Deaths From Congenital Heart Disease In California, 1945–64

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THE TWO decades since the close of World War II have been marked by significant advances in the treatment of congenital heart disease. In the early years of this period, techniques for the division of patent ductus arteriosus, resection of coarctation of the aorta, and anastomoses to relieve tetralogy of Fallot came into widespread use in cardiac centers throughout the nation. By the midfifties the development of the heart-lung machine opened the way for significant advances in surgical repair of many defects within the heart itself.

In 1947 the crippled children services in the California State Department of Public Health authorized payment for closed-heart operations in a few medical centers in the State. In 1957 open-heart operations were authorized by crippled children services and the number of centers providing these services had increased to 10. In 1964 operations were being performed on heart patients in 23 cardiac centers under the program, and analysis of the death certificates for that year reveals that physicians in at least 34 additional hospitals were doing heart surgery.

If these techniques are lifesaving, their impact on mortality from congenital heart disease should be evident in the vital statistics of the State. This paper is an analysis of deaths from congenital heart disease over the 20-year period 1945–64, with emphasis on the second 10 years. Decedents are described by age and race, and age-specific death rates are examined to determine what changes have occurred in mortality due to congenital heart disease.

Data on deaths from congenital circulatory malformations, published by the California Department of Public Health, and population estimates of the State department of finance have been used to calculate rates. Death certificates for all State residents who died of congential circulatory malformations in the period 1955–64 were analyzed.

The Decedents

Most of those who died of congenital malformations of the cardiovascular system were infants, although the percent of the total deaths from this cause occurring in infants decreased from 79 percent to 62 percent in the 20-year period. The number of persons who died of this disease in each succeeding year of life decreased markedly, but even after age 65 there were a few deaths attributed to congenital malformations of the cardiovascular system.

Table 1 shows the number of deaths from this cause by age group in California for the years 1945–64. The percent distribution of these

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Table 1. Deaths from congenital cardiovascular malformations by age

Age group (years)	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Total	538	613	668	716	600	634	542	669	668	739	711	776	893
Under 1	426	481	517	541	443	491	409	505	513	543	537	573	643
1–4	42	44	51	49	44	49	45	61	57	70	47	76	85
5–19	29	32	31	33	23	37	30	30	32	35	39	48	59
20–44	26	42	40	60	58	37	43	42	44	64	56	41	53
45 and over	15	14	29	33	32	20	15	31	22	27	32	38	53

deaths by age group is shown in figure 1. The decrease in the percent of deaths occurring in children under age 1 was matched by an increase in the percent of deaths occurring in children over age 5, an indication that those with congenital heart malformations are living longer than previously.

The general downward trend of the percent of deaths from this cause occurring in children less than 1 year old was interrupted by marked increases in such deaths in 1950, 1955, and 1962. The number of infants who died of congenital cardiovascular malformations in 1950 was 48 greater than in 1949, and 31 greater in 1962 than in 1961. Since there was no corresponding increase in the total deaths due to this cause, the proportion of children who died in infancy was increased. The reports of the State bureau of communicable diseases indicate that 1949 was an epidemic year for German measles, with more than four times as many cases reported that year as in the preceding and succeeding years. This may account for the increase in deaths of infants with congenital cardiovascular malformations in 1950. Unfortunately, reporting of German measles was discontinued and such data are not available for 1961–62.

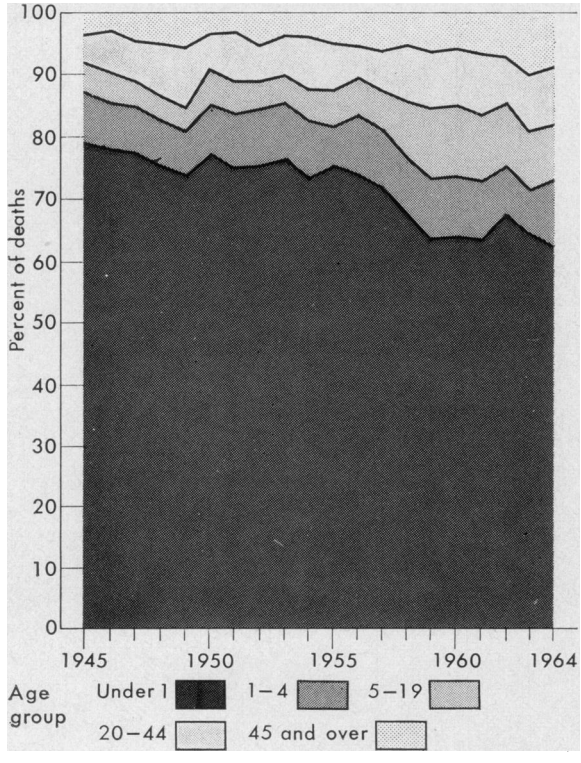
The racial distribution of the persons who died of congenital cardiovascular malformations in 1959–61 was compared with the racial distribution of the population in the 1960 census. Annual death rates per 100,000 population are shown in table 2.

