value of different branches of his own work by a practising health officer see, Terry, C. E., Annual Report of the Board of Health for 1915, Jacksonville, Fla., page 47.

and for possible differences that may be occasioned by local conditions, the following conclusions seem fully justified: The prevention of infant mortality is a fundamental activity, and one of the most valuable a health department can pursue. Very exceptional is the city in which this work can be ignored without convicting the health authorities of gross neglect. Anti-tuberculosis work and that involved in the control of the common contagious diseases, are other activities of prime importance. In addition, it seems time to admit the venereal diseases to the group of larger opportunities. In most cities the value of the above mentioned lines of activity is considerably greater than that of the various forms of sanitary inspection.