numbers of elderly patients with more comorbidities undergo valve replacement, the influence of valve-related factors on mortality rate is likely to continue to decline compared with patient-related factors. In addition, with the improved durability of later generation tissue valves, the long-term results of mechanical valve replacement are also likely to be affected by increased use of bioprosthetic valves in younger patients.

In summary, this series of patients undergoing AVR and MVR with the St Jude Medical mechanical prosthesis with follow-up to 20 years confirms the excellent performance of this valve that we have documented in our earlier reports. In addition, the complete absence of structural valve deterioration makes the St Jude Medical mechanical heart valve prosthesis an excellent choice for patients who require mechanical prosthetic valve replacement.

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Discussion

Dr Alfredo Trento *(Los Angeles, Calif).* This is an important retrospective review because it further conclusively supports with a longer follow-up the data on the St Jude Medical valve, which I think can be translated with minor differences to the other bileaflet valves.

Two years ago we published our 20-year comparison between St Jude Medical and tissue valves. There were 670 St Jude Medical valves and 720 tissue valves in the aortic position, about 500 St Jude Medical valves and 400 tissue valves in the mitral position. The mean age of patients with the St Jude Medical valve was almost 10 years greater. The 10- and 20-year actuarial survival for all the patients with mechanical and biological prostheses was similar to that presented here by you today.

Freedom from thromboembolic events was also similar for both St Jude Medical and tissue valves in both aortic and mitral position. Freedom from hemorrhage was also similar. The only difference is that in the aortic position, biological prostheses fared much

Appendix. Variables examined for association with operative mortality and late death

Operative mortality	Late survival
Aortic valves	Aortic valves
Gender	Gender
Age at operation	Age at operation
Body surface area	Year of surgery
Year of surgery	Race
Race	Valve size < 21 mm
Valve size 19 mm	Effective orifice area <2.59
CABG 3 or more vessels	Effective orifice area index
Reoperation	Associated CABG
Preoperative NYHA class IV	Reoperation
Lesion (aortic stenosis)	Preoperative NYHA class III or IV
	Lesion (aortic stenosis)
Mitral valves	Mitral valves
Gender	Gender
Age at operation	Age at operation
Body surface area	Year of surgery
Year of surgery	Race
Race	Valve size
Valve size 19 mm	Associated CABG
CABG 3 or more vessels	Reoperation
Reoperation	Preoperative NYHA class III or IV
Preoperative NYHA class IV	Lesion (mitral insufficiency)
Lesion (mitral insufficiency)	Ischemic etiology
Ischemic etiology	

NYHA, New York Heart Association; *CABG,* coronary artery bypass grafting.

better, with a freedom from hemorrhage of 94% and 92% at 10 and 20 years, respectively.

We have also learned from other retrospective studies, as well from the 2 randomized studies that are published, that in general, long-term survival is not influenced by the type of valve that we use, mechanical or biologic, but by other factors, as you mentioned, like age, coronary artery disease, New York Heart Association class, diabetes, and finally, and probably, valve to patient size mismatch.

In view of this background, justifiably or not, over the past 10 years, in the aortic position we have reduced the use of St Jude Medical valves from 55% in 1991 to less than 20% in 2002. In the mitral position the same things happened in favor of mitral valve repair.

Quality of life, freedom from warfarin, and increased mobility of the patient population, which makes follow-up more difficult, have steered patients and physicians away from warfarin. Has your experience been similar on the choice of valves? Could you also relate the thromboembolic and hemorrhagic complications to the patient's INR when they happen? Was the patient's INR out of range?

Now, the most important issue is the warfarin therapy. How low do you think you can push the INR? Do you think we can have a safe anticoagulation for the aortic valve with an INR between 1.5 and 2 for the aortic position and an INR around 2 for the mitral position? That would make warfarin therapy much more attractive.

Dr Ikonomidis *(Charleston, SC).* Thank you, Dr Trento, for those insightful comments and questions. With regard to comparing mechanical valves to tissue valves, what we have observed is what has generally been observed in most studies, namely that the durability of mechanical valves exceeds that of tissue valves, whereas tissue valves show superior freedom from thromboembolic and bleeding complications.

As far as relating thromboembolic and hemorrhagic complications to the patient's INR, we didn't specifically relate the incidence of the complication to the INR, but that would be something that worth looking at. As far as decreasing the targeted INR is concerned, despite the fact that we have decreased the INR in our institution, this has not resulted in an increase in thromboembolic rates; in fact, it has still dropped to a small extent. Therefore, at the present time we feel that our current target INRs are safe.