The number of Negroes who died of congenital cardiovascular malformations was higher in proportion to the population than the number of whites or other nonwhites. This difference was due partly to the younger age distribution of Negroes in California, as shown by the decrease from crude to age-adjusted rate. However, the rate for Negroes was almost 25 percent higher than the rate for whites even after allowance for age distribution.

Deaths Associated with Surgical Operations

The death certificate includes an item questioning if and when a surgical operation was performed. For the study, we have assumed that any surgical operation was for the con-

Figure 1. Percent distribution of deaths from congenital cardiovascular malformations by age group (years), California, 1945–64



group, California, 1945–64

1958	1959	1960	1961	1962	1963	1964
841	911	990	1,017	1,006	966	1,001
569	580	630	642	673	622	622
79	88	97	98	86	67	103
76	101	116	108	101	90	94
76	85	92	102	78	94	99
41	57	55	67	68	93	83

genital heart defect, although in rare instances some other operation may have been associated with the death.

The date of an operation appears if death followed it immediately, but may or may not be given if death occurred after some interval of time. Of a sample of children in the crippled children services program, 74 died following surgery. Death certificates indicated that an operation had been performed on 70 of these children. Twelve of the 74 deaths occurred 3 months or more after the operation, and an operation was indicated on nine of the certificates. The one case in which a death occurred immediately after the operation but was not indicated on the death certificate involved a child who had an exploratory operation in a hospital outside the State.

The percent of deaths from congenital cardiovascular malformations with an operation reported on the death certificate is shown by age group for the years 1955–64 (fig. 2). The percent of certificates indicating surgical operations increased from 11 in 1955 to more than 26 in 1964. In the age groups under 1 year and 1–4 years there were similar increases in the percent of certificates indicating operations. In the age group 5–19 and among those over age 20, however, the percent of certificates indicating operations increased to a peak in 1961 and 1962, and then declined.

Data from death certificates provide numerators only and do not indicate relative risk. The percent of certificates indicating an operation is influenced by several factors. Undoubtedly, more surgical operations on the heart are being done on younger children than were done a few years ago. However, if postoperative mortality were to improve markedly, it would be possible for the number of operations to increase without the percentage of deaths associated with such operations increasing. Children under 3 years who have successful operations are, of course, not candidates for surgical repair of the heart when they are between the ages of 5 and 9 years. If a child who had an operation at an early age dies several years later, there is some chance that the death certificate will not refer to the operation.

A possible explanation for the decrease in the proportion of persons who were in the age groups 5–19 years and 20 years and over who died after surgical operations is that there was a backlog of patients for whom corrective surgical operations became possible after 1957. Some of these patients may have passed the optimum time for correction of their defects by the time they were treated and thus were more likely to die following operations. By 1964 the backlog had been eliminated, and it is anticipated that the proportion of persons who die after surgical operations who are in the older age groups will increase as advances are made in techniques which make more lesions operable. Undoubtedly deaths will continue to be associated with surgical intervention because it is often used in situations that would otherwise be hopeless.

The racial distribution of deaths associated with surgical operations is of some interest because it indicates the availability of medical care to segments of the population. In table 3

Table 2. Deaths from congenital cardiovascular malformations and average annual death rates per 100,000 by race with age-adjusted rates, California, 1959–61

Race	Population in 1960 [1]	Number of deaths (1959–61)	Annual death rate per 100,000	
			Crude	Age adjusted [2]
Total	15,720,860	2,909	6.17	6.17
White	14,459,486	2,624	6.05	6.11
Negro	880,486	221	8.33	7.54
Other nonwhite	380,888	64	5.60	5.40

[1] 1960 census, PC(1)–6D, California, p. 473. [2] For proportion of population over and under age 20.

the proportion of persons who died after surgical operations is shown by color or ethnic origin. The percent of white and "other nonwhite" persons who had operations was about the same—22.3 and 25.9. The percent of Mexicans who had operations was 13.7, and the percent of Negroes, 12.4. It is possible that the higher death rate from congenital cardiovascular malformations noted among Negroes is a result of their failure to receive the kind of medical care that is available to whites with similar defects.

Trends in Death Rates

Figure 3 shows the age-specific death rates from all causes. In the 20-year study period, the death rate for all ages has declined by 14 percent, from 9.8 to 8.4 deaths per 1,000 population. All age groups did not share equally in this decline, however. The infant mortality rate declined by 34 percent, from 32.8 to 21.7 deaths per 1,000 population, and the death rate for children 0–4 years and 5–19 years dropped approximately 50 percent, while the death rate for persons 20 years of age and older remained virtually unchanged.

