EuroHOPE

Building register-based performance indicators for

ACS and AMI

using individual-level administrative health care data

Version of August 27, 2016

BRIDGEHEALTH WP11
Integrating data sources into a comprehensive EU Information System
for Health Care Monitoring and Reporting

Contents

1. Introduction and objectives

The principal aim of the BRIDGE Health Work Package 11 "Integrating data sources into a comprehensive EU Information System for Health Health Care Monitoring and Reporting" is to create databases to enable comparison of performance in the care of specific patient groups between countries, within countries (regions and hospitals), and over time, using patient-level administrative health care data. The specific aims are updating the protocols, data processing, and reporting for selected diseases/conditions included in the European Health Care Outcomes, Performance and Efficiency (EuroHOPE) project. This paper updates the earlier version of the protocol for acute myocardial infarction (AMI)[1], which has been applied in making of the database that has been utilized in several articles (Hagen et al. 2015, Hagen et al. 2015b, Häkkinen et al. 2015) as well as in the making of regional indicators available at www.eurohope.info. In addition, acute coronary syndrome (ACS) is now added to the protocol and the protocol has been revised accordingly.

In the earlier stage of EuroHOPE, the AMI data was gathered from Finland, Hungary, Italy, Netherlands, Scotland and Sweden for the years 2006-2008 and from Norway for 2009. Now the data will be updated for Finland, Hungary, Italy, Norway, and Sweden to cover more recent years. In addition, data from Denmark and Spain (Madrid) will be compiled as new entrants to the comparison.

The main objective of the comparison database is to produce performance indicators at country, regional and hospital level for international benchmarking. The database enables to extend and deepen the international comparative research on the relationship between outcomes/quality and costs/resources as well as on the reasons behind the differences in outcomes and costs (Hagen et al. 2015, Häkkinen et al. 2015).

This specific protocol for international comparisons for ACS/AMI describes how the EuroHOPE international comparison data is constructed when based on hospital discharge registers, mortality registers, and other available administrative health care registers (such as data on medication use, specialist visits etc.). The protocol is used for preparing both the **national ACS and AMI databases for each country and for international comparative ACS and AMI databases,** which are produced using the national databases (Figure 1).

This protocol also defines how we have produced indicators on ACS and AMI at national level and also on regional- and hospital-level within countries. The indicators include basic information on patients (number of patients, demographic characteristics, co-morbidity), on the

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[1]The paper was a joint work established by Eva Belicza, Anne Douglas, Terje P. Hagen, Unto Häkkinen, Amber van der Heijden, Antti Malmivaara, Emma Medin, Dino Numerato, Mikko Peltola, Clas Rehnberg and Timo T. Seppälä. Éva Belicza was the first author.

content of care (use of services and procedures, costs, treatment practices, process indicators) and outcomes (mortality, recurrence, rehospitalisation, complications).

The protocol has been updated to be applied in the present project. Participants in the present project are:

