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REVIEW

The vascular access in the elderly: a position statement of the Vascular Access Working Group of the Italian Society of Nephrology

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Abstract The incident hemodialysis (HD) population is aging, and the elderly group is the one with the most rapid increase. In this context it is important to define the factors associated with outcomes in elderly patients. The high prevalence of comorbidities, particularly diabetes mellitus, peripheral vascular disease and congestive heart failure, usually make vascular access (VA) creation more difficult. Furthermore, many of these patients may have an insufficient vasculature for fistula maturation. Finally, many fistulas may never be used due to the competing risk of death before dialysis initiation. In these cases, an arteriovenous graft and in some cases a central venous catheter become a valid alternative form of VA. Nephrologists need to know what is the most appropriate VA option in these patients. Age should not be a limiting factor when determining candidacy for arteriovenous fistula creation. The aim of this position statement, prepared by experts of the Vascular Access Working Group of the Italian Society of Nephrology, is to critically review the current evidence on VA in elderly HD patients. To this end, relevant clinical studies and recent guidelines on VA are reviewed and commented. The main advantages and potential drawbacks of the different VA modalities in the elderly patients are discussed.

Keywords Vascular access · Elderly · Arteriovenous fistula · Arteriovenous graft · Central venous catheter

Introduction

People aged over 65 years are increasing worldwide, and it is predicted that over the next few decades the number of people over 65 years will increase by a factor of three [1]. It is estimated that almost half of 65–74 year-olds have five or more chronic health conditions, and this may reach 70 % once individuals are aged over 85 years [1]. As nephrologists, we are facing increasing numbers of elderly patients affected by chronic kidney disease (CKD) and a high

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prevalence of comorbidities such as diabetes mellitus, peripheral vascular disease, hypertension and congestive heart failure. Between 1982 and 2000, the greatest growth in incident hemodialysis (HD) patients was in those older than 65 years [2]. The 2012 Annual Report of the European Renal Association–European Dialysis and Transplant Association (ERA–EDTA) registry shows that patients aged 65–74 years and >75 years represent, respectively, 22 and 20 % of the total prevalent renal replacement therapy population [3]. The clinical practical guidelines for the evaluation and management of CKD recently published by the Kidney Disease Initiative Global Outcomes (KDIGO) provide only minimal recommendations targeted to the elderly [4]; in addition, renal replacement therapy in elderly patients raises several critical questions concerning life expectancy, quality of life, and other moral, ethical, financial, social, and legal issues [5].

Arteriovenous fistulas (AVFs) are recommended by many national clinical guidelines as the vascular access (VA) of choice in HD patients; however, there is concern about whether general guidelines also apply to the elderly population [6], and suggestions have been made on how to modify the recommendations for VA choice in these patients [7]. In fact, VA planning in the elderly is different from that in younger patients, and the Fistula First Initiative may not be the preferred approach for older patients because of their reduced life expectancy and conflicting results after surgery [8]. Although AVF may be superior to arteriovenous graft (AVG) and central venous catheter (CVC) in all age groups, including the elderly, many elderly patients have a heavy burden of comorbidities and insufficient vasculature for fistula maturation, resulting in a reduced rate of AVF patency [9]. Patients over 65 years have a fistula failure rate double that of younger patients [10]; furthermore, many fistulas will never be used due to the competing risk of death before dialysis initiation in this group [11]. Unsuccessful fistula placement results in a high incidence of CVC use at start of HD treatment, with significant risks and complications such as bacteremia and thrombosis [12]. However, the rate of bloodstream infections in older patients may be significantly less than in younger patients [13]. Data on AVG in the elderly are conflicting. Some studies advocate the use of AVF rather than AVG and provide evidence that in elderly patients autogenous VA may have a patency rate similar to that of younger patients [14]. In contrast, other data support the opposite strategy of 'AVG first' in octogenarians and show a higher risk of death before the start of dialysis with AVF than with AVG [15]. Patient survival is strongly influenced by important factors, such as nutritional status, pre-dialysis nephrology care, cardiovascular disease, and most importantly the VA. Nephrologists should strive for the most appropriate VA if the hope to prolong an enjoyable life span exists. The aim of this position statement is to critically review the current evidence on HD VA in elderly patients. Experts of the Vascular Access Working Group of the Italian Society of Nephrology prepared this position statement in order to discuss the main advantages and potential drawbacks of the different VA modalities in elderly patients.