Figure 2. Percent of deaths from congenital cardiovascular malformations with surgical operations reported on the death certificate by age group (years), California, 1955–64

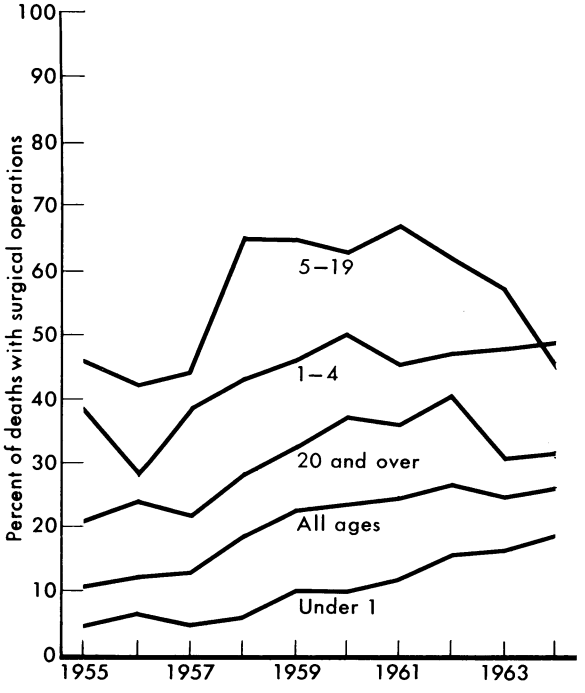


Table 3. Deaths due to congenital cardiovascular malformations including percent with surgical operations indicated on death certificates, by color or ethnic origin of patient, California, 1955–64

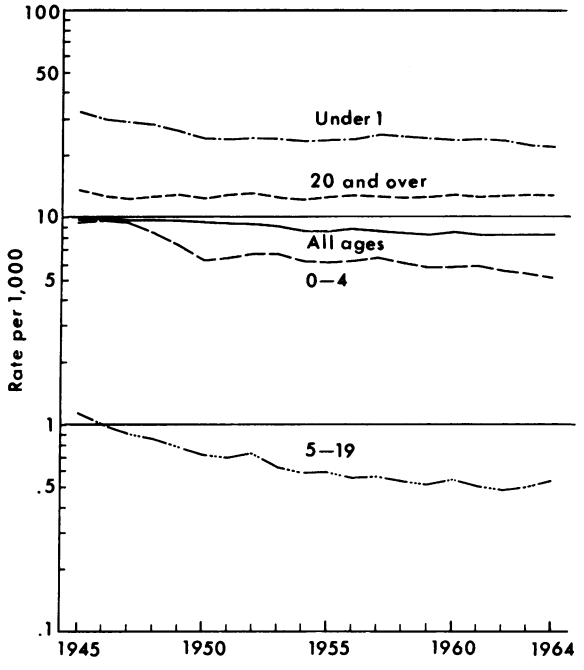
Color or ethnic origin	Number of deaths	Percent with operation [1]
Total	9,042	21.5
White	7,998	22.3
Mexican	131	13.7
Negro	716	12.4
Other nonwhite	197	25.9

[1] Indicated on death certificate. May be surgical operation for any condition.

The corresponding rates for deaths due to congenital cardiovascular malformations are shown in figure 4. The rate for all ages has declined in about the same proportion as the rate for all causes, from 6.6 (1945–47 average) to 5.6 deaths per 100,000 population in 1963–64. The decrease in deaths among infants due to congenital heart disease has almost matched the overall death rate for that age. The parallel decrease in the overall infant mortality and the mortality due to congenital cardiovascular disease suggests that infants with heart defects benefited from improvements in nutrition, antibiotic therapy, prenatal care, and other factors which have lowered the infant death rate dramatically.

For the age groups 5–19 years and 20 years and over there was no correspondence between the trends of the overall death rate and the rate for deaths due to congenital heart disease. Although there were chance variations in the rates because relatively small numbers of deaths were involved, the general trend in the rates for congenital heart disease in both age groups was upward, in contrast to the decline in the overall death rate for the age group 5–19 years and the relatively constant death rate for the age group 20 years and over. In the age group 5–19 years there was a marked increase in the death rate in the period 1954–60, followed by a decline the following 4 years. In the age group 20 years and over, there was an increase in the period 1945–

Figure 3. Infant mortality and age-specific death rates from all causes, California, 1945–64



48, followed by a decrease in 1949 and 1950; in 1951–64 there was a fairly steady increase in the rate for this group.

The similarity between the trend of the death rate in the 5–19 year age group and the percentage of patients who died following surgical operations in that age group (fig. 2) is striking, but inconclusive. Cause-specific death rates may increase because the number of cases increases although mortality remains the same, or because more patients die out of a fairly constant group of new cases from year to year.