- University of Southern Denmark, Odense, Denmark
- National Institute for Health and Welfare, Helsinki, Finland
- Centre for Research on Health and Social Care Management, Università Commerciale Luigi Bocconi, Milan, Italy
- Health Services Management Training Centre, Semmelweis University, Budapest, Hungary
- Instituto de Salud Carlos III (ISCIII), Madrid, Spain
- Medical Management Centre, LIME, Karolinska Institutet, Stockholm, Sweden
- Department of Health Management and Health Economics, University of Oslo, Oslo, Norway.
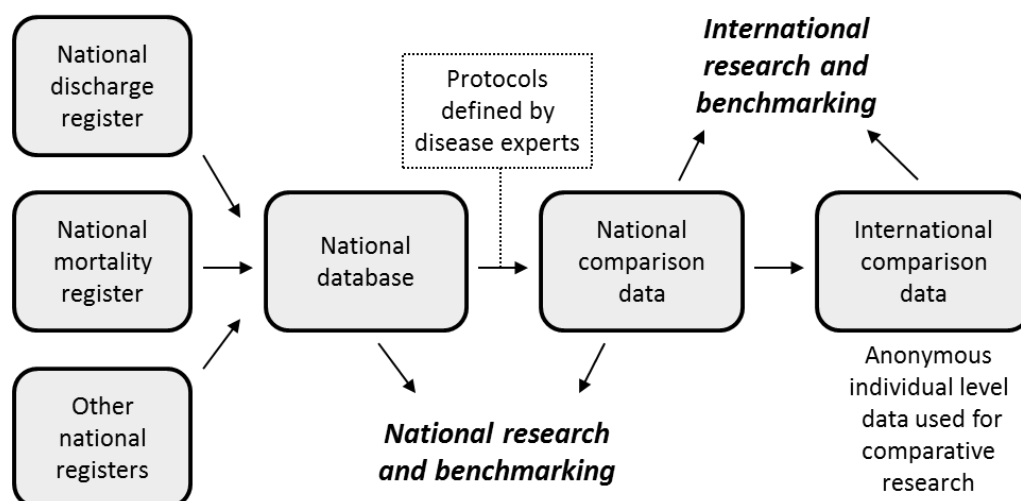
Figure 1. Schematic presentation of data flow in BridgeHEALTH WP11.

2. Construction of data

We will analyse separately patients suffering from acute myocardial infarction (AMI) and acute coronary syndrome ACS. ACS extends AMI to include patients suffering from unstable angina pectoris (UAP) because the increased use of diagnostic procedures has affected the number of Non–ST-segment elevation myocardial infarction (NSTEMI) patients (earlier defined as UAP patients).

ACS and AMI are analysed separately in order to guarantee comparability to other studies on AMI and earlier reporting of AMI in EuroHOPE.

National databases of AMI and ACS

Total incidence of ACS/AMI in a given calendar year comprises of all patients admitted to hospital due to ACS/AMI and persons who have died of coronary artery disease without being admitted to hospital. ACS/AMI may be fatal and the person may not reach a hospital. Partly the access to treatment may depend on the local health care system characteristics. In EuroHOPE we try to assess the number of persons who suffered from ACS/AMI irrespective of the access to hospital care. Persons who died of coronary artery disease without being admitted to hospital due to ACS/AMI are gathered from countries where available. The analysis of total incidence of AMI/ACS will be explored later. However, the health system's performance in treatment of ACS/AMI is assessed by analysing the persons being treated in hospital due to these diseases.

In EuroHOPE, every country has established national AMI and ACS databases, that includes patients treated in hospital due to AMI/ACS (prevalence of the diseases in acute care).From national discharge registers all patients that had been admitted to hospital inpatient care because of main diagnosis of AMI (International Classification of Diagnoses, 10th edition [ICD-10] codes I21*, I22*; ICD-9 codes: 410*) or ACS (ICD-10 codes I20.0*, I21*, I22*; ICD-9 codes: 410*, 4111*) were included in the databases.

AMI cases are classified into three subgroups[2]:

1. STEMI or recurrent AMI (ICD-10 codes: I21.0*, I21.1*, I21.2*, I21.3*, I22*; ICD- 9 codes: 4100*-4106*, 4108*, 41072, 41092).
2. Undefined AMI (ICD-10 code I21.9*; ICD-9 code: 4109* excluding if fifth digit is 2).
3. NSTEMI (ICD-10 code I21.4*; ICD-9 code: 4107* excluding if fifth digit is 2).

For ACS, a fourth subgroup is introduced:

4. Unstable angina (ICD-10 code: I20.0*; ICD-9-code: 4111*).

Using unique and linkable personal identification numbers, we have linked AMI and ACS patients' information from the following national registers:

- Hospital discharge registers
- Outpatient services in specialist care / hospitals
- Drug utilisation registers
- National mortality registers.

