Thorax (1959), **14**, 320.

FAILED MITRAL VALVOTOMY *

BY

J. K. ROSS

From the Middlesex Hospital, London

(RECEIVED FOR PUBLICATION MAY 4, 1959)

When valvotomy for mitral stenosis brings no relief to the patient, or when after temporary relief the patient's disability reverts to its pre-operative level or worse, the operation must be regarded as a failure. Obviously, all patients needing a second valvotomy must be classed as failures. For the purpose of the present investigation are also included as surgical failures patients who have died over six months after operation, during the follow-up period (late deaths), and all who have developed embolism subsequent to but not directly attributable to the operation (late embolism).

These surgical failures cannot usually be explained simply in terms of a single cause, for often they are due to a variety of adverse factors operating in combination. Nevertheless, analysis of a sufficiently large number of consecutive surgical failures, as already defined, may identify the major causes and permit their contribution to the bad result to be assessed.

MATERIAL

The records of every patient who has undergone mitral valvotomy at the Middlesex Hospital from the first operation in February, 1951, until December 31, 1956, have been examined, providing a minimum follow-up period of two years.

The operations have been performed by Mr. T. Holmes Sellors and Mr. J. R. Belcher, and a smaller number by Mr. J. W. Jackson.

The total number of cases investigated is 263, of which 61 fall in the failed category, but, of the 16 late deaths, three were due to incidental causes (one myocardial infarction, one peritonitis, and one carcinoma of the bronchus), and are therefore excluded for the purposes of analysis (Fig. 1). Thus there are 58 failures (22% of total valvotomies) available for consideration, and wherever applicable the 155 successful cases are used as a control series.

*Presented at a meeting of the Thoracic Society, London, November, 1958.

The word "failure" is used repeatedly; this refers to members of this group of 58 cases and not to cardiac failure unless specifically stated.

LIMITATIONS OF THE INVESTIGATION

First, this is not intended to be an exhaustive study in the manner of previously reported series of large numbers of mitral valvotomies, e.g., Goodwin, Hunter, Cleland, Davies, and Steiner (1955), interest in this investigation being focused on failed cases. Secondly, there is a weakness in drawing statistical conclusions from a miscellaneous group, in this instance the 58 failures, suffering from mitral stenosis at all stages in the natural history of the disease. Table I, showing the incidence of five factors in the failed and control groups, gives some indication of this problem.

Failed mitral valvotomy may represent: (1) Failure in selection; (2) technical failure at operation; (3) the summation of many associated factors in the pathological make-up of the individual.

In many instances these pathological factors are present before operation, e.g., associated aortic valve disease or mitral incompetence, and therefore have a bearing on selection. ". . . the possible permutations and combinations are almost endless . . . and the decision to advise or withhold mitral valvotomy can be very difficult" (Wood, 1956).

TABLE I

ANALYSIS OF SUCCESSES AND FAILURES

	58 Failures	155 Successful Cases
Age 40 to 50+	52%	43%
Congestive cardiac failure pre-operatively . .	21%	6%
Atrial fibrillation (pre-operatively)	52%	35%
Cardiac enlargement (C.T.R. 60–65%) . .	24%	14%
Pulmonary hypertension (severe and extreme) . .	36%	30%

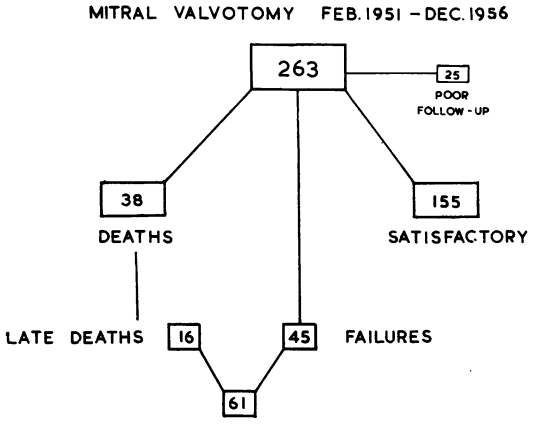

FIG. 1.—The 25 patients who were poorly followed up are dispersed in many countries, and attempts to trace them failed.

