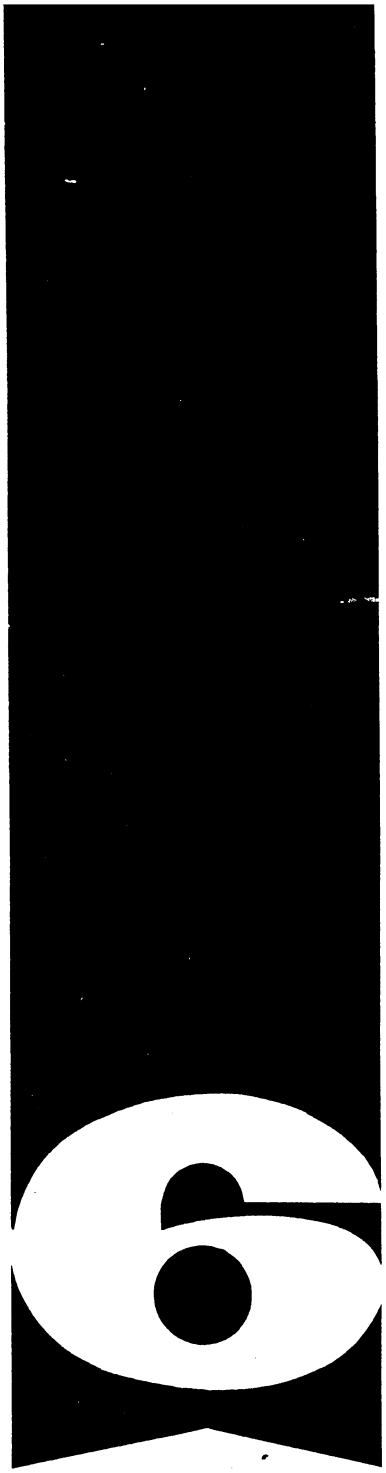

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1965 to provide funds for the establishment of regional centers to provide services for deaf-blind children and the Handicapped Children's Early Education Assistance Act has allocated funds for handicapped children requiring special education and related services. Locating and channeling handicapped children to available services and providing these agencies with meaningful surveillance data is of paramount importance. Surveillance, therefore, cannot only be a tool in eradication of congenital rubella syndrome, but a mechanism for assisting those already handicapped.

COSTS OF THE 1964-1965 RUBELLA EPIDEMIC

Steven M. Shavell, B.A.

Until Gregg observed congenital cataracts in the offspring of women who acquired the disease during pregnancy, rubella was not thought to be of much public health importance. Since that time (1941), of course, various investigators have demonstrated that the congenital damage is not limited to cataracts, but may also include deafness, heart defects, microcephaly, and motor and mental retardation. Rubella is now considered a major public health problem chiefly because it is suspected that a large number of children have been affected by the (congenital rubella) syndrome.

Although the purpose of this paper is to estimate the cost of the rubella epidemic of 1964-1965, one may obtain—by implication—an idea of the size of the rubella problem in average (non-epidemic) years, when incidence is approximately one-third that of the 1964-1965 outbreak.

Analyzing the magnitude of a health problem is a complex job. It requires careful evaluation of information coming from diverse sources. It also requires making judgments or assumptions which cannot always be documented. Consequently, we have adopted a "conservative," but not ultra-conservative, attitude throughout. In some areas, we felt it best to present a range of possible costs.

It was convenient to express costs in terms of dollars and also in terms of health and resources. The economic or dollar costs are (1) direct or (2) indirect. Direct economic costs include medical expenses connected with all rubella cases (not just the "rubella babies"—see Table II), charges for institutional care for the mentally retarded, and costs of special education for the rubella babies fortunate enough to be educable. Indirect costs, on the other hand, are an approximation of the dollar value of the productivity losses related to rubella.

Productivity losses may arise from premature death or from mental retardation, since both prevent individuals from joining the labor force. Rubella also strikes employed adults, resulting in work losses. In addition, parents sometimes miss work in order to care for sick children. (We were not, however, able to estimate the importance of this last factor.)