Timely VA placement in the elderly

A formalized predialysis pathway and timely placement of VA are considered good clinical practice in VA care. Timely preparation and education for dialysis are crucial as they are associated with a number of benefits, including elective dialysis start with access in place, reduction in hospitalizations, higher prevalence of patients choosing a home-based dialysis modality and, in those starting HD, a reduced prevalence of CVC [16]. Older patients lose renal function at slower rates than younger ones, have a lower rate of events of progression to end-stage renal disease (ESRD), and have shorter survival [5]. Elderly patients may be more likely to die before benefiting from an AVF and to experience primary fistula failure with a high incidence of CVC use at HD initiation, which is associated with increased morbidity and mortality [17, 18]. A study has shown that placing an AVF >9 months before starting HD did not improve the success rate but, on the contrary, was associated with an increased number of interventional procedures: from 0.64 procedures/patient for AVFs created 6–9 months predialysis to 0.72 procedures/patient for AVFs created >12 months in advance; hence, placing an AVF >6–9 months predialysis in the elderly is not associated with a better success rate [19]. Despite this, there is a trend to construct AVFs earlier before HD initiation, although it is reported that the time between the referral to a nephrologist and the start of dialysis is 3.5 weeks for individuals >75 years vs. 20.5 weeks for those <75 years [16]. Delaying AVF placement may in fact be better, in that some authors suggest that elderly patients with CKD should be referred later to reduce the risk of creating an AVF that will never be used [20]. In this regard, the AVG becomes a valid alternative form of VA if no suitable anatomy for AVF creation and slow renal progression are present [21]; in such cases, the use of early stick graft might be suitable, because of the high risk of non-maturing autologous AVF [22], even though the mortality benefit of AVG over CVC may not apply in the oldest-old (>89 years) age-group [8]. Life expectancy as well as quality of life are important aspects for most patients considering dialysis, and recent data suggest that if dialysis is adequately prepared for in advance it is safe to delay starting HD until the development of signs and symptoms of uremia [23].

In the context of an intent-to-defer HD treatment strategy, a tunneled CVC could be the best choice, because no maturation time is required. Some authors have supported a generalized use of CVC in older patients [24] and, due to the lower risk of catheter-related bloodstream infections in elderly patients, tunneled CVC may represent a suitable dialysis access option in the setting of non-maturing AVF or poorly functioning synthetic grafts [13]. However, strict protocols for nursing care and proper catheter management need to be implemented [25]. Citrate solution has been suggested as an effective and safe catheter lock in hemodialysis [26]. A systematic review and meta-analysis of 13 randomized controlled trials has shown that an antimicrobial-containing citrate lock is better than a heparin lock in the prevention of catheter-related infection. Citrate locks of low (1.04–4 %) to moderate concentration (4.6–7 %), rather than high concentration, were superior to heparin locks in preventing catheter-related bloodstream infection [27]. In elderly patients, 4 % sodium citrate is a suitable choice of lock solution to maintain patency of tunneled CVC and decrease bleeding episodes.

