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Age, Knowledge, Preferences, and Risk Tolerance for Invasive Cardiac Care

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Abstract

BACKGROUND/OBJECTIVES: The extent to which individual knowledge, preferences, and priorities explain lower use of invasive cardiac care among older vs. younger adults presenting with acute coronary syndrome (ACS) is unknown. We directly surveyed a group of patients to ascertain their preferences and priorities for invasive cardiovascular care.

DESIGN: We performed a prospective cohort study of adults hospitalized with ACS. We surveyed participants regarding their knowledge, preferences, goals, and concerns for cardiac care, as well as their risk tolerance for coronary artery bypass grafting (CABG).

SETTING: Single academic medical center.

PARTICIPANTS: 628 participants (373 <75 years old; 255 ≥75 years old).

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Author Contributions

MG Nanna: Dr. Nanna had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Dr. Nanna contributed to the data analysis, the data interpretation, the manuscript drafting, and the critical revision of the manuscript.

ED Peterson: Dr. Peterson contributed to the conception and design of the study, the supervision, the data acquisition, the data analysis, the data interpretation, the manuscript drafting, and the critical revision of the manuscript.

A Wu: Ms. Wu contributed to the data analysis, the data interpretation, the manuscript drafting, and the critical revision of the manuscript.

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KP Alexander: Dr. Alexander contributed to the conception and design of the study, the supervision, the data acquisition, the data analysis, the data interpretation, the manuscript drafting, and the critical revision of the manuscript.

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MEASUREMENTS: We compared baseline characteristics, knowledge, priorities, and risk tolerance for care across age strata. We also assessed pairwise differences with 95% confidence intervals (CI) between age groups for key variables of interest.

RESULTS: Compared with younger patients, older participants had less knowledge of invasive care; were less willing to consider cardiac catheterization (difference between 75–84 and <65 years old: –7.8%, 95% CI: –14.4%, –1.3%; for 85 vs. <65: –15.7%, 95% CI: –29.8%, –1.6%), percutaneous coronary intervention (difference between 75–84 and <65 years old: –12.8%, 95% CI: –20.8%, –4.8%; for 85 vs. <65: –24.8%, 95% CI: –41.2%, –8.5%), and CABG (difference between 75–84 and <65 years old: –19.0%, 95% CI: –28.2%, –9.9%; for 85 vs. <65: –39.1%, 95% CI: –56.0%, –22.2%); and were more risk averse for CABG surgery ($p<0.001$), albeit with substantial inter-individual variability and individual outliers. Many patients who stated they were not initially willing to undergo an invasive cardiovascular procedure actually ended up undergoing the procedure (49% for cardiac catheterization and 22% for PCI or CABG).

CONCLUSION: Age influences treatment goals and willingness to consider invasive cardiac care, as well as risk tolerance for CABG. Individuals' willingness to undergo invasive cardiovascular procedures loosely corresponds with whether that procedure is performed after discussion with the care team.

Keywords

older adults; invasive cardiac care; patient preferences; surgery

INTRODUCTION

High quality evidence supports survival,¹ quality of life,² and functional status benefits from revascularization^{3,4} in patients with acute coronary syndrome (ACS), but older adults remain less likely than younger adults to be treated with an invasive strategy.^{5–7} Major efforts to improve awareness and close gaps in care for older adults with ACS have been successful.^{8–13} Even with substantial progress, gaps in evidence-based invasive care persist, including differential use of coronary angiography and revascularization.^{6,7,10} Guidelines encourage an individualized approach to evidence-based care for older adults, given limited representation in the evidence particularly for patients with advanced age, multiple chronic conditions, or frailty.^{14–18} Data to inform the care of this complex population are lacking, making decisions more nuanced and magnifying the importance of incorporating individual patient preferences into shared decision-making.^{19,20}

Despite the important role of individual preferences for care, there has been no systematic study of the knowledge, beliefs, and preferences among older patients prior to invasive cardiovascular procedures and how age influences these preferences. Also, a quantitative assessment of risk tolerance for invasive care has not been published. Additionally, the relationship between the priorities and concerns a patient brings to a decision and actual treatment remains unclear. As a result, we sought to systematically investigate whether older adults consider risks and benefits of invasive procedures differently than younger adults. Specifically, we set out to examine the role age plays in the: 1) knowledge, preferences, goals, and concerns for cardiac care; 2) risk tolerance for coronary artery bypass grafting

(CABG) surgery; and 3) whether willingness to consider catheterization, percutaneous coronary intervention (PCI), or CABG, corresponds with actual utilization of the procedure.

