Comparison of Frequency, Risk Factors, and Time Course of Postoperative Delirium in Octogenarians After Transcatheter Aortic Valve Implantation Versus Surgical Aortic Valve Replacement

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Postoperative delirium (PD) after transcatheter aortic valve implantation (TAVI) remains to be explored. We sought to (1) determine the incidence of PD in octogenarians who underwent TAVI or surgical aortic valve replacement (SAVR), (2) identify its risk factors, and (3) describe possible differences in the onset and course of PD between treatment groups. A prospective cohort study of consecutive patients aged ≥80 years with severe aortic stenosis who underwent elective TAVI or SAVR (N = 143) was conducted. The incidence of PD was assessed for 5 days using the Confusion Assessment Method (CAM). Risk factors for PD were studied with logistic regression. Patients treated with TAVI were older (p ≤0.001), had lower cognitive scores (p = 0.007), and more co-morbidities (p = 0.003). Despite this, significantly fewer (p = 0.013) patients treated with TAVI (44%) experienced PD compared to patients treated with SAVR (66%). Undergoing SAVR (p = 0.02) and having lower cognitive function (p = 0.03) emerged as risk factors for PD, whereas gender, activities of daily living, frailty, atrial fibrillation, and postoperative use of opioids and anxiolytics did not. Patients treated with TAVI and without PD during the first 2 postoperative days were unlikely to experience PD on subsequent days. The onset of PD after SAVR could occur at any time during the postoperative evaluation. In conclusion, SAVR in octogenarian patients with aortic stenosis might be considered as a predisposing factor for PD. Our data also suggest that the onset of PD was more unpredictable after SAVR. **(Am J Cardiol 2015;115:802−809)**

Older patients undergoing cardiac surgery often develop postoperative delirium (PD).[1] Transcatheter aortic valve implantation (TAVI) is offered to patients with aortic stenosis (AS) without reasonable surgical alternatives.[2] Many TAVI patients are 80 years and older.[3] Delirium, an acute and fluctuating change in cognition and attention,[4] is often associated with adverse short- and long-term health implications.[5,6] Although the cause of PD is not fully understood, it is known that impairment in cognition and activities of daily living (ADL), advanced age, co-morbidities, preoperative atrial fibrillation (AF), major surgery, and use of opioids and benzodiazepines are risk factors.[4,7,8] The relation between PD and the patients' status score in The American Society of Anesthesiologists (ASA) Physical Status Classification System, logistic EuroScore,[9] and general anesthesia has been questioned.[10] Frailty[11] is a predictor of adverse health outcomes and death in the elderly,[12] but whether frailty is also a risk factor for PD in octogenarian patients with AS remains to be established. Because TAVI is a less-invasive treatment currently offered to individuals with higher surgical risk, it is warranted to investigate if patients undergoing TAVI are less likely to develop PD. Knowledge about octogenarians undergoing invasive cardiovascular therapy is scarce. Although the incidence of PD after cardiac surgery has been explored,[1,13,14] these studies included younger patients (<80 years) needing coronary artery bypass grafting (CABG) alone or combined with surgical aortic valve replacement (SAVR). Further predisposing factors can be identified by restricting the study population to octogenarians with severe AS who underwent elective treatment. A recent study[15] described the incidence of PD after TAVI, studying only the first postoperative day and including few octogenarians. Therefore, the aims of this study were to (1) determine the incidence of PD in octogenarians with AS requiring SAVR or TAVI, (2) identify risk factors for its development, and (3) describe possible differences in the onset and course of PD in the 2 treatment groups.