It is possible that with improvements in prenatal care, fetal mortality is decreasing and hence more children are born with congenital defects than heretofore, but the influence of this factor is probably not great. It is more likely that increases in the age-specific death rates reflect a real increase in the mortality from congenital heart disease. The increases in deaths of persons over 5 years of age, shown in figure 4, are probably the result of the increased survival rate of children under age 5. Children with congenital heart defects are surviving infancy and early childhood in larger numbers than they did 20 years ago, but are dying in the teenage and young adult years. The role of surgical operations in this situation is difficult to assess. It is probable that in some cases an operation hastens an inevitable early death, and that in others it adds years to what would have been a short life.

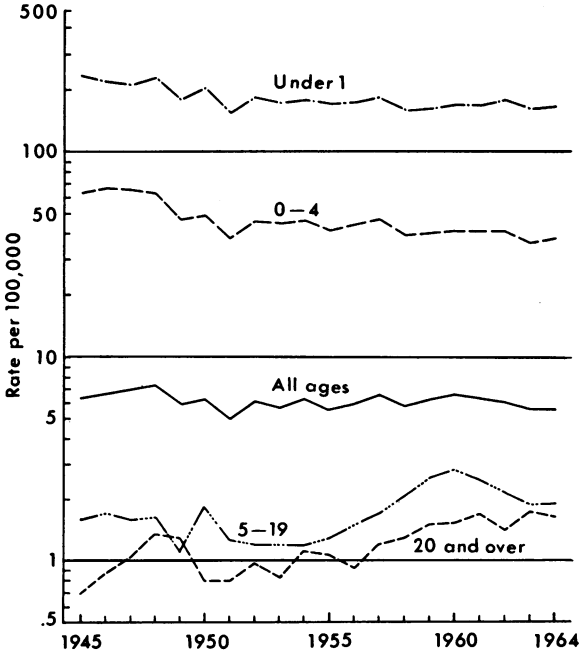
Summary

The major portion of deaths from congenital cardiovascular malformations in California from 1945 to 1964 occurred in infants. However, children born with congenital heart defects live longer now than they did 20 years ago, as indicated by the increased proportion of the deaths due to the defects that occur in persons in the older age groups, as well as by the age-specific rates which show a decline in deaths in persons under age 5.

The death rate from congenital cardiovascular malformations was about 25 percent higher in Negroes than whites even when adjusted for age.

Surgical operations were mentioned on more

Figure 4. Infant mortality and age-specific death rates due to congenital cardiovascular malformations, California, 1945–64



than 26 percent of the death certificates for persons with congenital cardiovascular malformations in 1964, an increase from the 11 percent mentioning operations in 1955. The proportion of certificates with mention of surgical operations has increased steadily in the youngest age group. However, there is indication that surgery was performed on a backlog of cases in persons older than 5 years after new techniques became available in 1948–50 and again in the early 1960's.

Whether advances in surgery contributed to the decline in mortality from congenital cardiovascular malformations cannot be demonstrated from an analysis of the cases of decedents alone. Death rates from this cause have declined at almost the same rate as the overall death rate for infants and children under 5 years of age, in which the proportion of death certificates with mention of surgical operations was relatively small.

In recent years the death rate has been increasing in the age group over 20 years, in which 30–40 percent of the persons who died had had surgical operations. In the age group 5–19 years, critical years for treatment, the death rate increased in the period when the highest proportion of the persons who died had had surgical operations. If these operations were performed in a backlog of cases in which the optimum time for surgical correction had passed, it is possible that the downward trend in the death rate of the 5–19 year group, which was evident in 1960 to 1964, will continue. As children in this age group reach maturity, if surgical treatment has been successful, there may be a downturn in the death rate from congenital heart disease for those over the age of 20 years.

Therapy by Automated Systems for Critically Ill Patients

A Hill-Burton research grant of $2,508,574 has been awarded to the University of California to develop automated systems which not only assist physicians in the diagnosis and continuous monitoring of critically ill patients, but also may be used to initiate or assist certain therapeutic measures.

The prime purpose of the project is to refine and improve methods of achieving, through automation, prompt diagnosis, effective monitoring, and optimal care of critically ill patients. Important features of the system include continuous measurement of changes in items such as central venous pressure, cardiac output, urine output, and skin temperatures of various regions of the body. Repetitive tests on blood and urine will be performed automatically by means of a direct linkage between the patient and laboratory test equipment.

The intent of the project is to develop simple servo-systems to automatically engage corrective actions for pathophysiological conditions under the supervision of a physician. These will include the automatic infusion of fluids and medications, the regulation of respiration based on automatic measurement of blood gases, the control of heating and cooling devices, and the control of cardiac pacemakers.