The costs in health and resources as well as in dollars and cents are listed in some detail in the Tables. For each category of cost, two figures are suggested. One is based on the assumption that there were 10,500 infants with moderately severe to severe congenital rubella syndrome; the other, that there were 30,000 such infants.

Results

For the most part, the statistics in the Tables speak for themselves: the rubella epidemic of 1964-1965 was very costly in terms of physical and of medical and educational resources. Particularly significant is that a large number of children were affected by the congenital rubella syndrome. This tragic cost and other associated costs of the rubella epidemic represent a potential saving which the Nation would realize if a similar outbreak is prevented in the future.

One thing that the statistics do not show is the relative role that rubella plays in handicapping children. No national statistics are available on this point, but California has conducted an extensive survey of multiply-handicapped children in the State.[1,2] Among the findings is that rubella is one of the most important causes of multiplehandicaps in children of all ages. However, among children of *preschool* age, it is often the single most important factor. For instance, the survey found rubella to be responsible for at least 71 percent of cases of deaf-blindness in children of preschool age. The investigators believed rubella to be responsible for the damage done to over 50 percent of all deaf, multiply-handicapped children of preschool age. Furthermore, they linked rubella to two findings: first, that the average degree of handicapping in handicapped preschool age children is greater than that in school age children; and second, that actual number of handicapped preschool age children is greater (in many categories, by a factor of two or more) than the number of handicapped children of school age.

Important aspects of the breakdown of economic costs are that (1) direct expenditures exceeded productivity losses, and that (2) the excess cost of special education (for the handicapped children) was the single most important category of economic costs.

The high cost of special education only hints at the magnitude of the financial problem involved in training thousands of children with not one, but *several,* handicaps. "When we consider that a single child who is deaf (or blind) is a substantial educational problem, and that a single child who is deaf (or blind) with one added handicap constitutes an almost insurmountable educational challenge, the specter of (thousands of) multihandicapped, deaf (and blind) children under the age of six years waiting for an education, from a system where special programs for multihandicapped . . . children are almost nonexistent for older children, constitutes an educational and social catastrophe."[1]

In addition, it is probably true that the non-assessable costs—such as the worry facing many women of child-bearing age—are more evident in rubella than they are in many other diseases. The implication is that emotional, as well as medical and economic, reasons for eradicating rubella are very strong.

Notes on Tables

1. The estimate of total rubella incidence in 1964-1965 is based on many considerations. Some of the bits and pieces of information used were: (a) reported rates of incidence among certain clinical populations, as described in the literature, (b) reported incidence in selected States, as recorded by State health departments, (c) reported rubella incidence for the Nation, as detailed by the National Center for Health Statistics, and—most important—(d) estimated sero-immunity curves for selected populations. Perhaps surprisingly, estimates based on different methods often supported each other. For instance, it is estimated that at least three and a quarter million serologic cases (or roughly two and one-sixth million clinical cases) must have occurred during the average each year to account for the level of natural immunity which our population has acquired. In 1964, the rubella morbidity reported by States was roughly 5½ times above the average. Applying the ratio 5½ to the average number (2 million plus) of clinical cases, one gets a figure of about 12 million—which agrees in rough fashion with what we calculated, using NCHS data.

2. Estimates of the number of damaged children are, likewise, based on many considerations. First, it was necessary to

estimate the number of pregnant women affected with rubella in their first trimester. Approaches used were (a) to project the national experience on the basis of what happend in certain clinical populations, as reported in the literature (b) to apply the historically determined distribution of reported morbidity among major age and sex groupings to our estimate of total morbidity. Our final estimate of the number of women who contracted rubella in the first trimester of pregnancy is a compromise figure reflecting what the two methods above and several other ones suggest.

If one assumes that 20 percent of children born of mothers who had rubella in the first trimester of pregnancy would have moderately severe to severe congenital rubella syndrome, then the number of such infants would be 10,500. The 30,000 figure reflects a much higher rate. The distribution of the excess in neonatal deaths and of abnormalities among this group was, again, a compromise among the parameters reported in the literature.