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Methods

We conducted an observational, prospective cohort study of consecutive octogenarian patients who had undergone elective TAVI or SAVR in a tertiary university hospital in western Norway. Patients aged 80 years and older previously accepted for TAVI or SAVR were eligible. The study was entitled "Delirium in octogenarians undergoing cardiac surgery or intervention (CARDELIR)", and presence of delirium was the primary outcome. A group of experts in cardiothoracic surgery and invasive cardiology evaluated octogenarian patients with AS and identified those not suitable for SAVR. Exclusion criteria were inability to speak and understand Norwegian and declining consent to participate. Severe AS was defined as aortic valve area <0.6 cm^2/m^2, mean gradient of >40 mm Hg, and maximum jet velocity >4.0 m/s.[16] The main reasons disqualifying patients for standard SAVR included previous CABG, severe respiratory insufficiency, co-morbidities that could compromise recovery, and previous thoracic radiotherapy. From February 2011 to August 2013, 162 octogenarians were admitted for TAVI or SAVR. Of these, 147 fulfilled the eligibility criteria and 144 agreed to participate. One patient withdrew consent before surgery, and 7 were either not responsive or died within 5 days after treatment, leaving us with data for 136 patients (Figures 1 and 2). One patient who underwent TAVI was discharged on the fourth postoperative day.

Assessment of the presence of PD was performed with the Confusion Assessment Method (CAM).[17] CAM is based on operationalized criteria derived from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and assesses 4 features: (1) acute-onset and fluctuating course, (2) inattention, (3) disorganized thinking, and (4) altered level of consciousness. Delirium is diagnosed when features 1 and 2 are present and either 3 or 4 are displayed.[17] The accuracy of CAM has

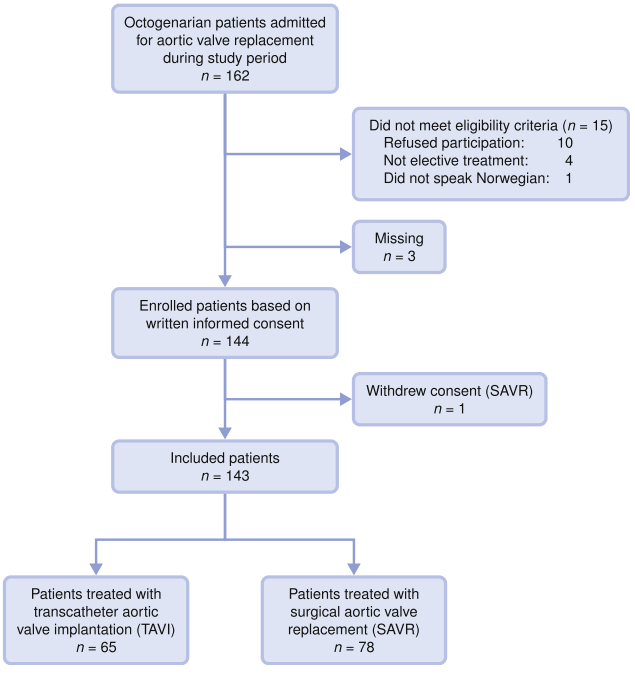

Figure 1. Recruitment flow diagram of octogenarian aortic stenosis patients who underwent TAVI or SAVR.

