Incidence of Bacterial Endocarditis in Ventricular Septal Defects


BACTERIAL ENDOCARDITIS has been well recognized as an important complication of congenital heart disease, although its incidence has been represented by figures that lack authenticity. Since the ventricular septal defect is the most common form of congenital heart defect, it is important to assess the true incidence of bacterial endocarditis in this lesion. The need has become more urgent since it has been recommended that the surgical closure of a small ventricular septal defect be undertaken because of the possible risk of developing bacterial endocarditis at some time in the future. The evaluation of the problem requires a full knowledge of the natural history of the ventricular septal defect. While this is not completely clarified as yet, an approximate estimate can be made on the available data.

It has been recognized that some patients die in infancy; some develop progressive pulmonary vascular disease (Eisenmenger complex), and a significant number have spontaneous closure of the defect. Population studies of Rose and Keith1 seem to suggest that in more than half of the population with ventricular septal defects the defects persist into adult life and many of these appear to have a benign prognosis at least in the early adult years. Since the majority of patients survive childhood, it is evident that a relatively large number of such children are therefore potential candidates for subacute bacterial endocarditis. The present study attempts to review the available evidence regarding the occurrence of this complication in individuals with ventricular septal defect and to arrive at some conclusion regarding the risk in childhood and adult life.

Previous Literature

Autopsy Material

A major source of data in the literature has been the autopsy figures. Gelfman and Levine, in 1942,2 reviewed 34,023 autopsied cases from different centers in Boston and observed 31 cases of uncomplicated ventricular septal defect in persons over the age of 2 years. Thirteen of these (42%) had bacterial endocarditis: the highest incidence being in the second and third decades. Two of these cases were in persons over 40 years of age. Selzer3 gathered autopsy data on 73 cases of ventricular septal defects published before 1940 and added 12 cases from his autopsy records. He reported that in 18 of the total of 85 cases (21%) death had been due to bacterial endocarditis after the age of 1 year. More recently Bloomfield4 assembled autopsy findings on 17 cases of ventricular septal defect and observed bacterial endocarditis in five (28%). Of these five patients, one had chronic, rheumatic aortic valvar disease with vegetations on the valve as well; another had aortic incompetence with aneurysm of the sinus of Valsalva; the third had hypertensive heart disease with renal failure. Much of the information derived from these autopsy studies was obtained in the pre-antibiotic era when a fatal outcome was the rule in virtually all cases of bacterial endocarditis.5 In these three studies, the incidence of bacterial endocarditis varied from 21 to 42%. All these figures together indicate that

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bacterial endocarditis developed in 36 of the 133 autopsied cases of ventricular septal defect (27%).

The risk of bacterial endocarditis to a population of children or adults with ventricular septal defects is difficult to estimate from the autopsy data, as these figures lean heavily toward critically ill patients. Obviously the figures must be related to the survivors as well as those that die in order to make a meaningful assessment of the risk of the complication for a given disease. When this is considered, the incidence of bacterial endocarditis would be expected to be much lower.

Clinical Material

A number of studies reporting information derived from the clinical material have appeared. Wood, in 1964,6 did not find a single case of ventricular septal defect in which bacterial endocarditis developed in 638 patient years. Griffiths and associates, in 1964,7 recorded four attacks in approximately 837 patient years. Walker and associates, in 1964,8 reported six cases in 1,407 patient years. Bloomfield4 in an 8 to 12-year follow-up study of 21 patients with uncomplicated ventricular septal defect noted one who developed bacterial endocarditis in 222 patient years. Thus, in combining the clinical experience of these four reports, the incidence of bacterial endocarditis would appear to be 11 cases in 3,104 patient years or 1 in 282 patient years.

Clinical Material from Toronto and Results Hospital for Sick Children

At The Hospital for Sick Children in Toronto, we have seen 1,041 patients between the ages of 2 and 17 years with uncomplicated ventricular septal defect during a 15-year period (1950 to 1964). During the same period, only seven cases of bacterial endocarditis were observed from among this group. In five of these, the diagnosis was established with positive blood cultures, and in two, it was made on clinical grounds. Since close contact has been maintained with the majority of the patients with ventricular septal defects, it seems likely that only an exceptional case could have escaped our notice during this period. Furthermore, both well and ill patients are referred to us from the area for diagnosis or treatment as The Hospital for Sick Children is the only children's hospital serving this area. The patients less than 2 years of age are not included as the incidence of bacterial endocarditis is recognized to be very low in this group.9

In terms of follow-up of this group of patients, it can be stated that seven cases of bacterial endocarditis occurred in 8,223 patient years or approximately 1 in 1,000 patient years (table 1).

