high-risk, patients.¹¹ If the STS predicted risk of mortality of a nonagenarian patient is elevated solely because of age, then procedural outcomes may be better than expected. On the other hand, nonagenarians with excessive frailty or other comorbidities that limit quality of life postprocedure should not be treated with TAVR.

Based on the data from Greason and colleagues,⁷ one can argue that TAVR should be the treatment of choice for properly selected nonagenarian patients with severe aortic stenosis. With a continuously increasing number of nonagenarians in the general population, TAVR may become “the new normal” and no longer be considered “pushing the limits” in this very elderly population.

References

1. He W, Muenchrath MN. *U.S. Census Bureau, American Community Survey Reports, ACS-17, 90+ in the United States: 2006-2008*. Washington, DC: U.S. Government Printing Office; 2011.
2. Saxena A, Poh CL, Dinh DT, Reid CM, Smith JA, Shardey GC, et al. Early and late outcomes after isolated aortic valve replacement in octogenarians: an Australasian Society of Cardiac and Thoracic Surgeons Cardiac Surgery Database Study. *Eur J Cardiothorac Surg*. 2012;41:63-8.
3. George I, Yerebakan H, Kalesan B, Nazif T, Kodali S, Smith CR, et al. Age alone should not preclude surgery: contemporary outcomes after aortic valve replacement in nonagenarians. *J Thorac Cardiovasc Surg*. 2014;148:1360-9.
4. Leon MB, Smith CR, Mack M, Miller DC, Moses JW, Svensson LG, et al. Transcatheter aortic-valve implantation for aortic stenosis in patients who cannot undergo surgery. *New Engl J Med*. 2010;363:1597-607.
5. Smith CR, Leon MB, Mack MJ, Miller DC, Moses JW, Svensson LG, et al. Transcatheter versus surgical aortic-valve replacement in high-risk patients. *New Engl J Med*. 2011;364:2187-98.
6. Popma JJ, Adams DH, Reardon MJ, Yakubov SJ, Kleiman NS, Heimansohn D, et al. Transcatheter aortic valve replacement using a self-expanding bioprosthesis in patients with severe aortic stenosis at extreme risk for surgery. *J Am Coll Cardiol*. 2014;63:1972-81.
7. Greason KL, Pochettino A, Sandhu GS, Mathew V. Transcatheter aortic valve insertion in the nonagenarian patient. *J Thorac Cardiovasc Surg*. 2015;150:720-1.
8. Akin I, Kische S, Paranskaya L, Schneider H, Rehders TC, Turan GR, et al. Morbidity and mortality of nonagenarians undergoing CoreValve implantation. *BMC Cardiovasc Dis*. 2012;12:80.
9. Holmes DR Jr, Brennan JM, Rumsfeld JS, Dai D, O'Brien SM, Vemulapalli S, et al. Clinical outcomes at 1 year following transcatheter aortic valve replacement. *JAMA*. 2015;313:1019-28.
10. Holzhay DM, Seeburger J, Misfeld M, Borger MA, Mohr FW. Learning minimally invasive mitral valve surgery: a cumulative sum sequential probability analysis of 3895 operations from a single high-volume center. *Circulation*. 2013;128:483-91.
11. American College of Cardiology. SAPIEN 3 improves 30-day outcomes for major endpoints: First report from U.S. trial of third-generation device in high- and intermediate-risk patients. Available at: <http://www.acc.org/about-acc/press-releases/2015/03/15/14/04/sapien-3-improves-30-day-outcomes-for-major-endpoints>. Accessed May 15, 2015.

EDITORIAL COMMENTARY

Transcatheter aortic valve implantation in nonagenarians: Looking beyond survival

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See related article on pages 720-1.

As life expectancy increases in the developed world, the prevalence of severe symptomatic aortic stenosis (AS) in nonagenarians is following a similar trend. Transcatheter aortic valve implantation (TAVI) is a safe and effective treatment

for severe degenerative AS in patients with prohibitive or high surgical risk. However, only a few studies have reported on TAVI outcomes specifically in nonagenarians.¹⁻³

The paper by Greason and colleagues⁴ reports single-center TAVI outcomes in a nonagenarian patient population including 46 patients with a median age of 91.5 (range: 90-95) years. They demonstrate impressive, low treatment-related mortality (4.7%), and excellent 2-year survival (84.6% ± 10.6%). However, they additionally report a soberingly high complication rate, with about one half of patients suffering a complication, and more than one fifth incurring a vascular complication.