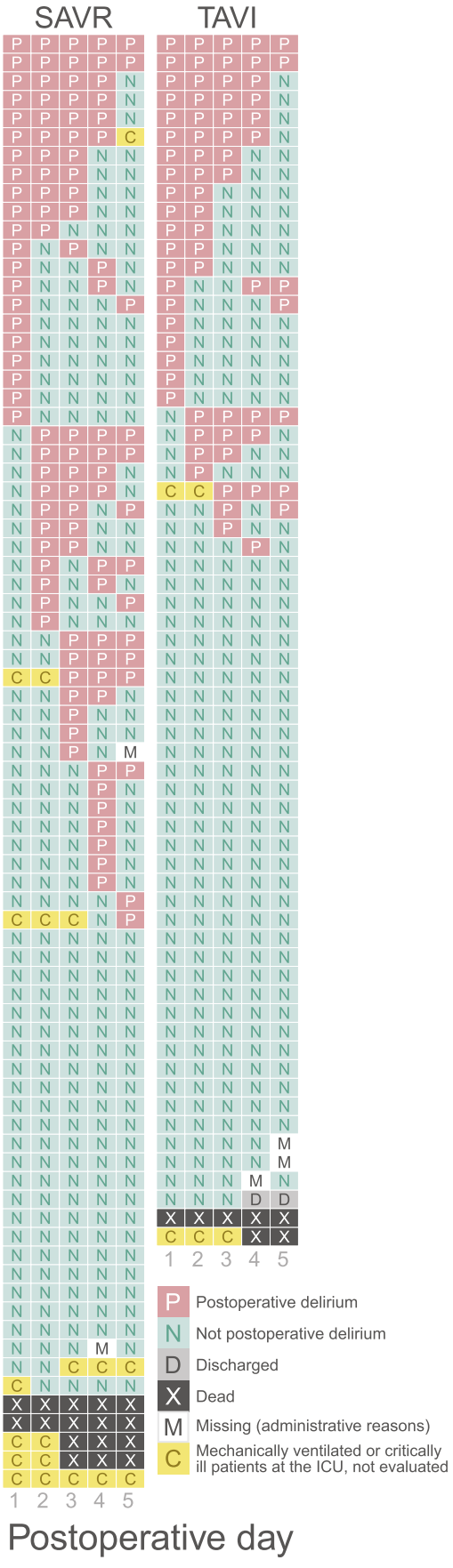

Figure 2. Diagram of TAVI and SAVR patient (N = 143) status, displayed sequentially for each postoperative day.

Table 1
Characteristics of delirious and non-delirious octogenarian patients undergoing Transcatheter Aortic Valve Implantation (TAVI) or Surgical Aortic Valve Replacement (SAVR)

Variables	Total (N=143) Mean or count	±SD or (percent)	Non-delirium n=60 Mean or count	±SD or (percent)	Delirium n=76 Mean or count	±SD or (percent)	Univariate P-value
Age (years)	83.5	±2.7	83.4	±2.8	83.5	±2.7	0.76
Women	81	(57%)	37	(62%)	39	(51%)	0.23
Marital Status							0.68
Married	77	(54%)	31	(52%)	42	(55%)	
Cohabital status							0.21
Live alone	67	(47%)	31	(53%)	31	(41%)	
SOF Frailty Index							0.36
Robust	48	(34%)	19	(32%)	27	(36%)	
Prefrail	39	(27%)	20	(33%)	17	(22%)	
Frail	56	(39%)	21	(35%)	32	(42%)	
MMSE	27.2	±2.9	27.6	±2.3	26.9	±3.3	0.14
MMSE≤27	63	(44%)	24	(40%)	34	(45%)	0.58
BI	18.9	±1.5	19.2	±1.4	18.8	±1.5	0.11
BI≤18	44	(31%)	16	(27%)	26	(34%)	0.34
BMI (Kg/m^2)	25.5	±4.1	25.4	±4.8	25.6	±3.8	0.72
BMI (Kg/m^2) ≤20	13	(9%)	8	(13%)	5	(7%)	0.18
Charlson Comorbidity Index	2.1	±1.2	2.1	±1.2	2.1	±1.2	0.91
Logistic EuroScore*	14.0	(9.2%)	15.4	(9.3%)	12.9	(9.1%)	0.11
NYHA function class							0.33
I-II	48	(38%)	19	(34%)	28	(42%)	
III-IV	80	(62%)	37	(66%)	38	(58%)	
Left ventricle ejection fraction (%)	56.4	±10.3	56.4	±11.1	56.6	±9.7	0.89
Max aorta gradient (mmHg)	79.3	±24.9	78.6	±25.5	79.4	±24.1	0.85
Mean aorta gradient (mmHg)	48.2	±16.6	48.0	±16.5	48.1	±16.5	0.99
Aortic valve area (cm^2/m^2)	0.4	±0.2	0.4	±0.1	0.4	±0.2	0.30
Preoperative atrial fibrillation	39	(27%)	14	(23%)	25	(33%)	0.22
Hemoglobin (g/dL)	13.1	±1.4	13.0	±1.3	13.2	±1.5	0.25
Creatinine concentration, (μmol)	91.3	±27.8	88.6	±26.7	93.2	±26.9	0.32
GFR, (mL/min/1.73m^2)	54.8	±9.0	55.6	±8.6	54.5	±8.8	0.47
Albumin, (g/L)	44.0	±3.0	43.7	±2.9	44.2	±2.8	0.32
Perioperative variables							
Type treatment: TAVI	65	(45%)	35	(58%)	25	(42%)	0.01
ASA-Classification							0.28
III	120	(84%)	48	(80%)	66	(87%)	
IV	23	(16%)	12	(20%)	10	(13%)	
Anesthesia time (hours)	3.9	±1.6	3.4	±1.3	4.1	±1.5	0.005
Type of anesthesia (sedation)	34	(24%)	20	(33%)	13	(17%)	0.03
Preoperative medication							0.02
Oxazepam (Sobril)	51	(36%)	29	(49%)	21	(28%)	
Morfin scopolamine	77	(55%)	24	(41%)	21	(28%)	
None	12	(9%)	6	(10%)	5	(7%)	
Blood transfusion	29	(20%)	8	(13%)	17	(22%)	0.18
Hypotension	75	(52%)	29	(48%)	41	(54%)	0.52
Tachycardia	8	(6%)	4	(7%)	4	(5%)	0.73
Hypoxia†	6	(4%)	0	(0%)	5	(7%)	0.07
Post-operative medication							
Opioids required	117	(83%)	45	(76%)	67	(88%)	0.07
Loop diuretics required	127	(89%)	50	(83%)	73	(96%)	0.01