SELECTION

It is not intended to discuss the selection of patients for mitral valvotomy and apply the lessons learned over the years to the series of cases under review.

If age alone is considered, it is found that most of the patients operated on were between 30 and 50 years old. That there should be more failures in this age bracket is not surprising (Fig. 2). There is an upward trend in the incidence of failure with increasing age, and in those over 50 the failure rate is high.

THE OPERATION

The operation in all the failed cases under discussion was by the transatrial route. Some of the more difficult valves might have yielded to the more recently introduced transventricular procedure.

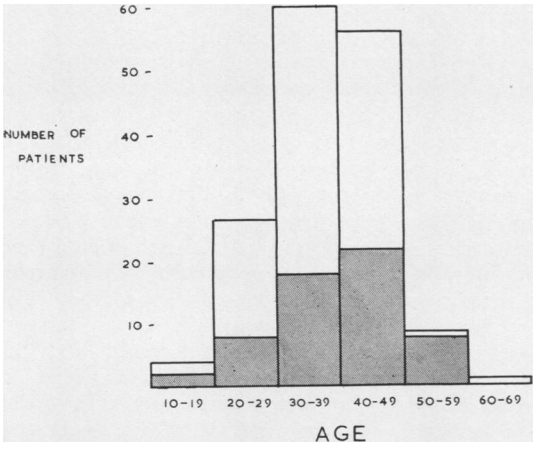

FIG. 2.—Age and failure incidence. (Failed cases shaded.)

There are incalculable factors inherent in the fact that, to date, mitral valvotomy is a blind procedure, but with increasing technical skill and experience it has become a more deliberate procedure and increasingly accurate assessment of the technical result has been obtained. This has a bearing on the present investigation, and the first step was to trace the failures to their year of operation (Fig. 3).

The year 1953 was the peak for failures.

It may be argued that this is simply because, with the passage of time, more early cases have had the chance to enter the failed category compared with those of succeeding years. However, 100 valvotomies had yet to be performed by the end of 1953, and it seems reasonable to allow that the steady decrease in the incidence of failures from 1953 onwards is as likely to represent increasing technical efficiency as duration of follow-up.

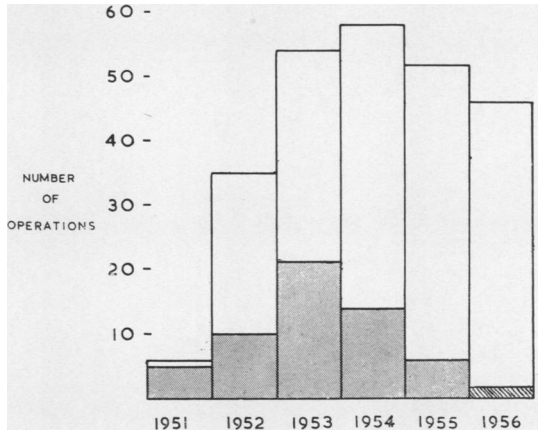

FIG. 3.—Diagram showing failed cases traced to their year of operation.

Had the technical result achieved at operation, as assessed by the surgeon at the time, anything to do with failure? This is the most difficult factor to evaluate scientifically and the easiest about which to be critical in retrospective research.

For practical reasons the efficiency of valvotomy has been judged and recorded on the efficiency of the commissural split and not on the basis of valve diameter or circumference. This is not an admission of scientific defeat, but an effort to preserve uniformity in the results so that they may have meaning.

Five degrees of operative result have been recorded, both in writing and by diagrams, describing the efficiency of the commissural split.