METHODS

We performed a single-center study to directly ascertain the patient-reported preferences, goals and concerns around decisions to undergo invasive cardiovascular care which provide the context for decision-making in older adults. We prospectively surveyed 628 participants (373 age <75 years, and 255 age ≥75 years) admitted to Duke University Medical Center from August 2000 to July 2001 on their priorities and risk tolerance for cardiac care. Inclusion criteria were >45 years of age admitted for ACS, defined as chest pain with either positive cardiac enzymes, stress test, or electrocardiogram (EKG) changes. All patients were stable patients on the wards; patients with STEMI were excluded. Exclusion criteria were prior CABG or PCI within the preceding 6 months, cardiac catheterization within the preceding 3 months, primary congenital or valvular heart disease, dementia, terminal illness with prognosis of less than 1 year, or inability to provide informed consent. Informed consent was obtained in all patients prior to the survey administration. The Duke Institutional Review Board approved this study.

We abstracted baseline demographics and clinical characteristics from chart review and interviewed all participants prior to discussion of treatment and possible cardiac catheterization to ascertain their knowledge. This was done by two study coordinators using a survey and standard gamble instrument. This study coordinators followed a script to ensure consistency in approaching participants. The survey included assessments of quality of life, as well as prior knowledge and willingness to consider invasive care (cardiac catheterization, PCI, or CABG) if recommended by their clinician. Knowledge of cardiac catheterization, PCI, or CABG, respectively, was defined as responding “Yes” to any of the following: 1) having had that procedure previously; 2) having a family member, friend, or acquaintance who underwent that procedure; or 3) having received information or a description of that procedure during their hospital stay. Willingness to consider cardiac catheterization, PCI, or CABG, respectively, was defined as responding “Definitely Yes” or “Probably Yes” to the question of whether they would consider those procedures if their doctor recommended them. General health status was assessed using the Short Form 36 Health Survey (SF-36) instrument.²¹ The SF-36 provides a physical and mental component summary score using a norm-based scoring system standardized to a mean (standard deviation) of 50 (10), with higher scores indicating better health status. We asked participants about the role of age in treatment decisions, and to rank their top three goals (choosing from: lengthen life, relieve symptoms, maintain independence, maintain mental acuity, and prevent heart attack), as well as their top three concerns for care (choosing from: loss of independence, burden on others, cost of care, long hospital stay, loss of physical strength/ability, loss of mental capacity, and dying). Responses were summarized in heat maps to represent commonly selected goals or concerns across age groups. We counted participants willing to consider CABG if they responded “Definitely Yes” or “Probably Yes” to the question, “If your doctor recommended that you have CABG surgery to improve the blood flow to your heart, would you consider doing so?” We asked participants to state their preference if they had to choose between quality and quantity of life. We asked if age should be an important component in their

treatment decisions and if there was an age at which they would decline CABG surgery. Participants also answered questions about how religious (scale 1–4), optimistic (scale 1–5), and satisfied with life they are.^{22–24}

We used a standard gamble to assess risk tolerance for CABG surgery. The standard gamble is a hypothetical scenario comparing treatment with medical therapy or CABG surgery, which has a varying risk of operative mortality (Supplementary Material). Participants were asked to choose between medical therapy and CABG surgery in scenarios where operative mortality associated with CABG surgery changed, alternating from high (e.g., 90%) to low (e.g., 2%), from each extreme progressing towards the middle. The highest risk prior to the participant changing preference away from CABG is their tolerated risk of CABG mortality. Laminated pie chart illustrations supported the standard gamble assessment that was also performed by a single coordinator. We collected catheterization, revascularization, and survival through 30 days of baseline assessment.