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[2] In Hungary, AMI cases can not be reliably classified into these subgroups 1 to 3.

National comparison database for calculating indicators

For an explanation regarding the approach used in this part of the study, please see Häkkinen et al. (2013).

Registry data on hospital discharges, prescription drugs and causes of death were acquired in the participating European countries. This chapter describes in detail how the 2013 cohort of the **national ACS/AMI comparison data** in EuroHOPE was created, starting from the prevalence of ACS/AMI in acute hospital care. Datasets covering other cohorts are created using the same logic. The steps in constructing the Finnish national comparison data are also shown in flow charts in Appendix 4.

First, using hospital discharge data all patients admitted between 1st January 2013 and 31st December 2013 with a main diagnosis of ACS/AMI were identified. The hospital discharge records and all the identified patients' records in the other data sources mentioned above were gathered for the period between 1.1.2012 and 31.12.2014, i.e. for the preceding and following calendar years in addition to the cohort year data. The first ACS/AMI admission (index admission) of the year was identified as it starts the follow-up of the patient.

Patients with an ACS/AMI admission during the previous 365 days before the index admission were excluded from the 2013 cohort (ACS/AMI admission = hospital discharge record with an ACS/AMI diagnosis as the main diagnosis).

For each patient all continuous hospital treatment (the first hospital episode) starting from the first ACS/AMI admission (index admission) in 2013 was constructed by combining all consecutive hospital stays for each patient. The consecutive hospital stays need not be in the same hospital, i.e. hospital transfers are taken into account when making the first hospital episode.

In case a patient had different ACS/AMI subtypes during the first hospital episode, the most 'severe' diagnosis was chosen to characterize the condition of the patient. For this purpose, the following hierarchy of ACS/AMI subtypes was applied (from the most to the least severe)[3]: STEMI or recurrent AMI, undefined AMI, NSTEMI, unstable angina. The most severe diagnosis was chosen as the ACS/AMI subtype characterizing the first hospital episode.

The included patients were followed for up to 365 days from the first day (index day) of the index admission for inpatient and outpatient care in hospitals, medication purchases and vital status. In addition, the hospital discharges and use of prescribed medicines in the 365 days prior to the start of the index admission were used in assessing the presence of comorbid diseases among the patients.

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[3] In Hungary it was not possible to identify different AMI subtypes.

In each country, patients under 18 years of age, tourists, visitors and other residents with incomplete personal identification numbers as well as patients with incomplete data on look-back and/or follow-up period of 365 days were excluded from the national comparison data[4].

The main analysis will be done using the patient data collected from the national discharge registers as described above[5]. Specific information on registers in each country is provided in Appendix 1 and on country specific procedure codes in Appendix 2. Appendix 3 gives a characterization of the classification of regions used in the project. Variable definitions, together with definitions of comorbid conditions, procedures, complications and hospital hierarchy are described in a separate excel file.

3. Hospital and first hospital episode

Definition of a hospital

A hospital is a health care institution providing treatment for a number of medical conditions by specialized staff and equipment. In the present project, we speak of hospitals meaning institutions providing somatic (non-psychiatric) inpatient care for patients staying overnight (for at least one night, i.e. inpatients), and usually also health care services (diagnosis, treatment, or therapy) for patients without staying overnight (i.e. outpatients). A hospital may be a single building or a number of buildings on a campus. Also, in some countries a hospital can consist on many buildings in a certain geographical area. For example, in Finland after reorganization of Helsinki University Hospital in 2006, it includes several buildings in different municipalities in the capital area.