VA in elderly patients: recent findings

There is currently no general consensus as to the best dialysis VA for elderly patients with ESRD, and debate continues. The elderly have specific health care requirements, as they are at increased risk of comorbidities that may result in frailty and reduced physical and cognitive function; furthermore, they often face complex psychosocial, financial, and transportation issues [28]. The creation and use of a VA in elderly patients requires the complex integration of patient, biological and surgical factors because the VA type might be a key factor influencing their survival [2, 9, 22, 29]. Data from the ERA-EDTA registry show that the likelihood of being treated with an AVF was 20, 24 and 37 % lower in the three oldest patient age-groups (60–69, 70–79 and >80 years) when compared to patients aged 22–44 years [30]. The advantages and disadvantages of each form of access may vary depending on the timing of the access placement relative to dialysis initiation [12]. A summary of the recommendations and suggestions from recently published studies on VA in the elderly are reported in Table 1. Many studies clearly demonstrate a high rate of technical feasibility of fistula construction in the elderly [8, 31–33] and age alone should not disqualify patients older than 80 years from access surgery [14, 34]. Nevertheless, it has been shown that in patients aged 67 years or older, only 50.7 % of those with AVF placement initiated dialysis using the AVF, and 43.4 % started with a CVC; in contrast, among patients that received a graft as first access only 25.4 % started dialysis with a CVC; in other words, patients who receive a graft are less likely to require a catheter at first HD treatment compared to those who receive a fistula [15]. In a retrospective cohort study addressing the early failure of dialysis access in the elderly, it has been shown that AVF is associated with a lower mortality rate than AVG in the first 12 months after creation. However, the incidence of repeat AVF/AVG creation and CVC placement is substantially higher in the first 12 months after AVF creation compared to AVG [35]. Although grafts require more procedures to *maintain* patency, fistulas require more procedures to *establish* patency, with the result that overall patency may not differ substantially between the two forms of permanent access [36]. Due to the high primary failure rate and need for multiple procedures to maintain patency with a poor patient quality of life, the eligibility in elderly patients should be carefully determined [37, 38]. However, in skilled hands the endovascular treatment of AVF complications appears to be a valuable approach even in nonagenarians in view of its low invasiveness, low complication rate, and relatively good long-term patency rate [39]. Furthermore, a recent analysis from USRDS data between 2005 and 2007 on the apparent survival advantage of AVFs, after adjustment for health status, suggests that AVF should still be the VA of choice for elderly individuals beginning HD, until more definitive findings eliminating selection bias become available [40]. The benefits of an AVF over AVG only become evident when the use or expected use of the AVF is >18 months, suggesting that patients with a life expectancy of less than 18 months do not experience the benefit of the longer patency expected from AVF placement [41]. A recent decision analysis on the VA choice in incident HD patients provided evidence that the AVF attempt strategy is superior to AVG and CVC with regard to mortality and cost for the majority of patient characteristic combinations; on the contrary, in women with diabetes and elderly men with diabetes the outcomes are similar, regardless of access type. The advantages of an AVF attempt strategy significantly diminish among older patients, in particular in women with diabetes [42]. In fact, in a survey of European experts exploring barriers to the 'fistula first' concept, less than a third of the respondents believed that the majority of nephrologists in their country would consider AVF creation in a 75-year-old woman with comorbidities [43]. The VA-related outcomes may be optimized by considering individual patient characteristics, and a patient-based approach is recommended [44].

Surgical strategy in elderly patients

Vessel mapping has been highly encouraged and current international guidelines support the routine use of color-Doppler Ultrasound (CD-US) before AVF surgery [26, 45]

Table 1 Summary of the recommendations and suggestions from studies on vascular access in the elderly

Author, Journal, Year of publication, and Country	Study design	Patient characteristics	Intervention comparator	Outcomes	Results	Notes
Azevedo, Sem Dial, 2015, France	Retrospective on prospectively collected data	Nonagenarians = 38 patients, mean age 93.9 years	Only AVF, mostly radio-cephalic ($n = 30$)	PPR and SPR after endovascular treatment of upper limb AVF (stenosis or thrombosis)	PPR = 60 and 43 % at 1 and 2 years; SPR = 95 and 92 % at 1 and 2 years	Endovascular treatment is a valuable approach in nonagenarian patients
Bonforte, JVA, 2000, Italy	Retrospective	198 patients >65 years	Toledo-Pereira, snuff-box, wrist AVF	Primary survival	Best outcome from proximal radial AVF (Toledo-Pereira) in spite of comorbidities	Toledo-Pereira AVF suggested as first access option in the elderly
Borzumati, JVA, 2013, Italy	Retrospective	78 patients mean age 82.5 years		Survival and complication rate for distal, mid arm, proximal AVF	Overall survival 76 and 71 % at 12 and 24 months for AVF	Choice of distal AVF if possible in the elderly AVF is gold standard in both elderly and younger patients
Chang, Sem Dial, 2011, USA	Retrospective USRDS Wave II	764 patients >65 years	AVF vs. AVG diabetics vs. non diabetics	Mortality and intervention referral	No mortality differences AVF vs. AVG, for intervention referral for diabetics and non diabetics	Potential benefits derived from AVF compared to AVG and CVC may not apply universally
Cloudeanos, Ann Vasc Surg, 2015, USA	Retrospective	31 patients, mean age 82 years	32 AVF	PPR, SPR at 1 and 2 years	PPR = 51 and 38 % at 1 and 2 years SPR = 75 % at 1 and 2 years High level of reintervention to maintain patency, high use of CVC Poor survival	Doubts on advantages of AVF in the elderly
De Leur, Vasc Endovsc Surg, 2013, Netherlands	Retrospective	107 AVF in 90 patients, aged 75 years or older	65 RCF vs. 42 BCF	PPR and SPR, QOL	PPR for RCF at 1 year = 31 %, at 2 years = 22 % SPR for RCF at 1 = 58 %, at 2 years = 50 % PPR for BCF at 1 and 2 years = 52 and 41 % SPR for BCF at 1 and 2 years = 70 and 57 %	Significant benefit in creating proximal access QOL high despite a high mortality rate
DeSilva, JASN, 2013, USA	Prospective cohort study	115,425 Incident HD patients Age: 76.9 ± 6.4 years Gender: 52.9 % male	Fistula graft catheter	Mortality	HR: 1.77 CVC vs. AVF ($p < 0.001$) HR: 1.05 Graft vs. Fistula ($p = 0.06$)	Fistula was not superior to graft
Hicks, J Vasc Surg, 2015, USA	Retrospective	507791 patients on USRDS 2006–2010	Age group	Mortality	AVF is superior to AVG and CVC regardless of the patient's age, including in octogenarians	Mortality benefit of AVG over CVC may not apply in older (>89 years) age-groups