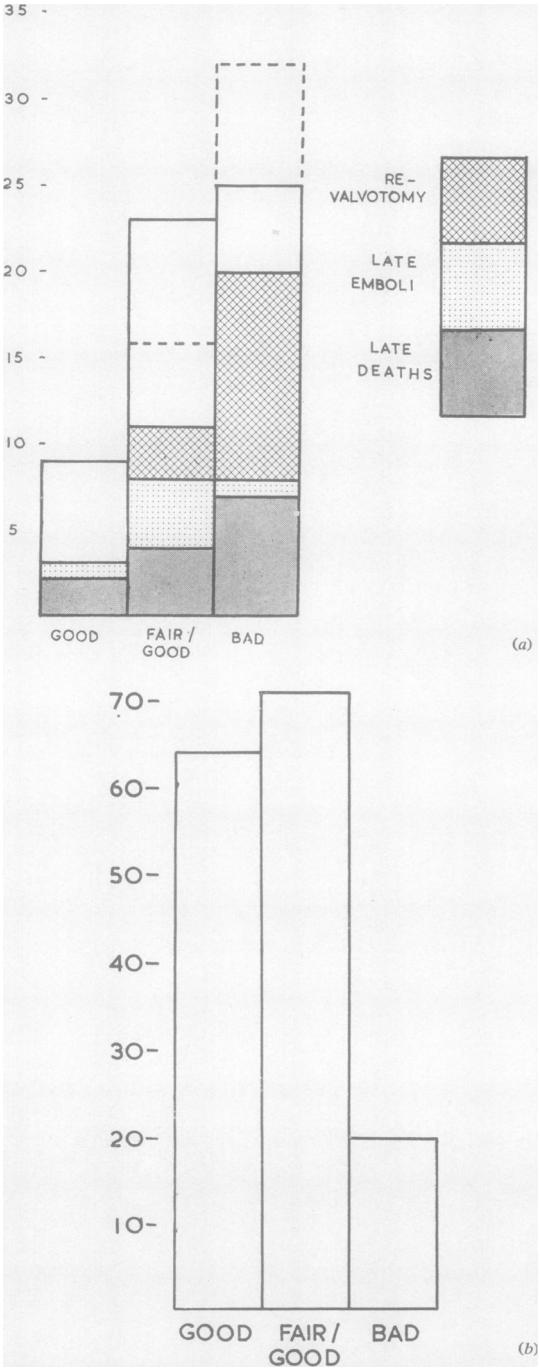

FIG. 4 (*a* and *b*).—Diagram showing the operative assessment of those with "failed" clinical results, compared with that of the successful group. The broken lines indicate re-evaluation of some earlier cases. The remaining subdivisions are self-explanatory.

"Good," implying complete separation of the cusps to the valve ring;

"Fair-to-good," implying, commonly, a one-and-a-half commissure split;

"Fair," "fair-to-poor," and "poor," representing decreasingly complete valvotomy.

Again, for practical purposes, these five grades can be reduced to three: "Good," "fair-to-good," and "bad."

Use of the word "bad" in this context invariably means that the surgeon completed the operation dissatisfied with the result achieved and committed this fact to the case record.

The failed group includes 25 patients whose operative assessment was "bad"—in fact 43% of the failures (Fig. 4).

On this evidence, it can be said that the operative assessment is all important. The regularity with which a bad result followed a "bad" operation is inescapable. If this point needs stressing, it can be seen that the majority of those submitted to a second valvotomy had an unsatisfactory first operation.

Among these 25 with "bad" operations, there were three valves with gross calcification and one valve with funnel deformity, instances in which it may be said that the valve itself presented difficulties that could only partially be overcome. The remainder have to be classed as technical failures.

Those whose operative assessment lay in the "good" and "fair-to-good" group also have a relatively high incidence of failure (33/58).

Why should a good operation be followed by a bad result? There is no clear-cut answer to this question, but, of the 33 whose operative assessment was "good" or "fair-to-good," one-third (11) had mitral incompetence (six severe and five moderate). In one of these, serious mitral incompetence was produced at operation. One-third (13) had calcific valve disease, seven of them advanced. Also in this group of 33 cases are found two examples of established and three of probable re-stenosis (re-fusion); and in seven, the operative assessment if reconsidered to-day would undoubtedly be thought over-optimistic (Fig. 4). Two more have dominant chest disease and one dominant aortic incompetence. The conclusions drawn from these observations are: (1) A technically unsatisfactory operation is almost invariably followed by a bad result, and the surgeon's appraisal of the result achieved at operation is an important guide to the future of the patient. (2) In patients whose operative assessment is "good" or "fair-to-good" the

outlook is better, but is less certain in those who have mitral incompetence or calcific valve disease, often present in combination.