All baseline characteristics and survey responses are stratified by four age groups (<65, 65–74, 75–84, and ≥85 years). Categorical variables are shown as percentages and tested with chi-square tests. Continuous variables are shown as medians and interquartile ranges and tested with Kruskal-Wallis tests. We evaluated the association between willingness to consider catheterization, PCI, CABG, or revascularization (PCI or CABG), as well as the respective procedural outcomes, using chi-square tests. In addition, we assessed pairwise differences in frequencies for categorical variables and least squared means for continuous variables with corresponding 95% confidence intervals (CIs) between older age groups (65–74, 75–84, and ≥85 years old) compared with the <65 group. Specifically, we assessed pairwise differences for physical component score, knowledge of cardiac catheterization, PCI, & CABG, willingness to consider cardiac catheterization, PCI & CABG, age as an important consideration in decisions, and the age beyond which you would refuse CABG. A test of linear trend in standard gamble scores was performed across age groups (<65, 65–74, 75–84, ≥85). Finally, we reported rates of cardiac catheterization, PCI, CABG, and all-cause mortality within 30 days by age group. We used logistic regression to test the association between age (per 10-year increase) and invasive care, reporting ORs with 95% CIs.

For all comparisons, we used two-sided tests at a nominal significance level of 0.05. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

RESULTS

Baseline Characteristics

Sex, race, education, income, diabetes, peripheral vascular disease, and history of CABG and myocardial infarction differed across age groups (Table 1). Older participants were frequently retired or widowed, while younger participants were frequently married, smokers, or had hyperlipidemia. Quality of life measures differed between the four groups with lower physical function scores in the oldest old (≥85) compared with the <65 group (Table 1; difference between ≥85 and <65: −14.5, 95% CI: −27.6, −1.4). All ages reported high levels of optimism, religiosity, and life satisfaction.

Knowledge, Risk Tolerance, and Willingness to Consider Invasive Care

Knowledge of invasive procedures and willingness to consider an invasive procedure varied across age groups, with consistently lower knowledge of cardiac procedures in the 85 group vs. <65 group (Table 2; difference in cardiac catheterization: -26.6%, 95% CI: -41.7%, -11.5%; for PCI: -22.2%, 95% CI: -39.3%, -5.1%; for CABG: -20.0%, 95% CI: -36.6%, -3.4%). Willingness to consider cardiac catheterization ($p=0.02$), PCI ($p<0.001$), and CABG ($p<0.001$) all differed significantly by age. Compared with younger participants (<65 years old), older groups were less willing to consider cardiac catheterization (difference between 75–84 and <65 years old: -7.8%, 95% CI: -14.4%, -1.3%; for 85 vs. <65: -15.7%, 95% CI: -29.8%, -1.6%), percutaneous coronary intervention (difference between 75–84 and <65 years old: -12.8%, 95% CI: -20.8%, -4.8%; for 85 vs. <65: -24.8%, 95% CI: -41.2%, -8.5%), and CABG (difference between 75–84 and <65 years old: -19.0%, 95% CI: -28.2%, -9.9%; for 85 vs. <65: -39.1%, 95% CI: -56.0%, -22.2%). Still, a majority of those 75–84 years of age (84.2%) and 85 years of age (76.3%) were willing to consider cardiac catheterization. Older persons frequently place importance on age in making treatment decisions (97.2% of 85 year olds vs. 81.7% of 75–84 year olds vs. 73.2% of 65–74 year olds vs. 62.9% of <65 year olds; $p<0.001$). Of those who thought there was an age beyond which they would not have CABG, the reported age limit was higher among participants in the highest two age groups compared with those <65 years old (Table 2; difference between 75–84 and <65 years old: 6.7 years, 95% CI: 2.8, 10.7; for 85 vs. <65: 10.9 years, 95% CI: 5.0, 16.8). Older age was associated with a lower risk tolerance for surgery, as evidenced by lower standard gamble scores (Figure 1, Table 2). Participants younger than 65 years reported a median risk tolerance for CABG mortality of 20% compared to 1% among those 85 years of age. A test of linear trend in standard gamble scores across age groups (<65, 65–74, 75–84, 85; $p\text{-value}<0.0001$) was significant, with an average decrease of 8.2% (standard error=1.2) mortality risk tolerance from CABG mortality per increase in age group. The presence of outliers in the 75–84 and 85+ age groups suggests individual response variation (Figure 1). Ten percent of participants (64/628) were missing their standard gamble score.