Data supplied to us by Dr. Louis Z. Cooper at the New York University Medical Center was especially helpful.

Statistics on the excess in fetal wastage and in therapeutic abortions are hard to come by. The actual number of therapeutic abortions may run much higher. It is interesting to note that our data shows that the poor obtained almost no therapeutic abortions.

3. Estimates of the number of school days and work days lost were based on the implications of serologic immunity curves for selected geographic populations and on relative incidence rates as derived from reported data.

4. Attaching a dollar figure to the costs: estimates of the cost of medical and educational services were made by using, to the extent possible, national averages. An estimate of the excess in costs of medical treatment and special education of rubella babies was obtained from several sources, by far the most helpful of which was Dr. Louis Z. Cooper.

No attempt was made to put a dollar value on the productivity losses among children just marginally affected by congenital rubella syndrome. Only the children severely affected were considered. The dollar value of these as well as other productivity losses *(due to premature death and to morbidity among the currently employed)* was calculated in the manner outlined in Rice's *Estimating the Cost of Illness.*

When feasible, we considered only the excess or additional costs due to rubella. For instance, in calculating the excess cost of special education, we subtracted from the total cost of education an estimate of the average cost of regular education in public schools.

When evaluating the present value of a cost which occurs in the future or recurs year after year, we were careful to use the procedure of "discounting" (at 4 percent). For example, if five years from now a parent must spend $1200 for the special education of a child, must he set aside $1200 today? Of course, the answer is no. (At today's interest rate of 5 percent, compounded quarterly, he would actually have to set aside, in the bank, less than $900.)

TABLE I

SUMMARY STATEMENT OF ESTIMATED COSTS OF THE 1964-1965 RUBELLA EPIDEMIC—POTENTIAL SAVINGS WHICH THE NATION WOULD REALIZE IF A SIMILAR EPIDEMIC IS PREVENTED

I. Economic Costs

	Assuming that the number of children affected with moderately severe to severe congenital rubella syndrome is: 10,500	30,000
Cost of Medical Treatment	$121,330,000	$152,778,000
Cost of Special Education—1964, 1965, and future years, discounted at 4%	348,288,000	1,156,615,000
Costs of Institutionalization—1964, 1965, and future years, discounted at 4%	69,483,000	230,783,000
Sum of Direct Expenditures	$539,041,000	$1,540,176,000
Value of Productivity Losses—1964, 1965, and future years, discounted at 4%	300,973,000	574,999,000
Total Economic Costs	$840,014,000	$2,115,175,000

II. Health and Resource Costs

	Assuming that the number of children affected with moderately severe to severe congenital rubella syndrome is: 10,500	30,000
Incidence of Clinical Cases	12,500,000	12,500,000
Deaths	2,160	2,160
Infants with Moderately Severe to Severe Congenital Rubella Syndrome	10,500	30,000
Hospital Days Lost*	842,000	842,000
School days Lost	14,445,000	14,445,000
Work days Lost	3,499,000	3,499,000

* Does not include days spent in hospital by infants with rubella syndrome.

TABLE II†

ESTIMATED ECONOMIC COSTS* ASSOCIATED WITH THE RUBELLA EPIDEMIC OF 1964-1965 ASSUMING THAT EITHER 10,500 OR 30,000 INFANTS ARE AFFECTED BY THE CONGENITAL RUBELLA SYNDROME**

