6th annual IMMUNIZATION CONFERENCE
March 11-13, 1969
Atlanta, Georgia

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
COSTS OF THE
1964-1965 RUBELLA EPIDEMIC

Steven M. Shavell, B.A.

Until Gregg observed congenital cata-
tracts in the offspring of women who ac-
quired the disease during pregnancy, rub-
ella 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, microceph-
aly, and motor and mental retardation.
Rubella is now considered a major public
health problem chiefly because it is sus-
ppected 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 impli-
cation—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. Conse-
quently, we have adopted a "conserva-
tive," 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 ex-
penses connected with all rubella cases
(not just the “rubella babies”—see Table
III), 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 pre-
mature death or from mental retardation,
since both prevent individuals from join-
ing 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 signifi-
cant 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 out-
break 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 sta-
tistics are available on this point, but
California has conducted an extensive
survey of multiply-handicapped chil-
dren in the State.12 Among the findings
is that rubella is one of the most im-
portant causes of multiple handicaps in
children of all ages. However, among
children of preschool age, it is often the
single most important factor. For in-
stance, the survey found rubella to be
responsible for at least 71 percent of cases
of deaf-blindness in children of pre-
school age. The investigators believed
rubella to be responsible for the damage
done to over 50 percent of all deaf,
multiply-handicapped children of pre-
school age. Furthermore, they linked ru-
bella to two findings: first, that the aver-
age degree of handicapning in handi-
capped preschool age children is greater
than that in school age children; and
second, that actual number of handi-
capped 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 expen-
ditures exceeded productivity losses, and
that (2) the excess cost of special edu-
cation (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 chal-
lenge, the specter of (thousands of) multi-
handicapped, deaf (and blind) children
under the age of six years waiting for
an education, from a system where special
programs for multi-handicapped . . . chil-
dren are almost nonexistent for older chil-
dren, constitutes an educational and social
catastrophe."13

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 im-
plication is that emotional, as well as
medical and economic, reasons for eradi-
cating rubella are very strong.

Notes on Tables

1. The estimate of total rubella incidence
in 1964-1965 is based on many considera-
tions. Some of the hints and pieces of in-
formation used were: (a) reported rates of
incidence among certain clinical popula-
tions, as described in the literature, (b)
reported incidence in selected States, as
recorded by State health departments,
(c) reported rubella incidence for the Na-
tion, as detailed by the National Center
for Health Statistics, and—most import-
antly—(d) estimated sero-immunity curves
for selected populations. Perhaps sur-
prisingly, 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 popula-
tion 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 happens 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 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

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (1966)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Medical Treatment</td>
<td>$121,330,000</td>
</tr>
<tr>
<td>Cost of Special Education—1964, 1965, and future years, discounted at 4%</td>
<td>348,288,000</td>
</tr>
<tr>
<td>Cost of Institutionalization—1964, 1965, and future years, discounted at 4%</td>
<td>69,483,000</td>
</tr>
<tr>
<td>Sum of Direct Expenditures</td>
<td>$539,041,000</td>
</tr>
<tr>
<td>Value of Productivity Losses—1964, 1965, and future years, discounted at 4%</td>
<td>300,973,000</td>
</tr>
<tr>
<td>Total Economic Costs</td>
<td>$840,014,000</td>
</tr>
</tbody>
</table>

#### II. Health and Resource Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (1966)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of Clinical Cases</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td></td>
</tr>
<tr>
<td>Infants with Moderately Severe to Severe Congenital Rubella Syndrome</td>
<td></td>
</tr>
<tr>
<td>Hospital Days Lost*</td>
<td>842,000</td>
</tr>
<tr>
<td>School days Lost</td>
<td>14,445,000</td>
</tr>
<tr>
<td>Work days Lost</td>
<td>3,499,000</td>
</tr>
</tbody>
</table>