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Disclosures: Authors have nothing to disclose regarding commercial interests.

Received for publication June 13, 2015; accepted for publication June 15, 2015; available ahead of print July 22, 2015.

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J Thorac Cardiovasc Surg 2015;150:723-4

0022-5223/\$36.00

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<http://dx.doi.org/10.1016/j.jtcvs.2015.06.026>

The major strength of this report⁴ is that it is 1 of the few published reports on TAVI in nonagenarians. The dearth of data in the literature on this rapidly growing, high-risk population highlights the need to report on their outcomes to guide clinical decisions. Without such reports, management of AS in nonagenarians is reduced to personal biases. The study demonstrates that TAVI can be reproducibly performed in nonagenarians, with excellent survival outcomes, albeit with high complication rates. Therefore, *chronologic age* alone should not preclude offering TAVI; rather, it is *physiologic age* that needs to be considered. Although age may surface as an important prognostic marker in many areas of medicine including TAVI, it likely reflects the higher likelihood of harboring other comorbidities.

Traditional risk models place considerable weight on chronologic age, while sometimes leaving behind arguably more-important prognostic factors, such as frailty and daily functioning, both of which reflect physiologic age. The overemphasis on chronologic age by risk models is highlighted by the low observed-to-expected mortality ratio of 0.55 in this study and others. These findings challenge the TAVI skeptics who still believe in the 1970s theory of “the failure of success”⁵ and that advances in medicine and technology can prolong life but cannot delay the onset of chronic, degenerative disease. In contrast, we encounter many healthy elderly patients who have an isolated acute decline, a testament to the theory of “compression of morbidity” described by Fries.⁶ Distinguishing between chronologic and physiologic age is paramount to the TAVI selection process.

Thus, we come to the major weaknesses of the study⁴: the lack of information on the selection process and several important patient characteristics and outcomes. First, although the authors mention that TAVI should not be denied in “select” patients, the report does not delve into what “select” means. The 46 reported patients seem to have been selected from an unknown denominator. The lack of information on the selection process threatens the generalizability of the results and may incorrectly cause

readers to think that TAVI can be offered to *all* nonagenarians.

Second, the authors do not report on quality-of-life measures and post-TAVI New York Heart Association class, despite reporting the class preoperatively. Moreover, 60% of patients were discharged to a nursing home, without any information on where the patients came from preoperatively. All of these factors are concerning, as it leaves the question of what quality of life these patients were experiencing after TAVI. For many elderly patients, the most important endpoint is “adding life to their years instead of years to their life.”⁷ Unfortunately, the excellent survival outcomes in this report are not sufficiently substantiated by evidence of improved quality of life in this specific patient population.

In conclusion, this study⁴ is an important start to the reporting of TAVI outcomes in nonagenarians and should encourage others to do the same to provide guidance on this rapidly growing population of high-risk patients. Although the survival outcomes are encouraging, caution should be exercised because of the lack of clear selection criteria and quality-of-life information, and the high complication rates, especially as they pertain to vascular access.

References

1. Noble S, Frangos E, Samaras N, Ellenberger C, Frangos C, Cikirikcioglu M, et al. Transcatheter aortic valve implantation in nonagenarians: effective and safe. *Eur J Intern Med*. 2013;24:750-5.
2. Murashita T, Greason KL, Suri RM, Nkomo VT, Holmes DR, Rihal CS, et al. Aortic valve replacement for severe aortic valve stenosis in the nonagenarian patient. *Ann Thorac Surg*. 2014;98:1593-7.
3. Pascual I, Lopez-Ortero D, Munoz-Garcia AJ, Alonso-Briales JH, Avanzas P, Moris C. Safety and efficacy of transcatheter aortic valve implantation in nonagenarian patients. *Rev Esp Cardiol (Engl Ed)*. 2014;67:583-4.
4. Greason KL, Pochettino A, Sandhu GS, Mathew V. Transcatheter aortic valve insertion in the nonagenarian patient. *J Thorac Cardiovasc Surg*. 2015;150:720-1.
5. Gruenberg EM. The failure of success. *Milbank Mem Fund Q Health Soc*. 1977;55:3-24.
6. Fries JK. Aging, cumulative disability, and the compression of morbidity. *Compr Ther*. 2001;27:322-9.
7. Leon MB, Smith CR, Mack M, Miller DC, Moses JW, Svensson LG, et al. Transcatheter aortic-valve replacement in high-risk patients. *N Engl J Med*. 2011;364:2187-98.