At hospital level analysis we have specified the definition of a hospital in order to be sure that we are comparing units with a similar structure and scope. For this end, we have formulated a definition of hospital, and a corresponding classification of different types of hospitals. We have used these definitions of hospitals in a specific variable depicting the type of care that the patient has received for each day of the follow-up daily information (during one year follow-up). In addition, we will gather more detailed information on the hospitals that have the main responsibility for the care. The more specific hospital-level information collection is to be gathered for the hospitals acting as the first hospitals in the care chain, and for the hospitals taking the responsibility of the patient in the first hospital episode (in the individual level data the hospitals are given variables named FSTHOSP and HEPHOSP, respectively). Thus, FSTHOSP is the hospital where the patient was initially admitted in. HEPHOSP is defined as the hospital that was highest in the hierarchy of hospitals which treated the patient during the first week[6].

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[4] In Hungary, patients being imprisoned are excluded as their use of health care services is not included in the hospital discharge register.

[5] In Finland we have excluded patients that had been only in health centers and other hospitals in departments without specialty code or specialty code is general medicine (Appendix 4).

[6] According to data of five countries (Häkkinen et al. 2015) about 13 % of the patients are transferred to a higher-level hospital within the first week of hospitalization due to AMI.

Definition of the first hospital episode

The total episode of care is defined as the entire treatment pathway from the beginning of the disease to the end of the treatment throughout any hospital admissions, other health service provisions or purchased medication in order to solve the health problem at hand in a specified time frame (Figure 2).

The first hospital episode covers all care given to patients as an inpatient in a hospital. Consecutive hospital discharges are included in the same hospital episode if the preceding hospital stay's discharge date is the same as the following discharge's admission date or the admission date is the next date after the preceding discharge date. If the patient is immediately transferred to a rehabilitation centre at the hospital this is included in the first hospital episode (Häkkinen et al. 2013). The first hospital episode ends when the patient is discharged to home (and is at home for at least one day), to a nursing home or to a long-term care institution, or the patient dies. The total episode of care was defined as the entire treatment pathway from the beginning of the disease (i.e. acute stage of the disease) to the end of the episode (predefined follow-up time, see below), irrespective of any organizational boundaries (Figure 2).

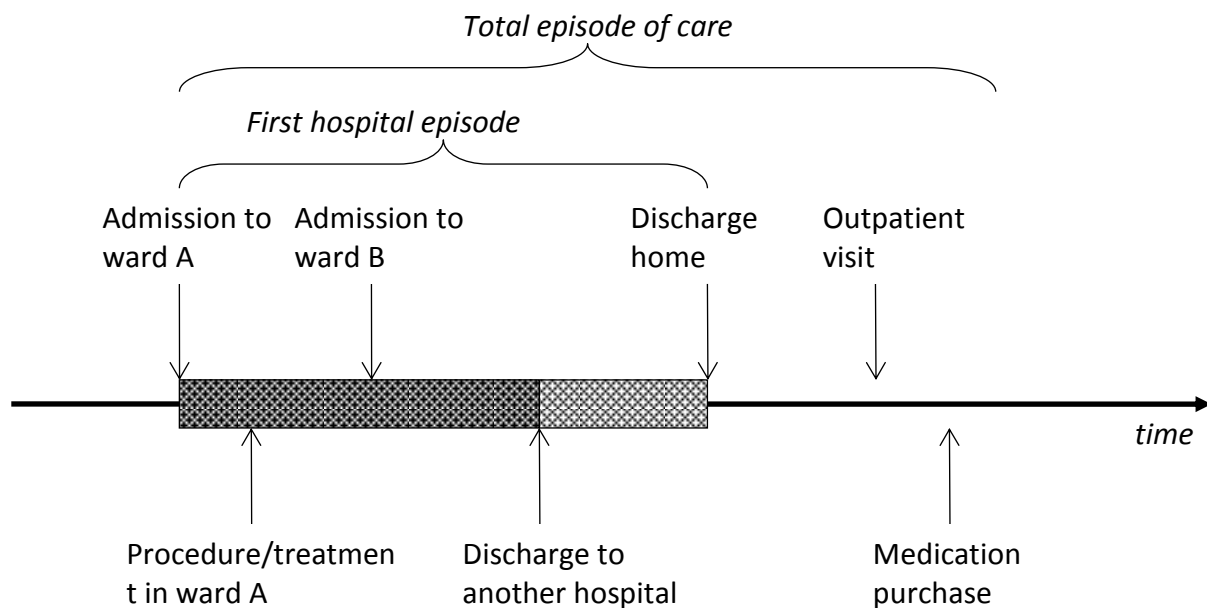Figure 2. A schematic presentation of the follow-up of patients throughout the treatment pathway demonstrating the definitions of the first hospital episode and the total episode of care.

