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EDITORIAL

Cognitive Outcomes of Cardiovascular Surgical Procedures in the Old: An Important but Neglected Area

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Older individuals can now undergo invasive cardiovascular procedures without serious concern about mortality, and the numbers and proportions of the over 65s and 85s doing so in Australia has been increasing over the last 20 years. There is overwhelming evidence linking cardiovascular conditions to late-life (65 years and over) cognitive impairment and dementia including Alzheimer's Disease, primarily due to impaired cerebrovascularisation and cascading neuropathological processes. Somewhat paradoxically, these cardiovascular interventions, carried out with the primary aim of revascularisation, are not usually associated with short- or long-term improvements in cognitive function in older adults. We discuss factors associated with cognitive outcomes post-cardiovascular surgeries in patients over 65 years of age. There are many opportunities for future research: we know almost nothing about cognitive outcomes following invasive cardiac procedures in the oldest old (85 years and over) nor how to predict the cognitive/delirium outcome using pre-surgical data, and lastly, intervention opportunities exist both pre and postoperatively that have not been tested. As our population ages with increased cardiovascular burden and rates of cardiovascular interventions and surgeries, it is critical that we understand the cognitive consequences of these procedures, who is at greatest risk, and ways to optimise cognition.

Keywords Old • Elderly • Cognition • Dementia • Cardiovascular surgery

The Australian population is ageing and with this comes increased prevalence of age-related conditions, including cardiovascular disease and dementias such as Alzheimer's disease. The two are strongly linked, with cardiovascular disease (and risk factors) consistently associated with increased risk of cognitive impairment and dementia in late-life [1–6]. In developed countries, less than 2% of 60–65 year olds have dementia, increasing to 35–48% in those over 90 years [7]. Vascular disease lowers brain perfusion and places vulnerable ageing neurons in a state of high energy compromise leading to a cascade of metabolic processes, neural damage and pathology, associated with cognitive impairment and dementia [8,9]. Accordingly, the vast majority (up to 84%) of late-life dementia cases present with mixed traditional Alzheimer's disease (aggregated proteins such as beta-amyloid and tau) and vascular neuropathologies [10–14].

Invasive cardiovascular procedures such as percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG) and transcatheter aortic valve implantation (TAVI) are increasingly being carried out in the old (65+ years) and very old (85+ years), due to increased disease prevalence and improvements in mortality outcomes through to octo- and nonagenarians [15,16]. Figure 1 displays the number and

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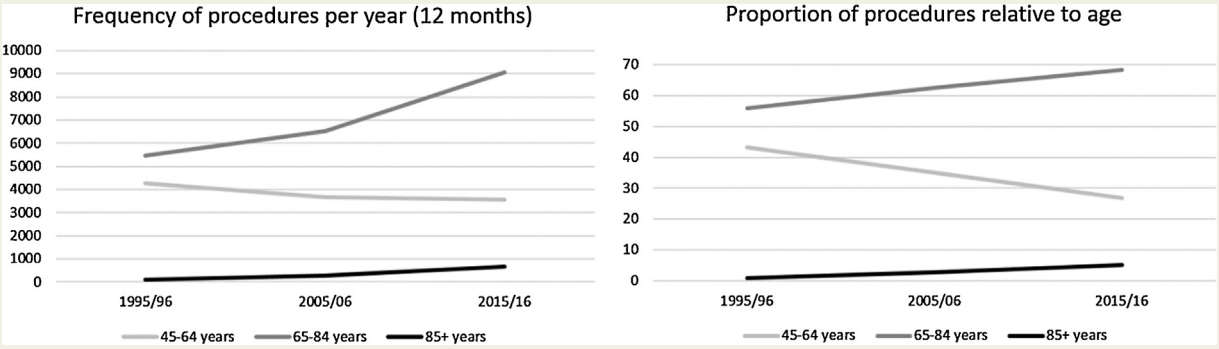

Figure 1 The number of PCA, TAVI and CABG procedures carried out in Australia in 1995/96, 2005/06 and 2015/16 (over 12-month periods) relative to age group (45–64, 65–84, 85+ years) (left), along with the proportion of procedures carried out relative to age (right) [17]. Note: TAVI not done in the 1990s.

proportion of these procedures – PCI, TAVI and CABG – carried out in Australia in 1995/96, 2005/06 and 2015/16 (over 12-month periods) relative to age group. It can be seen that the number of procedures has grown over the past 20 years, and further, the proportion of the young old (45–64 years) undergoing these procedures has decreased, while the proportion of the old (65–84) and oldest old (85+ years) has increased. These surgeries are undertaken with the primary outcome of improving vascularisation, however surgical and non-surgical factors mean that in many cases cognition is negatively impacted in this vulnerable older population.

Cognitive Function Post-Cardiac Procedures in the Old

We know almost nothing about cognitive functioning in the very old post-cardiovascular surgeries, despite over 650 procedures in Australia being carried out last financial year (2015/16) in those over 85 years and over 9000 in those 65–84 years [17]. The vast majority of research has focussed on patient cohorts with mean ages in the late 50s to early 60s [18]; therefore there is a major gap in our knowledge of cognitive outcomes after invasive cardiovascular procedures in the old. It is unlikely that we can simply apply findings from middle-aged adults, nor from the old to very old. Within the cognitive impairment field, there is evidence of qualitatively and quantitatively different associations existing between the younger old and older old in terms of dementia neuropathology and vascular factors. For example, hippocampal and cortical amyloid and tau does not differentiate those with and without dementia who die in their 80s and beyond, as it does for those who die younger [19]; and there is a paradoxical shift in the association between obesity (and more broadly, metabolic syndrome) and dementia in very late life, with those underweight at most risk rather than those who are obese [20].

There are no data regarding cognitive outcomes following PCI in the old or very old. One study (mean age in the low 60s) reported no significant cognitive impairments in patients randomised to PCI or CABG 6- and 12-months post-surgery [21]. In a smaller, older study of patients aged in the mid–late 50s, Blumenthal et al. [22] reported that, at discharge, those who underwent CABG or cardiac valve repair displayed impaired performance (as compared to their scores one day prior to surgery) on the Digit Symbol test, while percutaneous transluminal coronary angioplasty patients did not; reaction time performance improved for the coronary angioplasty patients but declined significantly for surgical valve patients.

In the single study that has assessed older adults (mean age 76 years) undergoing CABG, Jensen et al. [23] reported that 19% of patients displayed postoperative cognitive impairment one-year post-surgery in the off-pump group and 9% in the on-pump group. In younger patients (mean age around 60 years), there have been two reports of post-CABG cognitive impairments persisting to five years [24,25]. Newman et al. [24] reported that 53% of patients left hospital with impaired cognition post-CABG (greater than one standard deviation/SD decline in function as compared to pre-surgery), dropping to 36% at six-weeks and 24% at six months, then increasing to 42% at five years. Poorer cognitive performance at discharge and older age were independently associated with poorer cognitive function at five years [24].

Studies assessing cognition post-TAVI have typically examined older individuals, as this is a relatively new procedure, often carried out on octo- and nonagenarians who are unsuitable for more aggressive valve surgery [26]. There have been reports of no cognitive changes up to three months [27] and two years [28] post-TAVI, with both studies employing a battery of cognitive tests in patients with mean ages in the 80s. Age appeared to be the only significant predictor of cognitive decline in those who underwent TAVI, among a large pool of physical, brain-imaging and cognitive variables that were tested [28]; this reaffirms that older age is associated with poor cognitive outcomes post-cardiovascular procedures. Interestingly, a systematic review with a broader, and therefore younger age range reported that TAVI was not

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