Table 1 continued

Author, Journal, Year of publication, and Country	Study design	Patient characteristics	Intervention comparator	Outcomes	Results	Notes
Hod, JASN, 2014, USA	Retrospective	17511 patients mean age 76.1 years at the initiation of HD	AVF success group (success) vs. AVG + CVC group (failure)	AVF success initiation of HD using the AVF initially placed, regardless of the functionality and durability	Placing an AVF 6–9 months predialysis in the elderly may not be associated to a better AVF success rate	Success rate AVF use increased as time between creation and HD initiation increased (but not >9 months)
Lazarides, J Vasc Surg, 2007, Greece	Meta analysis	Ten studies: 1171 non elderly and 670 elderly Only five studies with PPR and SPR Elderly >65 years	Patency rate distal vs. proximal AVF or graft	Distal AV: elderly vs. non elderly Distal access in elderly vs. proximal or graft	More risk of failure in distal access in elderly Significant benefit in creating proximal access	A more liberal use of proximal access types may be justified
Murea, CJASN, 2014, USA	Retrospective 2005–2007	464 patients with tCVC:374 non elderly (18–74 years) and 90 elderly (≥75 years)	Risk of CVC infection in age group	Rate of catheter-related bloodstream infection (tCVC)	Hazard ratio = 0.33 for catheter-related bloodstream infection in the elderly	Lower risk of catheter-related bloodstream infection in elderly than younger patients
Nadeau-Fredette, Hemodial Int, 2013, Canadian	Retrospective 2005–2008	55 patients aged >80 years vs. 57 patients 50–60 years	AVF and AVG	Primary Failure (PF) Primary and secondary patency	PF older 40 % vs. 17 % younger patients. PPR similar. Secondary patency shorter in elderly patients ($p = 0.005$)	Need of a careful selection and evaluation in elderly prior to referral Patient-based approach recommended
Olsha, J. Vasc Surg, 2015, Israel	Retrospective study 2005–2009	146 access in 134 incident and prevalent HD patients Age: 85 ± 2.9 years Gender: 66 % male	128 AVF 18 AVG Forearm, upper arm AVF, AVG	Patency rate, non-maturation rate	PPR 39, 33, and 23 % at 12, 24, and 36 months SPR 92, 83, and 77 % at 12, 24, and 36 months No difference between the different types of access.	Age alone should not disqualify patients older than 80 years from access surgery
Swindlehurst, J. Vasc Surg, 2011, UK	Retrospective on prospectively collected data (6 years) first AV attempt	246 patients >65 years (Group A) 89 patients <65 years (Group B)	AVF and AVG	PP, APP, SP, ACPR, death with functioning conduit, mean conduit survival, failure to mature	Patency rates for different types of conduits were similar between the two groups. Failure to mature >elderly AVG higher cumulative patency in group A	AVF in elderly possible with high patency rate, short hospital stay and low revision rate
Vachharajani, CJASN, 2011, USA	Retrospective	37 Incident HD patients Age: 83.4 ± 3.4 years Gender: 64 % male	Facility HD Home HD	Day HD before death Facility vs home	52 ± 14 vs. 386 ± 90 days ($p < 0.05$).	Functional status and life expectancy should be assessed