	1964		1965		1964-1965		Percent	
if infants with syndrome number	10,500	30,000	10,500	30,000	10,500	30,000	10,500	30,000
I. DIRECT COSTS	430,385	1,231,171	108,656	209,005	539,041	1,540,176	64.2	72.8
A. Physicians Services	56,919	56,919	14,798	14,798	71,717	71,717	8.5	3.4
1. Office care—for								
a. Acute cases	(33,875)	(33,875)	(8,808)	(8,808)	(42,683)	(42,683)		
b. Contacts (pregnant women only)	(15,630)	(15,630)	(4,064)	(4,064)	(19,694)	(19,694)		
c. Arthritis cases	(664)	(664)	(173)	(173)	(837)	(837)		
d. Encephalitis cases	(17)	(17)	(4)	(4)	(21)	(21)		
2. Hospital care—for								
a. Arthritis cases	(4,645)	(4,645)	(1,208)	(1,208)	(5,853)	(5,853)		
b. Encephalitis cases	(288)	(288)	(75)	(75)	(363)	(363)		
c. Women who had spontaneous or therapeutic abortions	(1,800)	(1,800)	(466)	(466)	(2,266)	(2,266)		
B. Hospital Services—for	28,416	28,416	7,530	7,530	35,946	35,946	4.3	1.7
1. Arthritis cases	(26,507)	(26,507)	(7,024)	(7,024)	(33,531)	(33,531)		
2. Encephalitis cases	(1,161)	(1,161)	(308)	(308)	(1,469)	(1,469)		
3. Women who had spon. or ther. abortions	(748)	(748)	(198)	(198)	(946)	(946)		
C. Institutional Care for the Mentally Retarded	55,586	184,625	13,897	46,158	69,483	230,783	8.3	10.9
D. Medical Care for Rubella Babies	10,785	35,821	2,762	9,174	13,547	44,995	1.6	2.1
E. Special Education for Rubella Babies—1964, 1965, and future years discounted at 4%	278,583	925,294	69,645	231,321	348,228	1,156,615	41.5	54.7
F. Other—miscellaneous	96	96	24	24	120	120	0.0	0.0
II. INDIRECT COSTS	240,779	460,001	60,194	114,998	300,973	574,999	35.8	27.2
A. Morbidity losses	158,894	378,116	39,723	94,527	198,617	472,643	23.6	22.3
1. Among those unable to work (the severely retarded; deaf, blind rubella babies) future years, discounted at 4%	(94,434)	(313,656)	(23,608)	(18,412)	(118,042)	(392,068)		
2. Among the currently employed	(64,460)	(64,460)	(16,115)	(16,115)	(80,575)	(80,575)		
B. Mortality losses (earnings lost by premature death) 1964, 1965, and future years, discounted at 4%	81,885	81,885	20,471	20,471	102,356	102,356	12.2	12.2
TOTAL ECONOMIC COSTS	671,164	1,691,172	168,850	424,003	840,014	2,115,175	100	

* 1964 costs are expressed in 1964 dollars; 1965 costs, in 1965 dollars.
† In thousands of dollars.

TABLE III

ESTIMATED COSTS IN HEALTH AND RESOURCES ASSOCIATED WITH THE 1964-1965 RUBELLA EPIDEMIC

Type of Cost	Magnitude of Cost	
Incidence (clinical cases)	12,500,000	
Deaths*	2,160	
Encephalitis cases	2,084	
Arthritis cases	159,375	
Hospital days lost**	842,000	
Work days lost	3,499,000	
School days lost	14,445,000	
Therapeutic abortions	5,000	
Excess neonatal deaths	2,100	
Excess fetal wastage	6,250	
Children born of women*** who had rubella in their first trimester of pregnancy	52,500	
	If the number of children affected by congenital rubella syndrome is*	
	10,500	30,000
Deaf children	3,780	12,555
Deaf-blind children	1,680	5,580
Mentally retarded	840	2,790

* Include neonatal deaths.
** Excludes days spent in hospital by infants with rubella syndrome.
*** Includes women with subclinical cases.

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RUBELLA CONTROL: THE APPLICATION OF VACCINES

David T. Karzon, M.D.

I would propose that we think of the introduction of the rubella vaccine in two phases, conducted simultaneously. The first, and major, thrust is based on the concept of protection of the target group, women of childbearing age—protection by reducing their risk of contagion. And this is to be accomplished by the elimination of infection in children who are the major source of the transmission and survival of the virus in the population. Secondly, there is the careful and selective immunization of the women of childbearing age. I should like first to discuss introduction of the vaccine into the child population.