Goals and Concerns from Cardiac Care

Heat maps illustrate the frequency of goal and concern selections across age groups (Figure 2). Goals that were very infrequently selected by our population (“Increase my energy level” and “Avoid financial burdens”) were excluded for display purposes. Twenty-three percent of participants were missing primary goals data and 22% of participants were missing primary concerns data. Participants of all age groups had a top goal of preventing a heart attack; however, those 85 years of age (29%) prioritized symptom relief, while those <65 years of age (35%) prioritized preserving life in the years to come (Figure 2A). Death was the most frequently prioritized concern from cardiac care (Figure 2B), but for those 85 years of age, losing mental capacity was the top concern. Despite these age-related patterns of priorities and concerns, some individuals selected priorities and concerns that were atypical for their age strata. For example, 9.9% of individuals <65 years prioritized symptom relief, while 24.9% of patients 75–84 years prioritized preserving life in the years to come.

Of the 411 patients who indicated that they would undergo cardiac catheterization, 338 (82.2%) received the procedure within 30 days. Of the 49 patients who indicated that they would not consider it, 24 (49.0%) received the procedure within 30 days. The proportion of patients who received cardiac catheterization differed significantly based on whether they would consider receiving catheterization (p-value <0.0001). We did not observe a difference in the proportion of patients undergoing PCI, CABG, or revascularization between those willing and not willing to consider the procedure (Table 3). Older age was associated with significantly lower odds of cardiac catheterization (OR 0.79, CI 0.65–0.97 per 10-year increase in age), but not PCI (OR 0.98, CI 0.82–1.18), CABG (OR 1.00, CI 0.78–1.29), or any revascularization (OR 0.95, CI 0.82–1.10) through 30 days. By 30 days, there were 4 deaths: one person <75 years of age and three people ≥75 years.

DISCUSSION

Our study illustrates the role advanced age plays on patient knowledge and risk tolerance, as well as concerns and priorities of cardiovascular care, at the time of ACS hospitalization. When making decisions for invasive care, we observed that participants of older ages prioritized symptom relief, and had less risk tolerance for CABG mortality, yet the vast majority are willing to consider procedures if recommended, irrespective of age. Older adults also prioritized quality of life more often than quantity of life and chose mental functioning as a top goal. This was in comparison to younger participants who focused on long-term survival, even if that meant accepting a surprisingly high risk of death with procedures. We illustrate strong age trends in risk, priorities, and concerns, but these are as notable as the persisting variation among like-aged individuals across the age range. Also many patients who initially were not willing to undergo an invasive cardiovascular procedure ended up having one. Therefore, understanding the role of age in the decision-making process enables discussions to include the range of valued outcomes.

We demonstrate that older age corresponds with prioritization of different goals and concerns for invasive cardiovascular care. Given modern medicine's emphasis on moving away from disease-based care towards priority-directed care in older adults with multiple chronic conditions,^{25,26} it is important to understand what drives a patient's willingness to undergo potentially life-saving interventions; understanding these influences leads to more effective patient-clinician discussions. Prior studies have investigated preferences related to potential harms of cardiovascular disease treatment,^{27,28} though none have directly compared preferences between older and younger adults. Optimal cardiovascular care in older adults should align with priorities of care.²⁹ The American College of Cardiology/American Heart Association guidelines for non-ST-segment myocardial infarction also emphasize quality of life and patient preferences when considering treatment, specifically recommending that clinicians, "Undertake patient-centered management for older patients, considering patient preferences/goals, comorbidities, functional and cognitive status, and life expectancy" (Class I, Level of Evidence B).^{18,25,26} Variability in prioritization for health outcomes makes individual assessment necessary. For example, patients with chronic stable angina demonstrate fluctuations in their willingness to tolerate symptoms, assigning a range of health utilities to the same Canadian Cardiovascular Society Angina Grading Scale.³⁰ While 30% of patients older than 65 years of age would "rather die" than live in a skilled