Table 1 continued

Author, Journal, Year of publication, and Country	Study design	Patient characteristics	Intervention comparator	Outcomes	Results	Notes
Weale, J. Vasc Surg, 2008, UK	Retrospective	658 patients Median age 68.5 years	RCAVF BCAVF in age groups: <65, 66–79, >80 years	Usability, primary, secondary patency	Age did not affect usability, primary or secondary patency of either RCAVFs or BCAVFs	High failure rate Disagreement with Lazarides study
Weyde, Blood Purif, 2006, Poland	Retrospectve 1998–2004	131 consecutive HD patients Age 79.1 ± 3.6 years Gender: 50 % male	Only AVF considered (92 % forearm)	Successful surgery Primary and secondary AVF patency Patient survival	Successful AVF: 107/131 patients (82 %) PPR: 70 % at 6 months, 59 % at 12 months SPR: 92 % at 6 months, 84 % at 12 months Patient survival: 94 % at 6 months, 88 % at 12 months, 66 % at 3 years, 45 % at 5 years	Possible selection bias. Good patients and AVF survival
Zhang, Hemodial Int, 2014, Canada	Retrospective registry	39.721 incident patients 27 % 65–74 years, 26 % 75–85 years, 5 % >85 years	AV access (AVF and graft) Catheters	Mortality by vascular access and age category	Lower adjusted mortality compared with catheter use in each age category	Understand patient preference, complications, and resource use

AVF arteriovenous fistula, *AVG* arteriovenous graft, *CVC* central venous catheter, *PPR* primary patency rate, *SPR* secondary patency rate, *RCF* radiocephalic fistula, *BCF* brachiocephalic fistula, *QOL* quality of life, *PP* primary patency, *APP* assisted primary patency, *SP* secondary patency, *ACPR* assisted cumulative patency rate, *PF* primary failure

and, especially in the elderly, US examination can help to select the optimal location for the AV anastomosis. The available evidence suggests that the pre-operative clinical examination should always be supplemented with routine CD-US mapping before AVF creation. This policy avoids negative surgical explorations and significantly reduces the immediate AVF failure rate [46]. Venography and central vein evaluation should always be performed in patients known to have a previous catheter or pacemaker [44]. Several authors have highlighted the problem of early failure, which may span from 20 to 60 % [47]. A recent meta-analysis examining studies from 2000 to 2012 reported a primary failure rate (defined as non usable AVF for dialysis up to 6 months post creation) of 23 % [48]. A scoring system has been developed with the ability to predict the likelihood of failure to mature based on the patient clinical profile including factors such as age (>65 years), coronary artery disease, peripheral vascular disease and race [10]; however, elderly patients have a higher fistula failure rate [49], and the combination of age and diabetes impairs fistula outcome with significantly higher failure rates of up to 42 % [26]. A recent cohort study on the factors predicting failure of the AV 'fistula first' policy in the elderly demonstrated that there is an association of older age, female gender, black race, diabetes, cardiac failure, shorter pre-ESRD nephrology care and predialysis AVF failure, suggesting that the rate of AVF failure increases by 1 % for every year above the age of 67 years [50]. The aging incident ESRD population might require different strategies in order to minimize the risk of failure and the number of surgical procedures. A recent meta-analysis showed a significant higher rate of radial-cephalic AVF failure in the elderly compared to younger patients, with a pooled effect in favor of the elbow fistula [49]. The elbow fistula created at the origin of the radial artery is an efficient primary choice in elderly patients, and has a higher survival rate compared to wrist and snuff-box AVFs [31, 51]. In this regard, the bend of the elbow area is of great strategic interest for VA surgery. Arteries of adequate size and less affected by atherosclerotic processes, the venous network connecting the forearm and the arm, and presence of a patent perforating vein of the elbow allow the surgeon great flexibility in the type of AVF to construct. The perforating vein fistula may be preferred in elderly patients with diabetes and hypertension [52]. Thus, in elderly patients conservation of proximal access sites might be of lesser importance due to their limited life expectancy, and a more liberal use of proximal access types may be justified [49]. However, especially in the elderly, a VA conundrum does exist, as the distal VA more likely results in lower access blood flow and high incidence of early failure, although it has been demonstrated that the use of microsurgery enabled the creation of distal AVFs in elderly patients aged >70 years with an acceptable risk of failure [53]; on the other hand, the proximal VA more likely results in very high access blood flow, increasing the risk of steal syndrome and congestive heart failure.