ASA = American Society of Anesthesiologists; BI = Barthel Index; BMI = Body Mass Index; MMSE = Mini Mental Status Examination; NYHA function class = New York Heart Association Function Classification; SOF = Study of Osteoporotic Fractures; TAVI = transcatheter aortic valve implantation.
* P-value based on log-transformed values.
† Fisher's exact test.

been confirmed in several studies.[18] We studied this primary outcome as the presence of PD on daily basis and as the presence of PD in a period of 5 days after AS treatment.

ADL function, atrial fibrillation, cognitive function, co-morbidity, and postoperative use of opioids and anxiolytics as potential risk factors for PD were selected on the basis of review of reports[4,7,18,19] and clinical experience. Treatment with TAVI and baseline frailty were also included in the regression analysis. We assessed patient's self-care abilities with the Barthel Index[20] which evaluates

Table 2
Characteristics of octogenarian patients undergoing Transcatheter Aortic Valve Implantation (TAVI) or Surgical Aortic Valve Replacement (SAVR)

Variables	Total (N=143) Mean or count	±SD or (percent)	TAVI n=65 Mean or count	±SD or (percent)	SAVR n=78 Mean or count	±SD or (percent)	Univariate p-value
Age (years)	83.5	±2.7	84.8	±2.8	82.4	±2.0	<0.001
Female	81	(57%)	41	(63%)	40	(51%)	0.16
Marital Status							0.18
Married	77	(54%)	31	(48%)	46	(59%)	
Cohabital status							0.13
Live alone	67	(47%)	35	(54%)	32	(41%)	
SOF- Frailty Index							0.11
Robust	48	(34%)	16	(25%)	32	(41%)	
Prefrail	39	(27%)	21	(32%)	18	(23%)	
Frail	56	(27%)	28	(43%)	28	(36%)	
MMSE	27.2	±2.9	26.5	±3.1	27.8	±2.6	0.007
MMSE≤27	63	(44%)	36	(55%)	27	(35%)	0.01
BI mean	18.9	±1.5	18.8	±1.5	19.0	±1.5	0.37
BI≤18	44	(31%)	23	(35%)	21	(27%)	0.27
BMI (Kg/m^2)	25.5	±4.1	25.0	±4.4	25.9	±3.9	0.20
BMI≤20	13	(9%)	9	(14%)	4	(5%)	0.07
Charlson Comorbidity index	2.1	±1.2	2.5	±1.3	1.8	±1.0	<0.001
Logistic EuroScore*	14.0	±9.2	19.6	±10.6	9.4	±3.6	<0.001
NYHA function Class							<0.001
I-II	48	(38%)	11	(20%)	37	(51%)	
III-IV	80	(62%)	45	(80%)	35	(49%)	
Left ventricle ejection fraction (%)	56.4	±10.3	55.9	±10.1	56.8	±10.5	0.59
Max aorta gradient (mmHg)	79.3	±24.9	74.4	±23.8	83.6	±25.2	0.03
Mean aorta gradient (mmHg)	48.2	±16.6	45.6	±16.3	50.6	±16.7	0.08
Aortic valve area (cm^2/m^2)	0.4	±0.2	0.4	±0.1	0.4	±0.2	0.64
Preoperative atrial fibrillation	39	(27%)	22	(34%)	17	(22%)	0.11
Hemoglobin (g/dL)	13.1	±1.4	12.7	±1.6	13.5	±0.12	0.001
Creatinine concentration (μmol)	91.3	±27.8	93.9	±28.1	89.2	±27.5	0.32
Albumin, (g/L)	44.0	±3.0	43.5	±3.0	44.4	±2.9	0.07
Perioperative variables							
ASA Classification							<0.001
III	120	(84%)	44	(68%)	76	(97%)	
IV	23	(16%)	21	(32%)	2	(3%)	
Anesthesia time (hours)	3.9	±1.6	2.8	±0.7	4.9	±1.5	<0.001
Preoperative medication							<0.001
Oxazepam (Sobril)	51	(36%)	50	(81%)	1	(1%)	
Morfin scopolamine	77	(55%)	0	(0%)	77	(99%)	
None	12	(9%)	12	(19%)	0	(0%)	
Blood transfusion	29	(20%)	6	(9%)	23	(29%)	0.003
Tachycardia	8	(6%)	4	(6%)	4	(5%)	0.79
Hypoxia†	6	(4%)	5	(8%)	1	(1%)	0.09
Post-operative medication							
Opioids required	117	(83%)	40	(62%)	77	(100%)	<0.001
Loop diuretics required	127	(89%)	51	(78%)	76	(99%)	<0.001

