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Clinical Paper

Angiographic findings and survival in patients undergoing coronary angiography due to sudden cardiac arrest in Western Sweden☆

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ABSTRACT

Aim: Sudden cardiac arrest (SCA) accounts for more than half of all deaths from coronary heart disease. Time to return of spontaneous circulation is the most important determinant of outcome but successful resuscitation also requires percutaneous coronary intervention in selected patients. However, proper selection of patients is difficult. We describe data on angiographic finding and survival from a prospectively followed SCA patient cohort.
Methods: We merged the RIKS-HIA registry (Register of Information and Knowledge about Swedish Heart Intensive Care Admissions) and SCAAR (Swedish Coronary Angiography and Angioplasty Registry) for patients hospitalized in cardiac care units in Western Sweden between January 2005 and March 2013. We performed propensity score-adjusted logistic and Cox proportional-hazards regression analyses on complete-case data as well as on imputed data sets.
Results: 638 consecutive patients underwent coronary angiography due to SCA. Severity of coronary artery disease was similar among SCA patients and patients undergoing coronary angiography due to suspected coronary artery disease ($n = 37,142$). An acute occlusion was reported in the majority of SCA patients and was present in 37% of patients who did not have ST-elevation on the post resuscitation ECG. 31% of SCA patients died within 30 days. Long-term risk of death among patients who survived the first 30 days was higher in patients with SCA compared to patients with acute coronary syndromes ($P < 0.001$).
Conclusions: Coronary artery disease and acute coronary occlusions are common among patients who undergo coronary angiography after sudden cardiac arrest. These patients have a substantial mortality risk both short- and long-term.

1. Introduction

Sudden cardiac arrest (SCA) carries a dismal prognosis and accounts for more than half of all deaths from coronary heart disease. Overall survival ranges between 3 and 10% depending on initial recorded rhythm, underlying cause, patient characteristics, and time to cardiopulmonary resuscitation and/or defibrillation.[1–5]

Time to return of spontaneous circulation (ROSC) is the most important determinant of outcome. International guidelines and algorithms have been established and are being continuously advanced to ensure rapid ROSC.[6,7] However, successful resuscitation requires more than ROSC and recent studies have recognized and focused on appropriate post-resuscitation treatment. In selected patients, prevention of hyperthermia and/or timely coronary angiography followed, if indicated, by percutaneous coronary intervention (PCI) have been shown to improve outcome.[8–13]

European as well as American guidelines recommend urgent angiography in all patients with SCA where an acute coronary

Abbreviations: RIKS-HIA, Register of Information and Knowledge about Swedish Heart Intensive Care Admissions; SCAAR, Swedish Coronary Angiography and Angioplasty Registry; SWEDEHEART, Swedish Websystem for Enhancement of Evidence-Based Care in Heart Disease Evaluated According to Recommended Therapies.

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syndrome is suspected.[6,7] ST-segment elevation on post-resuscitation ECG has traditionally been used to select patients for intervention. However, there is evidence that post-resuscitation ECG alone is insufficient to decide which patients should be referred for urgent coronary angiography.[14] These studies indicate that angiography is feasible in all patients after SCA in whom an obvious non-cardiac cause cannot be identified, regardless of findings on post-reperfusion ECG.[15]

In this study we present data on angiographic findings and survival from all consecutive patients who underwent coronary angiography due to SCA in Western Sweden and who were prospectively followed within RIKS-HIA (Register of Information and Knowledge about Swedish Heart Intensive Care Admissions) and SCAAR (Swedish Coronary Angiography and Angioplasty Registry) between 2005 and 2013.

2. Methods

We merged data from RIKS-HIA and SCAAR for patients hospitalized in cardiac care units in Västra Götaland County in Western Sweden between Jan 2005 and March 2013. All patients who underwent coronary angiography in the region during this period were included in the study. The patients were considered to have diabetes, hypertension, hyperlipidemia, previous MI, previous PCI, previous stroke, cardiogenic shock or heart failure based on the ICD codes documented in the registry.[16] We plotted the percentage of patients per calendar year who underwent coronary angiography due to SCA and compared these patients to those undergoing angiography for other reasons. We also divided the patients into groups based on the indication for coronary angiography. We then plotted graphs for angiographic findings and for operator's primary decision regarding the treatment after the diagnostic angiography. We fitted multivariate models to compare outcomes between patients undergoing coronary angiography due to SCA with patients undergoing coronary angiography due to acute coronary syndrome. The study was approved by the regional ethical board in Gothenburg according to the Swedish law and regulations. Significant coronary artery disease was defined as >50% lumen narrowing on angiogram.