Dr Kit V. Arom *(Minneapolis, Minn).* I rise to congratulate the group from Charleston for their excellent long-term follow-ups, particularly with 98% completed. We, too, in Minneapolis, after Demetre Nicoloff implanted the first valve in 1977, have followed these people up to 20 years. At that time with 95.4% complete (21,342 patient years), we had 3937 patients available for the study. About 1300 of the patients were dead at that time or approximately one third of them.

The causes of death were 4.5% valve-related, 4% related to anticoagulation. The rest of them died from ongoing atherosclerosis and heart failure (48%). Linearized rate (percent per patient-year) included 1.24 for thromboembolism (TE), 1.00 for bleeding, 0.1 for perivalvular leak, 0.18 for prosthetic endocarditis, and valve thrombosis was 0.09.

If we translate this into actuarial analysis, we obtained results similar to yours, except in 2 areas. One is that at the end of 20 years our aortic valve had better survival rate than the mitral valve, being about 44%, comparing with about 33% for the mitral valve.

And the other area was the incidence free from bleeding and TE. There was about 82% incidence free from bleeding and 70% free from TE. If I remember correctly, this is quite different than yours, which it is about 60%.

We did lower the intensity of anticoagulation in 1985 by keeping the INR between 1.8 and 2.5 for AVR, 2.5 and 3.2 for MVR.

Dr Trento has suggested lowering intensity of anticoagulation, which I agree with. At the present time we still using a slightly lower intensity than what you just described, and I think this could be the reason why we see a slightly better TE and bleeding rate.

Dr Ikonomidis. How did you conduct the follow-up on your patients?

Dr Arom. Our follow-up is not quite as good as yours, which is being done yearly. We hope, however, that we can use the same approach that you do. In 1985, we also instructed the cardiologist and family physician to stop using prothrombin values and to have the INR strictly within the range that I have mentioned. I really believe that this approach has contributed to our recent outcomes.

Dr Ikonomidis. The less aggressive warfarin dosing that you described may help address your improved freedom from TE and bleeding compared with our series. In addition, conducting follow-up over longer time intervals may cause patients to forget some events, effectively increasing the documented freedom from TE and bleeding complications.

As for addressing the flip in terms of aortic and mitral valve survival, I think that this discrepancy may reflect inherent differ-

ences in the population as they relate to severity of comorbid factors such as hypertension, left ventricular hypertrophy, and perhaps even compliance with medications.

Dr W. R. Eric Jamieson *(Vancouver, British Columbia, Canada).* Congratulations on an excellent study. I just have 2 short questions. You shared with us your linearized occurrence rates for aortic and mitral valves. Could you share with us the linearized rates for major embolisms, including Reversible Ischemic Neurologic Deficits, and comment also on early and late events, because many patient mechanical populations can have major events in the first 30 days.

My second question is related: have you looked at actual versus actuarial freedoms when you assess the composites of complications, morbidity, mortality, and reoperation, which are probably better parameters when you are counseling patients to have a mechanical or any prosthesis?

Dr Ikonomidis. I am sorry, Dr Jamieson, can you repeat the second question?

Dr Jamieson. The concept of using actual freedoms compared with actuarial freedoms, which are better parameters to use when counseling patients as to which prosthesis they should have.

Dr Ikonomidis. All of the nondeath outcomes were analyzed by cumulative incidence analysis. I did not include them here in this presentation for purposes of simplicity but in all end points measured, the cumulative incidence curves were all shifted upward compared with the actuarial freedom curves, as one would expect. With regard to neurologic events, approximately one third were early and then the remaining two thirds occurred later on.

Dr Mohammed A. Quader *(Cleveland, Ohio).* Congratulations on your excellent presentation of this valuable data. I would like to ask you a question about the use of 19-mm valves. Fifteen percent of the patients had the 19-mm valve placed, and multivariate analysis has shown that there is an increased risk of death with that. Has there been a trend toward not using this valve more frequently in the recent past?

Also, have you looked for patient-prosthesis mismatch in that group of patients?

Dr Ikonomidis. We have trended toward not using 19-mm valves as much as possible. As far as patient-prosthesis mismatch is concerned, neither EOA nor EOA index were found to be multivariate predictors of death.