This figure is comparable to that obtained in a study of the ventricular septal defect at five pediatric centers which appeared in a Supplement of Circulation in December 1965.10 Among 273 patients with ventricular septal defect which covered a 9-year period there were two who developed bacterial endocarditis. This represented an incidence of two in 2,457 patient years or approximately 1:1,200 patient years, a figure similar to that obtained at The Hospital for Sick Children, Toronto.

City Population

We have approached this problem from yet another point of view. It is obviously important to obtain figures on the incidence of ventricular septal defect in various groups of the population. Rose and Keith1 have done this for the pediatric age group in the city of Toronto and found that during the early years of life the incidence of the ventricular septal defect is approximately 0.8 in 1,000 (popula-

| Table 1 |

Patients (Age 2 to 17 Years) with Ventricular Septal Defect in The Hospital for Sick Children in Toronto in 15 Years (1950-1964)

| Total patients | 1,041 |
| Age, mean | 7.9 years |
| Range | 2-17 years |
| Bacterial endocarditis, patients | 7 |
| Incidence for 15 years | 0.67% |

*Positive blood cultures were obtained in five cases. Adequate clinical data in other two.

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tion: birth to 5 years). Study of the city of Toronto school population (5 to 15 years of age) indicated the incidence to be approximately 1 in 2,000. The initial figure corresponds well with that reported by Hoffman and Rudolph in 1965, who found an incidence of 1 in 1,000 among children in the first year of life.

We have reviewed the case notes of all inpatients with ventricular septal defects seen in the 10-year period (1955 to 1964) in all major Toronto hospitals. These include The Hospital for Sick Children, Toronto General Hospital, Toronto Western Hospital, East General Hospital, St. Michael's Hospital, St. Joseph's Hospital, and Sunnybrook Hospital.

A resident of Toronto suffering from bacterial endocarditis is almost certain to be treated as an in-patient at one of these hospitals.

The patients residing in the city of Toronto and in metropolitan Toronto proven to have bacterial endocarditis clinically or at autopsy were separated into different age groups in relation to the age at the time of infection. These were then correlated with the population derived from the Dominion Census of 1961. The results are shown in the accompanying tables (tables 2 and 3).

The school children in the city of Toronto have periodic examinations by school medical staff (Rose and Keith). In a population of 96,397 children between the ages of 5 and 14 years, at least 47 had good evidence of this anomaly, approximately 1:2,000 (table 4).

In this age group only one patient developed bacterial endocarditis in a 10-year period (1 in 470 patient years). This would place the risk of infection at 2.1 per 100 cases per 10 years. An extension of this approach would indicate that a 5-year-old child has a 13.6% risk of developing bacterial endocarditis until the age of 70 years, and the calculated risk of a 15-year-old to a similar age would be 11.5%. It must be pointed out that this projection of the estimated risk assumes that the incidence of bacterial endocarditis in ventricular septal defect would be unchanged over the years. That the risk may decrease with increasing age is suggested from the data in the older population.

Risk

The accompanying tables also show the number of cases of bacterial endocarditis in

### Table 2

<table>
<thead>
<tr>
<th>Age group</th>
<th>Patients with VSD and SBE (1955-1964)</th>
<th>Population census (1961)</th>
</tr>
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<tr>
<td>5-14</td>
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<td>96,397</td>
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<td>15-24</td>
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<tr>
<td>25-34</td>
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<tr>
<td>35-44</td>
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<td>45-54</td>
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<td>55-64</td>
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<td>65-69</td>
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<td>26,283</td>
</tr>
<tr>
<td>Total (5-69 yr inc.)</td>
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<td>562,134</td>
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</table>

### Table 3

<table>
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<tr>
<th>Age group</th>
<th>Patients with VSD and SBE (1955-1964)</th>
<th>Population census (1961)</th>
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<tr>
<td>5-14</td>
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<td>65-69</td>
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<td>47,726</td>
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<tr>
<td>Total (5-69 yr inc.)</td>
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<td>1,360,048</td>
</tr>
</tbody>
</table>