Factors in the Pathological Make-up of the Individual

THE VALVE.—Had failure anything to do with the type of valve? On studying this factor, valve calcification emerged as being of significance.

It has been the experience of surgeons performing large numbers of mitral valvotomies that calcified valves, sometimes formidably calcified valves, may be successfully split along the lines of the commissure with surprising ease (Sellors, Bedford, and Somerville, 1953). It has also been appreciated that such calcification may be associated with varying degrees of incompetence (Wood, 1954; Baker, Brock, and Campbell, 1955) that may or may not be made worse by valvotomy, but that nevertheless gratifying subjective improvement can follow the successful opening of these badly damaged and deformed valves. Further, it may be said that a slight increase in incompetence may be the hall-mark of, as well as the price paid for, successful valvotomy in such instances.

In the failed group of 58 cases, 27 had calcific valve disease, 17 being severely affected. Four were funnel valves, two were described as rigid (fibrous), and the remaining 25 presented varying degrees of mobility, with no calcification.

Expressed as a percentage, the overall figure for calcific disease in the failed group is 46%, and for calcification of grades II and III 29%, the three grades being mild, moderate-severe, and gross.

Using the successful cases as a control (155 cases), the overall incidence of calcification in this group was 32%, with 13% severely affected (Fig. 5).

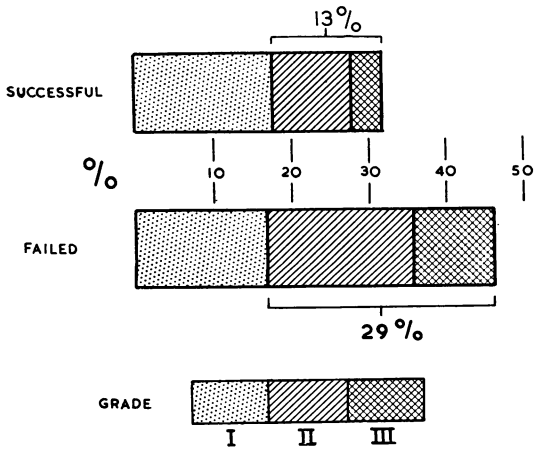

FIG. 5.—Diagram showing valve calcification, with higher incidence of calcific valve disease in the failed group.

In the failed group there is both a higher overall incidence of calcific valve disease and a significantly higher proportion of severely affected valves. On these grounds I hold that the severity of the calcification of the valve is a significant factor in determining failure, very nearly one-third of the failed cases being so affected. In some of the cases studied there is some evidence that progressive calcification may be yet another important factor.

The relationship between calcification and incompetence will be referred to later.

MITRAL INCOMPETENCE.—What part does mitral incompetence play in the production of a failed result?

It has already been seen that mitral incompetence is one factor in the production of a failed result after a technically satisfactory operation in terms of commissural split.

If mitral incompetence is considered separately as an isolated factor (Table II) it is found as a major cause of deterioration in nine instances (15.5%). Of these, two were found to have dominant incompetence on exploration before valvotomy, four had calcific valve disease (three gross), two had rigid fibrous valves, and one a funnel valve. Severe incompetence was produced at operation in two patients with mobile valves.

TABLE II
MITRAL INCOMPETENCE

Major factor	9 (15·5%)
Contributory factor	6 (10%)
Probably contributory	3
Total	18

Mitral incompetence appears as a contributory factor on six more occasions. In only one of these was serious incompetence created at operation in a relatively mobile valve. The remaining five had calcified valves (grades II and III), and established incompetence was made significantly worse by valvotomy.

In three more instances, incompetence was considered a factor of more doubtful significance.