ASA = American Society of Anesthesiologists Classification; BI = Barthel Index; BMI = Body Mass Index; MMSE = Mini Mental Status Examination; NYHA Function Class = New York Heart Association Function Classification; SOF = Study of Osteoporotic Fractures.

* P-value based on log-transformed values.

† Fisher's exact test.

ADL in 10 basic areas. This index is reliable and valid[21] and provides a score from 0 to 20, with 19 or more indicating functional independence.[20] General cognitive functioning was measured with the Mini-Mental State Examination (MMSE), a 20-item instrument, with maximum score of 30 points.[22] Co-morbidities were quantified using the Charlson comorbidity index. It predicts mortality in patients with co-morbid disorders, assigning a score of 1, 2, 3, or 6, summed to predict mortality.[23] Several studies have demonstrated the reliability and validity of the index.[23] Frailty was defined using the Study of Osteoporotic Fractures (SOF) Frailty Index.[12] It identifies subjects at risk of adverse health outcomes on the basis of weight loss, inability to rise from a chair 5 times without using his/her arms, and reduced energy level.[24] The SOF Frailty Index classifies patients as robust, prefrail, or frail. Its psychometrical properties have been confirmed.[12,24] We used patients' medical records to identify the presence of preoperative atrial fibrillation, as assessed by a cardiologist, and to recognize postoperative use of opioids and anxiolytics.

Table 3
Logistic regression model of risk factors for delirium in octogenarian aortic stenosis patients (n=135)

	Unadjusted			Adjusted		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	*P*-value
Gender			0.26			0.60
Male (ref.)	1	–		1	–	
Female	0.67	0.34−1.34		0.82	0.38−1.76	
ADL score	0.82	0.63−1.05	0.12	0.81	0.60−1.07	0.14
Atrial fibrillation	1.58	0.74−3.46	0.24	1.84	0.79−4.49	
Comorbidity score	1.02	0.76−1.36	0.92	1.08	0.78−1.51	0.64
Frailty			0.54			0.59
Robust (ref.)	1	–		1	–	
Prefrail/frail	0.80	0.38−1.64		0.80	0.35−1.81	
MMS score	0.91	0.79−1.02	0.11	0.85	0.73−0.98	0.03
Postoperative use of opioids	2.32	0.94-5.99	0.07	1.61	0.52−5.17	0.41
Postoperative use of anxiolytics	0.97	0.47-2.03	0.94	1.09	0.49−2.45	0.83
Treatment TAVI	0.43	0.21−0.85	0.02	0.34	0.14−0.82	0.02

ADL = Activities of Daily Living; MMSE = Mini Mental Status Examination; SOF = Study of Osteoporotic Fractures; TAVI = transcatheter aortic valve implantation.