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persons over the age of 15 years along with the population figures for each decade (tables 2 and 3). One cannot arrive at any clear estimate of the risk of infection as the incidence of ventricular septal defect in the population at these older age periods is not known. However, from the data in the city of Toronto and metropolitan Toronto, two interesting aspects emerge: (1) In the city of Toronto aged 5 through 69 years with a population of 562,134, there were four cases of ventricular septal defect with bacterial endocarditis in a 10-year period, while in metropolitan Toronto with a population of 1,360,048, there were eight cases. (2) We did not find a single case of ventricular septal defect with bacterial endocarditis above the age of 35 years in the population of 267,303 in the city and of 613,698 in the metropolitan Toronto. This forms nearly half the total population in either group and must include a good proportion of patients with small ventricular septal defects. The development of progressive, pulmonary vascular disease is unlikely to occur in this group, and from our data it is obvious that bacterial endocarditis has been a rare complication. The fate of patients with ventricular septal defect over the age of 40 years provides a mystery in cardiology. The possibility that many of these may close spontaneously in adult life may be reasonably considered, but whatever the explanation is, it must be emphasized that bacterial endocarditis is not a significant cause of death in this age group.

It is perhaps more difficult to assess the actual risk of death from such an infection. The seven patients seen at The Hospital for Sick Children were cured of the infection with no apparent deterioration of cardiac function. In the metropolitan Toronto population studies, all but one of the eight persons recovered from the infection. The one death was in a 26-year-old patient who also had chronic rheumatic heart disease affecting the mitral and aortic valves. The recent studies also show that with prompt and adequate therapy the mortality of bacterial endocarditis lies below 20%. From these figures, it would appear that the risk that a 5-year-old patient with uncomplicated ventricular septal defect would die as a result of bacterial endocarditis over the next 65 years would be approximately 2.7% and a similar risk for a 15-year-old patient over the next 55 years would be 2.3%. This is certainly no higher than the operative mortality for ventricular septal defect in most centers.

It must be pointed out that the surgery itself may initiate the occurrence of bacterial endocarditis. Linde and Heins reported five cases in which bacterial endocarditis developed in the early postoperative period out of 205 cases of heart pump surgery for congenital heart disease. Three of these had isolated ventricular septal defects. Our experience at The Hospital for Sick Children is somewhat similar. Surgical closure of ventricular septal defects has been undertaken in 200 patients. Three of these developed bacterial endocarditis in the early postoperative period. The surgery appeared responsible for precipitating the infection since the infective organism was Staphylococcus pyogenes in each case. These three cases are, therefore, not included in the overall hospital figures referred to in which seven cases of bacterial endocarditis were seen in 8,223 patient years. If these three additional cases are included, the incidence would be approximately 1 in 800 (or 10 in 8223 patient years) as against 1 in 1,000 patient years. It is not known whether the patients with a successful closure of ventricular septal defect (with or without the use of a patch) face any risk of bacterial endocarditis. This is a distinct possibility although only a long period of follow-up will indicate the true picture.

Another factor that must be considered is the influence of the advent of antibiotics on the incidence of bacterial endocarditis. The incidence of bacteremia has certainly lessened with the prompt use of antibiotics during infections and with dental care. Most of the autopsy figures are derived from material before 1940. These data would not appear to be applicable in this day and age since the means

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of prevention and early effective treatment of bacteremia are now available.

Discussion

There are obvious grounds for criticism in any study based on general population figures. The flux of population in a growing city may distort the figures somewhat. These figures, however, appear to indicate a more realistic incidence of bacterial endocarditis than the ones previously derived from either the autopsy studies or the clinical material. On the basis of these data, it is our opinion that surgery should not be advised for small uncomplicated ventricular septal defects merely to eliminate the risk of bacterial endocarditis.

Summary

In summary, the population figures presented place the risk of bacterial endocarditis for cases of ventricular septal defect in the 5 to 14-year age group as 1 in 470 patient years, or 2.1 per 100 cases in 10 years. The estimated risks for the 5-year-old and 15-year-old patient up to the age of 70 years would be 13.6% and 11.5% respectively. In the city of Toronto, only four cases were seen in 10 years in the general population of over half a million, while in metropolitan Toronto with the population of 1.3 million, eight cases were seen in a similar period. If the clinical experiences of the various authors reported in the literature are pooled with that at The Hospital for Sick Children in Toronto, one would have 21 cases of bacterial endocarditis in 11,328 patient years. This would place the incidence as approximately 1 in 500 patient years.

It is suggested that the surgery for ventricular septal defect may itself initiate bacterial endocarditis as noted in three of our cases.

On the basis of the available data, there is insufficient evidence to designate the risk of future bacterial endocarditis as an adequate reason for surgical closure of the defect.

References

1. Rose, V., and Keith, J. D.: To be published.
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