It may be said from the figures obtained that between 15% and 25% of the failed cases had mitral incompetence of such degree as to contribute to a failed result. Of these, one-fifth

had severe incompetence produced at operation, and 53% of these significantly incompetent valves were calcified.

ASSOCIATED VALVE DISEASE.—To what extent did associated valve disease determine failure?

(*a*) *Aortic Valve Disease.*—Failure was entirely attributable to aortic valve disease in two instances (3.5%). In one of these there was post-mortem evidence of a severe aortic valve lesion and of successful mitral valvotomy.

In six cases aortic valve disease was present and sufficiently advanced to contribute to failure, and in a further six it probably contributed to failure (Table III).

TABLE III
AORTIC VALVE DISEASE

Major factor	2 (3·5%)
Contributory	6
Probably contributory	6
Total	14

Overall incidence—failures, 52%
—control, 42%

Of these 14 cases, all but four had clinical evidence of aortic incompetence and/or stenosis before operation; in the remaining four, signs of aortic incompetence were evident only after operation.

Nearly half (six) of the late deaths had associated aortic valve disease.

(*b*) *Tricuspid Disease.*—Signs of tricuspid incompetence were either present persistently post-operatively or developed later in 10 of the failed group. There was one case of tricuspid stenosis with an 8 mm. Hg diastolic gradient across the valve. Atrial fibrillation was present in all but two of the 10 cases.

CHEST INFECTION.—After successful mitral valvotomy predisposition to repetitive chest infection may be reduced or abolished. Thus repeated attacks of bronchitis are a symptom rather than a cause of deterioration.

In this series, chest infection occurred to such degree as to contribute to the clinical picture of a failed result in 31 instances, and was the immediate cause of late death in three.

TABLE IV
COMPARATIVE OVERALL INCIDENCE OF RECURRENT CHEST INFECTION AS A FACTOR IN DETERIORATION IN SUCCESSFUL AND "FAILED" GROUPS

Major factor	2 (3·5%)
Cause of death	3 (5%)
Contributory factor	31 (54%)

Overall incidence—failures, 62%
—control, 23%

Dominant lung disease was held responsible as the major cause for deterioration in only two (3.5%) (Table IV).

Half the failed group with recurrent chest infection had evidence of pulmonary vascular disease and 11 had mitral incompetence.

The figure of 23% for the control group is too high and probably represents, in a proportion, symptomatic evidence of residual or recurrent stenosis.

PULMONARY VASCULAR DISEASE.—Of the 57 failures, 25 had cardiac catheter studies and seven had this investigation performed twice.

In 14 the pulmonary vascular resistance was measured, as a result of which six were found to have moderately or extremely elevated resistance (6–10 units:4; 10–30 units:2). In addition, 10 patients in whom the resistance was not calculated were found to have severely or grossly raised pulmonary artery pressures. On clinical, radiographic, and electrocardiographic evidence, further five patients were judged to have advanced pulmonary hypertension.

It may be said, therefore, that 21 (36%) of the failed group suffered from severe pulmonary vascular disease.

A study of the control series of 155 cases along similar lines, but relying more on electrocardiographic evidence, shows that 30% had moderate or severe pulmonary hypertension. There is, therefore, no great statistical difference between the incidence of this factor in the failed and control groups.

THE PATTERN OF FAILURE

LATE DEATHS (13).—The two commonest immediate causes of death proved to be congestive cardiac failure and multiple infarcts in the lungs (7/13).

Three died from severe chest infections, and in three the exact cause is unknown.

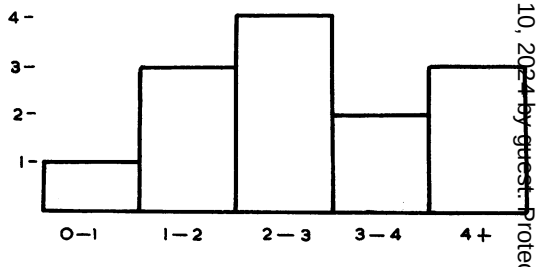

FIG. 6.—Diagram showing that the interval between operation and late death is variable.