Patients were approached for consent 1 day before intervention, and preoperative data were gathered that day. Demographic and clinical information was collected by interview or from medical records, as appropriate. ADL and cognitive function were measured at baseline, and data needed to score the SOF Frailty Index were collected at this time. Nursing staff were instructed about PD features regularly as reminders and were encouraged to report PD symptoms during every shift. However, research assistants trained to use the CAM were responsible for assessing PD after visiting the patients daily at noon, from postoperative days 1 to 5, including weekends. Patients were assessed for inattention, disorganized thinking, altered level of consciousness, and disorientation. Medical, nursing, and physiotherapist' reports from the previous 24 hours and results from meetings with health professionals in charge of the study patients were also considered when CAM was scored.

The study was approved by the Regional Committee for Ethics in Medical Research (REK Vest 2010/2936-6) and conducted in accordance with the Declaration of Helsinki. Patients were invited to participate in the study after receiving oral and written information. Registered nurses with extensive experience with geriatric and cardiac patients, but not involved in the care of the patients, were responsible for enrollment and data collection. Because of patients' advanced age and the nature of the procedure, we were particularly alert for verbal and nonverbal signs indicating displeasure or exhaustion during data collection.

Previous research on cardiac surgery populations and the primary outcome guided our power analysis. We determined a priori that 100 patients who underwent SAVR and 40 who underwent TAVI would be required to reach a statistical power of 80%, which would allow us to detect a reliable risk difference, given that 31% of patients in the SAVR group[25] and 10% in the TAVI group actually developed delirium. Because the incidence of PD after TAVI had not been previously studied, the last percent was estimated. Two years after the start of the study, fewer eligible patients than we initially anticipated received SAVR. A new power analysis showed that including 84 patients who underwent SAVR and 65 patients who underwent TAVI would give a power of 89%.

Data are presented as counts and percentages or means and standard deviations. Differences between groups were tested with the chi-square or Fisher's exact tests for categorical variables and the Welch t test (i.e., a t test not assuming equal variances) for continuous variables. Logistic regression was used to determine the impact of proposed risk factors on PD. A log-rank test for interval-censored data[26,27] was used to study differences in the time to onset of delirium. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY), and R 3.0.2. (R Foundation for Statistical Computing, Vienna, Austria). A 2-tailed p value of $\leq$0.05 was considered statistically significant.

Results

Characteristics of the participants, stratified by the presence of delirium, are presented in Table 1. Table 2 summarizes differences between patients in the TAVI and SAVR groups. TAVI was performed in 46% of the patients. General anesthesia was used in 48% of patients who underwent TAVI and in all patients who underwent SAVR ($p \leq 0.001$). The mean length of stay in patients who underwent TAVI was 8.8 days (SD 6.0) versus 7.9 days (SD 4.7) after SAVR. The relatively long length of stay after TAVI was partly related to the general condition of the patients and to the risk of postoperative AV blockage and pacemaker requirement up to a week after CoreValve implantation.

New cases of PD occurred at least once in 56% of octogenarians during the 5-day study period. Of patients in the TAVI group, 44% developed PD compared to 66% of patients in the SAVR group ($p = 0.01$). Of the TAVI patients developing PD, 54% received general anesthesia ($p = 0.40$). The logistic regression model revealed that PD was associated with cognitive function and treatment type