nursing facility, 26% report being very or somewhat willing.³¹ Patients with atrial fibrillation also vary in their preferences for warfarin use to reduce the risk of stroke across a variety of stroke risk estimates, at times exceeding commonly held guideline thresholds for warfarin initiation.³² Clinical care has yet to effectively incorporate preferences in an evidence-based or systematic construct, yet clinicians engage patients in discussions about choices. Patients are more likely to respond to choices framed around specific functional and health outcomes (i.e., something they are familiar with), rather than options for specific treatments or procedures.³³ Therefore, the most informative results came from patients ranking their priorities and concerns, even if many were willing to consider a recommended procedure. Older adults prioritize avoiding loss more than accruing gains, and may choose a less advantageous option if larger losses can be avoided.³⁴ The decline in risk tolerance with surgery on the standard gamble option reflects this concept: Older adults prefer to keep the hand they have been dealt, rather than risking it for an uncertain future state of health.

Knowledge and educational attainment are another dimension of medical decision-making. Older adults were less willing to consider procedures in all three procedural categories of cardiac catheterization, PCI, and CABG. Despite being somewhat less knowledgeable about medical procedures, the majority of those 75 years of age knew about invasive cardiovascular care and were willing to consider it. A procedural knowledge deficit independently influenced decisions. With that said, the knowledge, perceptions and risk tolerance that drive decision-making about a given procedure may change following a patient's interaction with their physician. In fact, nearly half of the patients who initially indicated that they would not consider cardiac catheterization eventually underwent that procedure. In the same vein, nearly a quarter of patients who replied that they would not consider PCI or CABG actually ended up undergoing PCI or CABG. On one hand, we are optimistic that this may reflect productive patient-centered discussions with individuals and their families to more effectively convey the risks and benefits of procedures and align the patient's goals of care with that of the care team. On the other hand, if this observation is partially explained by a failure to incorporate individual patient preferences into decision-making, this is suboptimal. Ultimately this emphasizes the importance of a comprehensive risk-benefit discussion with the care team to help guide patients' decisions to pursue invasive care, even when they are apprehensive about the procedure at the outset, while also supporting the decision to decline an invasive procedure when it does not align with that patient's individual preferences. Decision support should address knowledge gaps and care goals for patients of all ages; with this in mind, the Patient-Reported Preferences Affecting Revascularization Decisions (PREPARED) study developed and tested a decision aid for coronary artery disease.³⁵ Future efforts should focus on education, particularly in older adults who may lack sufficient knowledge and benefit from specific attention during the patient-physician interaction.

While we identified lower risk tolerance among older adults for invasive care, we also observed substantial individual variability. Prior studies have demonstrated differences in risk awareness of cardiovascular disease and risk perception as a function of age.³⁶ On the standard gamble, participants younger than 65 years were willing to accept up to a median of 20% mortality risk from surgery (if surgery was recommended) compared with 1% among those 85 years of age. Treatment selection should focus on those outcomes

important to older adults. Though top goals and concerns tended to change across age strata, there were still individuals of various ages who prioritized different goals and concerns than the majority. For example, some patients 85 years of age listed preserving their life in the years to come as their top goal, while some younger adults (<65) prioritized function over longevity. Prior studies in the non-cardiovascular care literature have suggested that racial minority status and religiosity correlates with preferences for more aggressive care.^{37–40} Anecdotally, individuals who accepted a surprisingly high risk of surgery (i.e., more than 50% likelihood of death in the standard gamble) explained their choice in religious terms. Most participants also responded that age was an important consideration in their decision, but the specific age where they would decline CABG increased for each older age group; this reflects a shift in perspective or reference point in older groups, and does not negate the relevance of age in their decisions. While patterns in patient knowledge, risk tolerance, and priorities provide important insights for clinicians when discussing cardiovascular care with older adults, chronologic age in isolation does not serve as a satisfactory substitute to identify individual preferences.