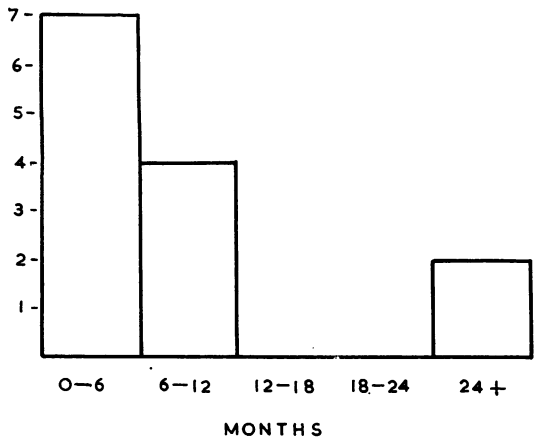

FIG. 7.—Diagram showing that the interval between established relapse and late death may be short.

The interval between operation and death is variable (Fig. 6), with a maximum incidence at two to three years, but what is much more striking is the time relationship between failure and death. When this is estimated it is found that the majority are dead within six to 12 months of deterioration reaching pre-operative levels or worse (Fig. 7). There is no common factor to be found within this majority and the number of cases is small, but it may be a pointer to the fact that once relapse is established, and if benefit can be expected from a second operation, then the sooner the second operation is done the better.

LATE SYSTEMIC EMBOLI. — Four patients suffered late cerebral emboli from 16 months to four years after operation, and one an embolus in the right brachial artery. Two had had thrombi in the left atria at operation and one had had a cerebral embolus pre-operatively.

Only one of the five could be classed as a failure in his own right regardless of the late embolus. The remaining four, in spite of undoubted residual stenosis, had, until the time of the emboli, got lasting benefit from operation. One of them remained in sinus rhythm.

In addition to these five cases, two of the late deaths showed post-mortem evidence of recent systemic emboli with infarcts in the kidney and spleen.

LATE PULMONARY EMBOLI.—Apart from the three late deaths due to pulmonary infarction, there were three further instances of pulmonary infarction not associated with overt congestive cardiac failure. In two the lesions have been multiple; both had funnel valves with a poor technical result. There is good but not conclusive evidence that two have raised pulmonary vascular resistance.

The common pattern of a failed result is that of gradual and progressive return of effort dyspnoea, punctuated by recurrent attacks of chest infection that may precipitate the onset of congestive cardiac failure. The clinical picture is commonly an "up-and-down" one, with the "up" phases becoming progressively shorter and the disability progressively worse.

The interval between operation and deterioration to failure level is variable, but a high proportion, 60%, occur within the first two years after operation (Fig. 8). The failures within the first year include four of the worst cases of mitral incompetence, but in general there is no striking correlation between the time interval and the factors involved.

Occasionally, deterioration is precipitated by the late onset of atrial fibrillation (three) or by paroxysmal atrial fibrillation (one) commonly associated with chest infection, but sometimes due to failure to take prescribed digitalis (two).

Psychoneurosis contributed to failure in two instances, and bad home conditions or an inability to live within the limits of their reserve were important factors in a further three.

RE-STENOSIS.—Re-stenosis may be used as a generic term to describe two pathological processes.

One is the passive resumption of its previous size by a stretched valve of which the commissures have not been opened beyond the critical areas of tendon insertion (Brock, 1952). This variety, although some healing of the partially separated commissures takes place, might be

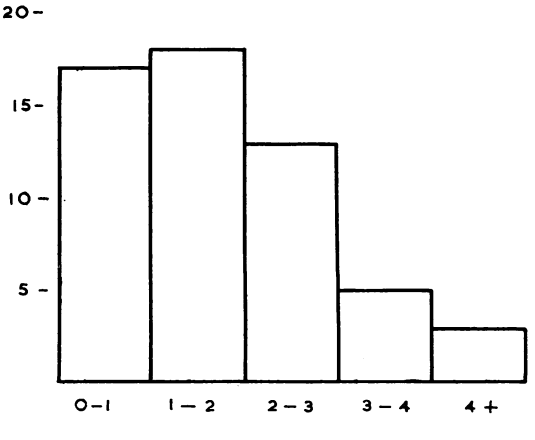

FIG. 8.—Diagram showing that the majority of failed results become manifest within two years of operation.

termed "recoil," for want of a better descriptive term, in order to distinguish it clearly from the other form of re-stenosis.