Immunization of boys and girls from the age of approximately 12 months through puberty is to me a very straightforward conceptual procedure. It makes sense from every point of view. The vaccine is well tolerated by this group. We have the mechanisms for such introduction. However, because of the epidemiology of rubella, we know if we cease to immunize at puberty, say at around age 13, that individuals above this age contain 30 percent or so of susceptibles. The percentage will vary from some populations to others. Immunization of children can be undertaken either in the school system or at the age of one year.

Many of the aspects of this program resemble our experience with measles and polio. If vaccine is temporarily in short supply, and it may be because of a sudden demand on modest production methods, it would make sense to immunize first of all that group which is involved in the highest transmission rate. As we have seen, this would be children in the 4- to 5-year age group to those near puberty. Again, the emphasis would be on trying to block transmission in the community.

Here I would interject a word about immunization of adolescent and young adult males. This is a difficult group from which to attain high immunization rates of any kind, and the question will arise as to what to do about them. They are of lower priority. If we immunize these individuals without pretesting, we will be wasting a lot of vaccine. Furthermore, we have no valid information as to how many individuals in this particular class in fact serve as the method of introducing virus into a household or of passing infection on to a pregnant woman. But of course in certain closed situations—institutions and so on—this should be considered.

Now, regarding immunization of the target group we will first make the assumption, which I think no one challenges, that the teratogenicity of the vaccines that we have is not clearly known and will probably not be known with precise accuracy for some time. Thus, we must assume that there is some risk. And we can therefore make the flat statement that immunization of pregnant women should not be undertaken. Having said this, what happens with women whose pregnancy status is unknown or who are not pregnant in the childbearing period? There are circumstances where adolescent or adult married or unmarried women may be considered, on an individual basis, for immunization. Now ideally, candidates for such immunization should be individually handled in the manner that follows. First, they should be screened as to antibody status by a sensitive HI test in a good laboratory. This will eliminate approximately 85 in 100 women—15 in 100 remaining susceptible. This serologic screening has several values. First, you can assure 85 in 100 women that they do not need vaccine, that they are safe in respect to rubella. Second, the supply of vaccine would not be decreased. Third, and this is terribly important, such a test would avoid, at least in part, some of the potential medical-legal issues and moral guilt wrongly associated with the background rate of 2 to 3 percent of birth defects which occur in the population and which are in fact, of course, unrelated to rubella. The screening, serological screening, does not circumvent the problem of what to do with the women who are sero-negative. To consider a sero-negative woman for immunization must be done individually. The woman must be free of pregnancy at the time of immunization, and furthermore she must be free of pregnancy for a period of 2 months thereafter. She may be vaccinated only if she understands that it is imperative for her to avoid becoming pregnant for the ensuing 2 months.

To insure this a medically-acceptable method for the prevention of pregnancy must be followed for the 2-month period. The reason for the 2 months is somewhat arbitrary. It is based on the fact that we know that natural rubella infection may persist for as long as one week prior to, to 3 weeks after, the rash, that is a period of a month. And this is after an incubation period. It is thought that 2 months is probably the briefest period to give us any freedom from anxiety of the virus and the fertilized ovum ever getting together. It has been suggested, and in fact field trials on this are underway, that immunization in the immediate post-partum period may have certain advantages. It has been suggested that this is a period when a woman, first, is available and, second, would be free from the risk of pregnancy. As a matter of fact, such a program at the present time is thought of highly in some of the other countries working on rubella vaccine. Immunization of women in the post-partum period to my mind, though, requires much, much more study before it could be recommended for general use. Thus far, it has been studied in only a relative handful of susceptible women. We require much more information about reactions; survival of the virus; this interesting phenomenon of cervical excretion of the virus during pregnancy: all must be studied.

Another consideration is this. Is the woman really free from danger of conception during this 2-month period that we ask for? My obstetrical colleagues tell me that this is really not so. There is an ovulation which occurs in 20 to 30 percent of women, I am told, at about the fourteenth day after delivery. It is relatively