This study provides insight into the dynamics surrounding age and cardiovascular care decisions but has some limitations. While progress in cardiovascular care may also influence general knowledge and receptivity in years to come, our study assessed goals and concerns that remain crucial to decision-making around invasive care in contemporary practice. The outcomes of patients with ACS are much better, but revascularization options (ie. PCI or CABG) are similar to the early 2000s when this data was collected. We recognize that evolving techniques in invasive care in the oldest patients with ACS may inform future decisions⁴¹, but the hypothetical scenarios for the standard gamble used in our study remain relevant. Furthermore, confirmatory studies across multiple sites and regions would be needed to confirm generalizability of our findings. We listed a number of possible goals and priorities, but no list is comprehensive, and limited choices may have influenced selection. Measures of patient preferences, priorities and concerns in our study are multifaceted, with multiple factors that contribute and significant overlap across categories. For example, willingness to undergo procedures may be influenced by variables that were not ascertained, such as physician trust and decision-making style. While the standard gamble provides insights into patients' risk tolerance from a mortality perspective, the format may be difficult to understand for patients, potentially impacted by factors such as religious beliefs and health literacy, and does not consider risks that older populations weigh in their decisions such as disability, future functional impairments and loss of independence. Moreover, approximately 10% of patients were missing their standard gamble score, which may be related to subject refusal to engage with the instrument. Thus, a more detailed query into how patients weigh these priorities and concerns against each other would provide further guidance for clinicians. While we did not administer any formal assessment of cognitive impairment or delirium, patients with clinical delirium or significant cognitive impairment would have likely been excluded from the study based on their inability to consent. In addition, we did not follow patients long-term to find out outcomes were associated with their invasive cardiac care decisions. Finally, the next step will require gaining a more granular understanding of how older adults decide to undergo invasive cardiac procedures.

In conclusion, individual priorities, preferences, risk tolerance and willingness to undergo invasive procedures varies across age groups. While older adults generally have a lower procedural risk tolerance and place a higher value on symptom relief and quality of life, substantial inter-individual variability persists across all age groups and many patients undergo invasive procedures despite initially not being willing to do so. Subsequent studies to effectively integrate patient preferences regarding invasive care and foster effective discussions with patients and their families for shared decisions are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Impact statement:

Our study is unique in describing the role of patient age in the knowledge, preferences, and priorities for invasive cardiovascular care at the time of hospitalization for acute coronary syndrome. Older participants prioritized physical and mental functioning and quality of life more often than younger participants who focused mostly on survival. Older adults were more risk averse than younger peers when considering CABG surgery, with median risk tolerance of just 1% among individuals 85 years old, yet preferences vary widely within each age group. In addition, a number of patients who were not initially willing to consider invasive procedures ended up undergoing those procedures. While patient age was strongly associated with trends in decision-making preferences and priorities, variation persists at every age making it vital to solicit individual priorities.

Figure 1. Risk Tolerance for CABG Surgery by Age Group

This figure demonstrates the risk tolerance for CABG by age group among individuals recommended for CABG, with risk tolerance quantified by the standard gamble score. Risk tolerance as determined by the standard gamble instrument on the Y-axis of this figure represents the patient-reported tolerated operative mortality risk associated with CABG surgery. The standard gamble results represent the threshold operative risk on a 0–100% scale. P-value for trend for the linear regression model standard gamble score ~ age group is <0.0001. Effect estimate: 8.2 (standard error=1.2); Bottom of the whisker: Q1 (25th percentile) – 1.5*IQR; Bottom of the box: Q1 (25th percentile); Middle of the box: Median (50th percentile); Top of the box: Q3 (75th percentile); Top of the whisker: Q3 (75th percentile) + 1.5*IQR; Squares: outliers, defined as data points beyond the whiskers; +: Mean.

Abbreviations: CABG, coronary artery bypass grafting; IQR, interquartile range; Q, quarter

Figure 2. Top Goals and Concerns for Cardiac Care by Age Group

Heat maps illustrating frequency of responses to: A) top goals (with darker shading indicating a higher percentage of adults selecting that choice as a top goal for cardiac care; a top goal was defined as a patient ranking the goal as #1 in their cardiac care); and B) top concerns for cardiac care by age group (with darker shading indicating a higher percentage of adults selecting that choice as a top concern for cardiac care; a top concern was defined as a patient ranking the concern as their #1 in their cardiac care).