* 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**

<table>
<thead>
<tr>
<th>if infants with syndrome number</th>
<th>1964</th>
<th>1965</th>
<th>1964-1965</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10,500</td>
<td>30,000</td>
<td>10,500</td>
<td>30,000</td>
</tr>
<tr>
<td><strong>I. DIRECT COSTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Physicians Services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Office care—for</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Acute cases</td>
<td>430,385</td>
<td>1,231,171</td>
<td>108,656</td>
<td>209,005</td>
</tr>
<tr>
<td>b. Contacts (pregnant women only)</td>
<td>(33,875)</td>
<td>(33,875)</td>
<td>(8,808)</td>
<td>(8,808)</td>
</tr>
<tr>
<td>c. Arthritis cases</td>
<td>(15,630)</td>
<td>(15,630)</td>
<td>(4,064)</td>
<td>(4,064)</td>
</tr>
<tr>
<td>d. Encephalitis cases</td>
<td>(664)</td>
<td>(664)</td>
<td>(173)</td>
<td>(173)</td>
</tr>
<tr>
<td>2. Hospital care—for</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Arthritis cases</td>
<td>(17)</td>
<td>(17)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>b. Encephalitis cases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Women who had spontaneous or therapeutic abortions</td>
<td>(4,645)</td>
<td>(4,645)</td>
<td>(1,208)</td>
<td>(1,208)</td>
</tr>
<tr>
<td>(288)</td>
<td>(288)</td>
<td>(75)</td>
<td>(75)</td>
<td>(363)</td>
</tr>
<tr>
<td>(1,800)</td>
<td>(1,800)</td>
<td>(466)</td>
<td>(466)</td>
<td>(2,266)</td>
</tr>
<tr>
<td>B. Hospital Services—for</td>
<td>(28,416)</td>
<td>28,416</td>
<td>7,530</td>
<td>7,530</td>
</tr>
<tr>
<td>1. Arthritis cases</td>
<td>(26,507)</td>
<td>(26,507)</td>
<td>(7,024)</td>
<td>(7,024)</td>
</tr>
<tr>
<td>2. Encephalitis cases</td>
<td>(1,161)</td>
<td>(1,161)</td>
<td>(308)</td>
<td>(308)</td>
</tr>
<tr>
<td>3. Women who had spon. or ther. abortions</td>
<td>(748)</td>
<td>(748)</td>
<td>(198)</td>
<td>(198)</td>
</tr>
<tr>
<td>C. Institutional Care for the Mentally Retarded</td>
<td>55,586</td>
<td>184,625</td>
<td>13,897</td>
<td>46,158</td>
</tr>
<tr>
<td>D. Medical Care for Rubella Babies</td>
<td>10,785</td>
<td>35,821</td>
<td>2,762</td>
<td>9,174</td>
</tr>
<tr>
<td>E. Special Education for Rubella Babies—1964, 1965, and future years discounted at 4%</td>
<td>278,583</td>
<td>925,294</td>
<td>69,645</td>
<td>231,321</td>
</tr>
<tr>
<td>F. Other—miscellaneous</td>
<td>96</td>
<td>96</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td><strong>II. INDIRECT COSTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Morbidity losses</td>
<td>158,894</td>
<td>378,116</td>
<td>39,723</td>
<td>94,527</td>
</tr>
<tr>
<td>1. Among those unable to work (the severely retarded; deaf, blind rubella babies) future years, discounted at 4%</td>
<td>(94,434)</td>
<td>(313,656)</td>
<td>(23,608)</td>
<td>(18,412)</td>
</tr>
<tr>
<td>2. Among the currently employed</td>
<td>(64,460)</td>
<td>(64,460)</td>
<td>(16,115)</td>
<td>(16,115)</td>
</tr>
<tr>
<td>B. Mortality losses (earnings lost by premature death) 1964, 1965, and future years, discounted at 4%</td>
<td>81,885</td>
<td>81,885</td>
<td>20,471</td>
<td>20,471</td>
</tr>
<tr>
<td><strong>TOTAL ECONOMIC COSTS</strong></td>
<td>671,164</td>
<td>1,691,172</td>
<td>168,850</td>
<td>424,003</td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Magnitude of Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence (clinical cases)</td>
<td>12,500,000</td>
</tr>
<tr>
<td>Deaths*</td>
<td>2,160</td>
</tr>
<tr>
<td>Encephalitis cases</td>
<td>2,084</td>
</tr>
<tr>
<td>Arthritis cases</td>
<td>159,375</td>
</tr>
<tr>
<td>Hospital days lost**</td>
<td>842,000</td>
</tr>
<tr>
<td>Work days lost</td>
<td>3,499,000</td>
</tr>
<tr>
<td>School days lost</td>
<td>14,445,000</td>
</tr>
<tr>
<td>Therapeutic abortions</td>
<td>5,000</td>
</tr>
<tr>
<td>Excess neonatal deaths</td>
<td>2,100</td>
</tr>
<tr>
<td>Excess fetal wastage</td>
<td>6,250</td>
</tr>
<tr>
<td>Children born of women*** who had rubella in their first trimester of pregnancy</td>
<td>52,500</td>
</tr>
</tbody>
</table>

* If the number of children affected by congenital rubella syndrome is*

<table>
<thead>
<tr>
<th></th>
<th>10,500</th>
<th>30,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf children</td>
<td>3,780</td>
<td>12,555</td>
</tr>
<tr>
<td>Deaf-blind children</td>
<td>1,680</td>
<td>5,580</td>
</tr>
<tr>
<td>Mentally retarded</td>
<td>$40</td>
<td>2,790</td>
</tr>
</tbody>
</table>

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

### REFERENCES


4. Unpublished data, Immunization Branch, National Communicable Disease Center.


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—insitutions 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 seronegative. 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 postpartum 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