The second variety, termed "re-fusion," is an active process of healing of successfully separated, cut or fractured commissures and is a totally different problem. When considering "re-fusion" as the cause of a failed result, the first essential is an accurate record of the initial valvotomy. If, after a successful valvotomy, the physical signs of obstruction at the mitral valve regress or are abolished, accompanied by a corresponding clinical improvement, and if after an interval the symptoms and signs reappear, then "re-fusion" can be blamed for the result until proved otherwise. It may be possible to confirm or refute this clinical diagnosis by serial catheter studies.

In this series of 58 failed cases, the physical signs of obstruction at the mitral valve were never abolished.

In 10 patients there was a definite improvement or modification of the physical signs on auscultation two months after operation, all but three having had "fair-to-good" or "good" operations. The improvement proved to be transitory in two, and in three the change was maintained for approximately one year. In five, the modification of the signs (which was never striking) has remained unaltered (Table V). Of these 10 cases, four have had second valvotomies as a result of which two were considered to have "re-fusion" of at least one commissure, and the relative ease with which the re-fused commissure opens has been commented upon. On clinical grounds "re-fusion" could be responsible for deterioration in a further three cases on applying the criteria set out above. In one late death, post-mortem examination of the valve was said to show some evidence of "re-fusion" of the commissures.

TABLE V
POST-OPERATIVE PHYSICAL SIGNS CORRELATED WITH RE-FUSION

Abolished	0	
Modified ..	10	
Transitory		2
1 year		3
No change ..		5
Re-stenosis—re-fusion:		
Established		3
Probable		3

The conclusion drawn is that "re-fusion," in this series, is a rare disease; the probability is that if this investigation were repeated in five or 10 years' time it would be more common.

In no instance can evidence be found for a recrudescence of rheumatic activity in those of the failed group, and no mention has been made of a myocardial factor (Mounsey, 1957) in regard to deterioration. In fact this has been suggested as a cause for relapse in only one instance in this series.

SUMMARY AND CONCLUSIONS

A group of patients submitted to mitral valvotomy has been studied and an attempt made to determine the importance of various factors in regard to those who have done badly after operation.

A technically unsatisfactory operation is the single most important factor in a "failed" result.

The problem of those who relapse after a satisfactory operation has been examined, but unsatisfactorily answered.

The importance of the type of valve found at operation is discussed with particular reference to calcification.

The parts played by mitral incompetence, associated valve disease, chest infection, and pulmonary vascular disease in the 58 failed cases have been described.

The problem of re-stenosis has been discussed in relation to the failed result in this series, and it is concluded that "re-fusion" of successfully opened commissures is rare.

My thanks are due to Mr. T. Holmes Sellors, Mr. J. R. Belcher, Dr. D. E. Bedford, and Dr. W. Somerville for their help in the preparation of this paper, and also to those practitioners who were kind enough to reply to questionnaires on their patients living at a distance from London.

REFERENCES

Baker, C., Brock, Sir Russell, and Campbell, M. (1955). *Brit. med. J.*, **2**, 983.
Brock, R. C. (1952). *Brit. Heart J.*, **14**, 489.
Goodwin, J. F., Hunter, J. D., Cleland, W. P., Davies, L. G., and Steiner, R. E. (1955). *Brit. med. J.*, **2**, 573.
Mounsey, P. (1957). Ibid., **2**, 311.
Sellors, T. H., Bedford, D. E., and Somerville, W. (1953). Ibid., **2**, 1059.
Wood, P. (1954). Ibid., **1**, 1051 and 1113.
—— (1956). *Diseases of the Heart and Circulation*, 2nd ed., p. 556. Eyre and Spottiswoode, London.