Table 1.**Baseline Characteristics, Knowledge & Preferences by Age Group**

	Age Group				
Characteristic	<65 (N=209)	65–74 (N=164)	75–84 (N=215)	85 (N=40)	p-value
Age, median (IQR), years	56 (51– 60)	71 (68– 73)	79 (77– 81)	87 (86– 90)	
Male	123 (58.9%)	95 (57.9%)	97 (45.1%)	23 (57.5%)	0.018
Race					<.001
White/Caucasian	112 (57.7%)	116 (77.3%)	153 (76.1%)	28 (71.8%)	
African American	59 (30.4%)	28 (18.7%)	31 (15.4%)	10 (25.6%)	
Other	23 (11.9%)	6 (4.0%)	17 (8.5%)	1 (2.6%)	
Marital status					<.001
Married	117 (65.4%)	90 (62.5%)	95 (50.0%)	11 (29.7%)	
Widowed	15 (8.4%)	36 (25.0%)	81 (42.6%)	25 (67.6%)	
Divorced/separated/never married	47 (26.3%)	18 (12.5%)	14 (7.4%)	1 (2.7%)	
Education					0.002
Eighth grade or less/some high school	48 (26.8%)	51 (35.2%)	74 (40.0%)	13 (36.1%)	
High school/GED/technical school/some college	103 (57.5%)	69 (47.6%)	70 (37.8%)	11 (30.6%)	
College graduate/professional degree	28 (15.6%)	25 (17.2%)	41 (22.2%)	12 (33.3%)	
Income					0.027
\$0 – \$19999	61 (38.6%)	55 (47.4%)	88 (57.9%)	13 (46.4%)	
\$20000 – 59999	58 (36.7%)	43 (37.1%)	40 (26.3%)	11 (39.3%)	
\$60000 or greater	39 (24.7%)	18 (15.5%)	24 (15.8%)	4 (14.3%)	
Retired	77 (43.3%)	124 (85.5%)	171 (90.5%)	35 (94.6%)	<.001
Diabetes	59 (28.2%)	60 (37.5%)	60 (27.9%)	5 (12.5%)	0.012
Hypertension	134 (64.1%)	116 (72.0%)	157 (73.0%)	26 (65.0%)	0.175
Smoking	117 (56.0%)	72 (44.7%)	68 (31.8%)	12 (30.0%)	<.001
Hyperlipidemia	116 (55.5%)	100 (62.1%)	93 (43.5%)	15 (38.5%)	<.001
Heart failure	31 (14.8%)	17 (10.6%)	43 (20.0%)	9 (22.5%)	0.056
COPD	25 (12.0%)	28 (17.4%)	29 (13.5%)	8 (20.0%)	0.342
PVD	28 (13.4%)	36 (22.4%)	59 (27.4%)	7 (17.5%)	0.004
Prior cardiac catheterization	56 (26.8%)	50 (31.1%)	72 (33.5%)	12 (30.0%)	0.515
Prior MI	64 (30.6%)	72 (44.7%)	88 (40.9%)	20 (50.0%)	0.013
Prior PCI	35 (16.7%)	37 (23.0%)	34 (15.8%)	3 (7.5%)	0.084
Prior CABG	28 (13.4%)	54 (33.5%)	63 (29.3%)	5 (12.5%)	<.001
Baseline health status and perspectives					
General health (SF-36), median (IQR)	47 (30– 62)	45 (30– 62)	50 (35– 70)	51 (35– 70)	0.400
Physical component score (SF-36), median (IQR)	55 (35– 85)	50 (25– 80)	45 (25– 70)	40 (20– 55)	0.028
Mental component score (SF-36), median (IQR)	68 (48– 80)	72 (56– 84)	72 (52– 84)	74 (60– 84)	0.015
Health utility (1–100), median (IQR)	70 (50– 80)	70 (50– 80)	60 (50– 75)	60 (50– 75)	0.402
Life satisfaction (1–15), median (IQR)	9 (6– 11)	10 (8– 12)	9 (7– 11)	9 (7– 12)	0.205