An Italian perspective

Although there is not an Italian model of dialysis access creation, the arteriovenous access surgery has traditionally been performed by nephrologists with little involvement of surgeons [54]. A knowledge of the different surgical techniques [53] is helpful in making the nephrologist a more active proponent of AVF creation. As demonstrated in a recent Italian survey, AVF still remains the dialysis access with highest prevalence also in older patients, with an excellent survival rate [55]. Again, the Italian data from the DOPPS study confirm the high rate of AVFs both in the prevalent and, more importantly, in incident patients [56]. In Italy, among patients with 4 or more months pre-ESRD care prior to starting chronic hemodialysis, 71 % had AV access. This indicates that the health service structure and organization may influence the delivery of vascular access care; for example, multiple centers sharing the services of a vascular access healthcare team reduces the waiting time for surgical creation. The overall attitudes towards native AVF as the preferred vascular access may partly explain the lower rate of AVG (7 % in prevalent patients). However, the complexity of AVF and AVG surgery with the aging of the dialysis population may explain the increase of tunneled catheters (25 % in prevalent patients).

Conclusions

It is well known that observational studies that established the superiority of fistulas have important limitations and a randomized study comparing mortality with different access strategies is very difficult to plan. The risk of biases in studies comparing clinical outcomes by HD access type is substantial [57], especially when elderly patients are included. To provide an optimal VA option in elderly people a semantic paradigm shift has been recently suggested: it should address comorbidity as the main subject line, and then age becomes one of the many covariates, instead of an independent risk factor for mortality [58]. Age should not be a limiting factor when determining candidacy for AVF creation [59].

In conclusion, due to the heterogeneity in life expectancy, health status, health priorities, and illness experiences of the elderly that could be difficult to estimate, no approach to VA can be expected to meet the needs of all

Table 2 VA advantages and disadvantages in the elderly

	Advantages	Disadvantages
Pre-emptive AVF	No age limit for this procedure with adequate vessels	Competing risk of death before HD start
	Lower infection rates compared to CVC and AVG	Higher rates of failure to mature compared to AVG
	Better survival (?)	More AVFs created than used (increased morbidity and costs)
	Patients can shower	
AVF after dialysis start	Surgery as needed	Start of dialysis with a CVC
	Most functioning AVF will be used	Higher AVF dysfunction and infection rates compared to pre-emptive AVF
	Advantages of pre-emptive AVF are maintained, but CVC is needed	Higher rates of failure to mature compared to AVG
		With low mean survival, actual AVF utilization may be short
AVG	Short timing from procedure to use (days–weeks)	Higher cost
	Lower infection rates compared to CVC	Needs accurate maintenance with interventional procedures
CVC	Quick and easy procedure	Increased infection rates, carrying higher morbidity and mortality
	No needle punctures	
	Higher patient preference	

older adults with advanced kidney disease. Moreover, among priorities for optimizing AV decision-making, strong patient preferences regarding access type and site, and management of access infection have emerged as most important [60]. A collaborative decision-making process around VA for hemodialysis should always be explored. In this context, our opinion is that a multidisciplinary team should carefully assess elderly patients starting on dialysis, in order to identify the most appropriate VA. In these circumstances, we believe that dialysis VA selection in the elderly should be guided by the patient's preference and surgeon's experience, based on comprehensive, balanced and unbiased information, including the relative advantages and disadvantages (Table 2), adopting an individualized approach that strives to achieve the best outcomes regardless of age.

Compliance with ethical standards

Ethical standards The research does not involve human participants or animals.
Informed consent is not required.

Conflict of interest The authors have no conflict of interest to declare.

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