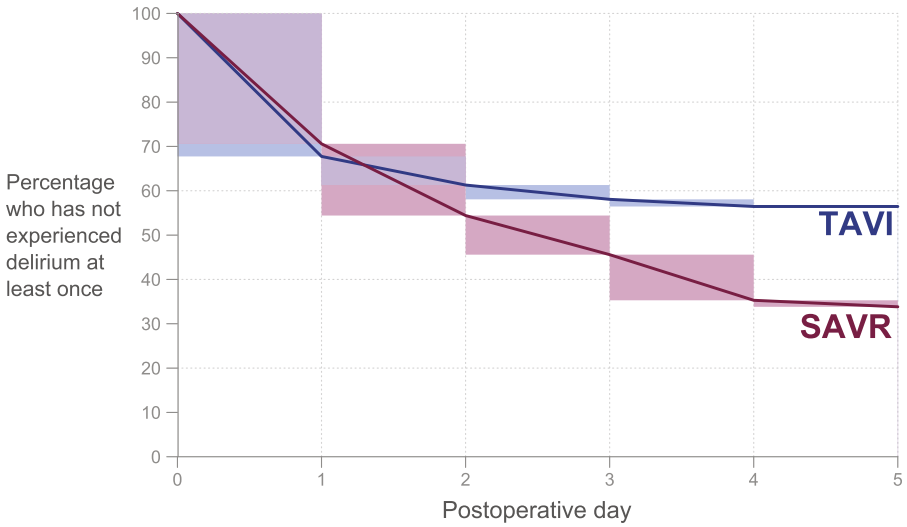

Figure 3. Kaplan–Meier survival curves showing time to onset of PD for TAVI and SAVR. Patients who died or became critically ill are excluded. Patients with data missing for administrative reasons or who were discharged were censored for the remaining duration of their hospital stay (n = 130).

(Table 3). The average number of days with PD for patients observed for all 5 days did not differ between patients treated with TAVI and SAVR (1.1 vs 1.5, p = 0.20), but the course of PD did. Figure 2 shows that patients in the TAVI group, who did not develop PD during the first postoperative day, usually did not experience PD in the succeeding 4 days. Seventy-four percent of patients in the TAVI group experienced PD on the first day, whereas only 46% of patients in the SAVR group did (Figure 2). Figure 3 shows PD-free survival for the treatment groups. The groups differed with respect to time to the first onset of PD (exact log-rank test for interval-censored data; p = 0.03).

Discussion

To the best of our knowledge, this is the first study to systematically explore factors associated with PD during 5 consecutive postoperative days in octogenarian patients needing TAVI or SAVR. The incidence of PD was significantly higher in octogenarians with reduced cognitive function and in those treated with SAVR. Differences in PD onset were also found between treatment groups.

The incidence of PD after cardiac surgery is high.[4,14] In general, patients accepted for TAVI have a higher surgical risk than patients receiving SAVR.[2,3] In our sample, patients who underwent TAVI were older, had lower MMSE scores, greater comorbidity scores, higher logistic EuroScore, and were classified in more-severe ASA categories. Despite this, 44% of patients scheduled for TAVI experienced PD compared to 66% of patients in the SAVR group, suggesting that TAVI is better tolerated with regards to PD.

Cognitive and ADL impairment are well-established risk factors for PD in cardiac and noncardiac patients,[4,19] and our analyses provide additional evidence linking lower cognitive function to higher risk for PD. Although entry of ADL function in the regression model did not reach significance, a ceiling effect may have been present and our results must be interpreted with caution. The relatively good cognitive function of our cohort is similar to other cardiac populations in which PD has been studied.[6,13] Yet, it must be taken into account that in recent years, the accuracy of MMSE in diagnosing mild cognitive impairment has been questioned.[28]

In our study, co-morbidity, ASA score, and EuroScore were not associated with PD, according to univariate and multivariate analysis. However, because of 90% of our patients had 1 or more co-morbidities, we had insufficient power to detect a difference between patients lacking and those having some co-morbidities. General anesthesia, sternotomy, and extracorporeal circulation are procedures related to SAVR that might put excessive burden on octogenarian patients. Sedation might moderate the adverse effects of general anesthesia that could lead to PD.[10] Univariate analysis showed a relation between PD and anesthesia type (general vs sedation). However, when controlling for other variables, this relation disappeared.