Characteristic	Age Group				p-value
	<65 (N=209)	65–74 (N=164)	75–84 (N=215)	85 (N=40)	
Optimism (O, VO)	131 (80.4%)	111 (86.0%)	138 (81.2%)	29 (85.3%)	0.568
Religious (R, VR)	147 (84.5%)	126 (90.6%)	171 (94.5%)	31 (86.1%)	0.017

Abbreviations: CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; GED, general education diploma; IQR, interquartile range; PVD, peripheral vascular disease; MI, myocardial infarction; PCI, percutaneous coronary intervention; SF-36, Short Form 36 Health Survey

For physical component score and mental component score of SF-36, higher is better; O, VO=Responded as “Optimistic” or “Very Optimistic”; R, VR=Responded as “Religious” or “Very Religious”.

Percentages were calculated as the percentage of non-missing values for that variable in that age group.

Table 2.**Knowledge and Preferences by Age Group**

	Age Group				
Characteristic	< 65 % (N=209)	65–74 % (N=164)	75–84 % (N=215)	85 % (N=40)	p-value
Knowledge of cardiac catheterization ^a	95.0 (171)	92.5 (135)	92.1 (176)	68.4 (26)	<0.001
Knowledge of PCI	74.9 (134)	74.7 (109)	61.9 (117)	52.6 (20)	0.003
Knowledge of CABG	82.1 (147)	79.5 (116)	84.3 (161)	62.2 (23)	0.017
Willing to consider cardiac catheterization	92.0 (162)	88.9 (128)	84.2 (160)	76.3 (29)	0.021
Willing to consider PCI ^b	87.0 (154)	85.9 (122)	74.2 (141)	62.2 (23)	<0.001
Willing to consider CABG ^b	79.7 (141)	67.4 (95)	60.6 (114)	40.5 (15)	<0.001
Should age be an important consideration in decisions? (% Definitely or Probably Yes)	62.9 (110)	73.2 (101)	81.7 (152)	97.2 (35)	<0.001
Is there an age beyond which you would refuse CABG? (% Definitely or Probably Yes)	48.5 (82)	43.4 (53)	47.8 (77)	66.7 (22)	0.131
If yes, what is that age? years, median (IQR)	76 (70– 80)	80 (75– 85)	84 (80– 85)	88 (85– 91)	<0.001
Would you choose quality over quantity of life if you had to choose? (% Yes)	73.3 (121)	73.4 (94)	82.5 (137)	73.3 (22)	0.164
Standard gamble risk tolerance for CABG mortality; median (IQR) ^c	20 (8– 55)	10 (1– 40)	8 (1– 20)	1(1– 4)	<0.001

Abbreviations: CABG, coronary artery bypass grafting; IQR, interquartile range; PCI, percutaneous coronary intervention

^aKnowledge of cardiac catheterization, PCI, or CABG, respectively, was defined as responding “Yes” to any of the following: 1) having had that procedure previously; 2) having a family member, friend, or acquaintance who underwent that procedure; or 3) having received information or a description of that procedure during their hospital stay.

^bWilling to consider cardiac catheterization, PCI, or CABG, respectively, was defined as responding “Definitely Yes” or “Probably Yes” to the question of whether they would consider those procedures if their doctor recommended them.

^cThe standard gamble results represent the threshold operative risk on a 0–100% scale. Percentages were calculated as the percentage of non-missing values for that variable in that age group.

Table 3:

Frequency of invasive procedures through 30 days stratified by willingness to consider undergoing the specified procedure.

Outcome	Would consider procedure?		p-value ^[1]
	Yes	No	
Cardiac catheterization	338/411 (82.2%)	24/49 (49.0%)	<.0001
PCI	84/380 (22.1%)	13/81 (16.0%)	0.2247
CABG	37/310 (11.9%)	11/148 (7.43%)	0.1412
PCI or CABG	130/471 (27.6%)	35/157 (22.3%)	0.1906

^[1] P-value represents p-value for a chi-squared test of association between willingness to consider a procedure and undergoing the procedure through 30 days.