3. The SWEDEHEART registry

SCAAR and RIKS-HIA registries are two components of SWEDEHEART registry (Swedish Websystem for Enhancement of Evidence-Based Care in Heart Disease Evaluated According to Recommended Therapies). SCAAR contains information on consecutive patients from all 30 centers that perform PCI in Sweden, 5 of which are localized in Västra Götaland County. In SCAAR, a coronary angiography is described by approximately 50 variables whereas a PCI is described by approximately 200 variables. RIKS-HIA contains a list of variables on all patients who are treated for acute coronary syndromes at cardiac care units in Sweden. The patients are informed about the registration of data as a part of the everyday clinical routine. RIKS-HIA gathers more than 100 variables with information about patient demographics, risk factors, past medical history, medical treatment before admission, in-hospital treatment and interventions, and treatment at discharge. The registry also holds information about whether SCA occurred before or after admission to the hospitals. Patients who suffered SCA before or after arrival were included in the SCA group.[17] Long-term survival data were obtained by merging the SCAAR and RIKS HIA databases with national Causes-of-Death registry based on the unique 10-digit personal identification number.[17]

3.1. Statistical analyses

Continuous variables are presented as mean ± SEM and categorical variables are reported as frequencies. Normal distribution of variables was assessed by inspecting the distribution of values on histograms and by Shapiro–Wilk test.

The database was evaluated for missing data and variables of interest with missing values were imputed using multiple imputation method. Analyses were performed on complete case data as well as after multiple imputation of missing data. The imputation protocol consisted of the chain-equation method[18] with 20 imputed data sets. Continuous variables were imputed by ordinary least squares multiple regression whereas binary variables were imputed using logistic regression and categorical variables by multinomial logistic regression. The following variables were used in the multiple imputation algorithm: indicator of missing data, age, gender, hypertension, diabetes mellitus, smoking status, hyperlipidemia, BMI, previous MI, previous PCI, previous cardiac surgery, 30-day mortality, angiographic findings and indication for angiography. Indication for angiography consisted of several categories including cardiac arrest, stable angina pectoris, unstable angina pectoris/NSTEMI, STEMI, undefined chest pain, arrhythmia, valvular heart disease, heart failure, or other.[19] Nelson-Allen cumulative hazards indicator was used in addition to above-mentioned variables for imputation algorithm for covariates used in Cox proportional-hazards regression. The imputation procedure and subsequent analyses were performed according to the Rubin's protocol[20] under the assumption that missing data are missing at random.

We used chi-square test to detect between group differences in binary variables and student's *t*-test to detect differences in continuous variables. We tested whether undergoing coronary angiography or PCI was associated with better short-term prognosis in patients with SCA by modeling with logistic regression 30-day mortality as dependent variable and age, gender, PCI, SCA, and an interaction between PCI and SCA, as predictor variables. We also modeled a propensity score-adjusted logistic regression with 30-day mortality as dependent variable and gender, SCA, and an interaction term between gender and SCA as covariates. The variables hypertension, diabetes mellitus, smoking, hyperlipidemia, previous myocardial infarction, previous PCI, previous CABG, age, gender and BMI were used to estimate propensity score. We tested the influence of gender on prognosis in patients that underwent angiography or PCI due to SCA by modeling with logistic regression 30-day mortality as dependent variable and age, gender, SCA, and an interaction term between gender and SCA, as predictor variables. We used test for trend to detect whether patients characteristics and mortality changed during the study period.

We compare the long-term prognosis of patients who had survived SCA to patients who survived an AMI using landmark analysis based on multivariate adjusted and propensity score-adjusted Cox proportional-hazards regression. The propensity score-adjusted Cox-regression with imputed data was the primary model. Subgroup analyses were performed using interaction test.

Propensity score was entered as a continuous variable in all regression models. Goodness-of-fit (calibration) for the models was assessed with Hosmer–Lemeshow test. Multicollinearity between the variables in the model was assessed by calculation of the variance inflation factor (VIF). Cox proportional hazards models were tested for proportionality of hazards by visual inspection of the Schoenfeld residuals and by Grambsch–Therneau's test based on scaled Schoenfeld residuals. All statistical analyses were performed using Stata® software (version 13.1, StataSorp, College Station, TX, USA). All tests were two-tailed and a *P*-value of <0.05 was considered statistically significant.