Stress and inflammation responses are associated with PD.[4] Lower activation of stress hormones might be present in patients who underwent TAVI as less tissue damage and inflammation is associated with the procedure. The SAVR procedure involved full sternotomy. Hence, we were unable to determine whether less-invasive procedures such as ministernotomy or minithoracotomy would influence the incidence or onset of PD in patients who underwent SAVR. It is still unknown if the new sutureless valve prostheses designed for fast deployment in the aortic root might reduce postoperative complications such as PD.

Appropriate pain management and mobilization can prevent PD after surgery; still, opioids have been associated with the onset of PD.[19] We did not find any statistical association between opioids and PD after adjusting for other risk factors. The postoperative use of anxiolytics was also entered in the regression model without reaching statistically significant values. Yet, the confidence intervals of these 2 variables are wide and results should be interpreted with caution. Our data revealed that patients who underwent TAVI received less amounts of postoperative opioids and paracetamol and earlier mobilization. It can be speculated that the gentler TAVI leads to lower postoperative pain and

easier mobilization. Postoperative routines in our hospital encourage patients to leave bed the same day TAVI is performed, and by the first postoperative day, patients who underwent TAVI are ambulating the cardiology ward. Mobilization after SAVR starts the day after surgery but is restricted by the use of electrocardiography devices, pulmonary tubes, temporal pacemaker, urine catheters, and intravenous lines during the first 48 hours, supporting evidence that physical restraints might precipitate PD.[4]

Delirium and frailty have been proposed to be different representations of the inability to compensate for stressors.[29] Additionally, the relation between frailty and delirium has been questioned.[29] Using the SOF Frailty Index, this study is one of the first to assess preoperative frailty as a risk factor for PD. The logistic regression analysis showed that frailty plays a limited role as a predictor of PD in octogenarian patients with AS.

PD developed at different times in the 2 groups of patients. During the first postoperative day, PD occurred in several patients regardless of the treatment (Figure 2). Differences emerged from the second postoperative day. Our data indicate that patients in the TAVI group who did not develop PD during the first postoperative day were unlikely to develop PD thereafter. In patients treated with SAVR, the onset of PD could occur at any time during the 5 days of assessment (Figure 2).

The strengths of this study lie in its prospective design and use of valid and reliable instruments. PD was assessed by trained research assistants who performed the assessments for 5 days, including weekends. Additionally, our hospital is 1 of 5 centers in Norway performing TAVI, and in western Norway all TAVI and SAVR procedures are performed in our hospital setting. This allowed us to study a representative group of octogenarian patients with AS from this part of the country. Few patients (6%) refused to participate, and <2% were not identified before treatment. Thus, these factors argue for generalizability. The high incidence of PD (56%) in our study can be explained by the robust method used to evaluate PD, which included a highly recommended tool used to identify delirium,[18] bedside contact with eligible patients, review of medical, nursing, and physiotherapist reports written 24 hours before assessment with CAM, and direct contact with nurses during the morning shift.

Limitations of the study include a nonrandomized treatment location. Yet, as pointed out in the PARTNER trial,[3] a randomized study to compare treatment modalities was not possible because TAVI and SAVR were used to treat distinctly different patient populations. Body Mass Index, sensory impairment, ASA, and EuroScore are important variables that could not be included in the logistic regression because of our modest sample size. This limitation warrants bigger studies of octogenarians patients with AS who underwent AVR. The lack of preoperative and postoperative information regarding brain pathology is also a limitation. However, important information about brain reserve and vulnerability for delirium comes from assessment of patients' preoperative cognitive function using the MMSE. Nevertheless, it is possible that other cognitive measurements should have complemented our data. Preoperative organic cerebral disease, precerebral vascular lesions, and thoracic aortic atherosclerosis may all be important risk factors for postoperative cerebral dysfunction. However, as cerebral computed tomography or magnetic resonance imaging or imaging of the thoracic aorta or precerebral vascularity was not part of the study protocol, we were unable to conduct any further evaluation of organic risk factors related to general atherosclerosis or embolic risk. The relatively good cognitive and ADL function of our patients might indicate the presence of patient selection bias before referral to our hospital. This can limit the generalizability of our results to populations living in areas where selection criteria for AS intervention are less strict. Additionally, our study did not evaluate the severity of PD.

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Disclosures

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