Rehabilitation

In some countries (e.g. in Finland) it is difficult to separate rehabilitation given in a hospital from acute care as well as to separate rehabilitation from long-term care. Some countries (e.g. Hungary)

may have data on all inpatient rehabilitation. Other countries usually have data on inpatient rehabilitation given in hospitals but no data on rehabilitation given in a specialized rehabilitation centre.

We have divided the first hospital episode to acute and non-acute care. In countries where rehabilitation is included in hospital inpatient data and can be separated from acute care this is coded in a STATE variable[7]. In addition, an own class in the hospital hierarchy is given for geriatric wards of hospitals.

We will include inpatient rehabilitation and thus keep our definition of the end of an episode. In addition, in countries where rehabilitation is included in hospital inpatient data and can be separated from acute care this will be coded like mentioned earlier. In addition, an own class in the hospital hierarchy will be given for geriatric wards in hospitals.

Length of stay, acute care and non-acute care

We measured the length of stay (LoS) in acute care during the first hospital episode from the index day at the start of the initial admission to the last day of acute hospital care during the period of continuous acute hospital treatment (LoS = last date in acute treatment – index date +1).

We defined acute hospital care as treatment given in a hospital's intensive care unit, or in other acute care settings (all medical and surgical specialties). In addition, we calculated several other LoS measures including the length of the first admission, the total length of the continuous episode of care, the number of days in rehabilitation during the first continuous episode of care, and the number of days in hospital during the entire follow-up year. All LoS measures were truncated at 365 days if the length of stay was longer.

Hospital hierarchy

The daily STATE variable describes in which place or state the patient is. It is based on the idea that a patient can only be in one place in each day and that with hospital discharge data the days in institutions can be located in time. In case of overlapping admissions, the STATE variable is marked with the hospital being in the highest step of hospital hierarchy (defined by each country). In descending order, the hospitals, institutions or units in the hierarchy are university hospitals, specialist hospitals, central or regional hospitals and general or local hospitals, rehabilitation, geriatric and general care, psychiatric care, and long term care.

1. University hospital

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[7] The daily STATE variable conveys information on if a patient was, in a given day, in a hospital or not, about the type of hospital where the patient was that date, whether the main diagnosis was related to a certain disease, information about the intensity of the treatment (i.e. acute care, non-acute etc. based on information known about the ward giving the treatment). Thus, the state variables give a possibility to extract and pinpoint the days the patient spent in rehabilitation, even within the first hospital episode or any other hospital stay during the follow-up. The codes for state variables are given in a separate excel-file.

A university hospital (teaching hospital) combines hospital treatment to patients with teaching to medical students and nurses and usually it is linked to a medical school, or university. University hospital has an extensive array of specialties and services, and university hospitals are able to provide treatment to the most demanding medical conditions and are responsible for the treatment of rare and severe medical conditions in their region. University hospitals are usually tertiary referral hospitals: Tertiary care is specialized consultative health care, usually for inpatients and on referral from a primary or secondary health professional, in a facility that has personnel and facilities for advanced medical investigation and treatment, such as a tertiary referral hospital (Healy, Mckee 2002). Examples of tertiary care services are cancer management, neurosurgery, cardiac surgery, plastic surgery, treatment for severe burns, advanced neonatology services, palliative, and other complex medical and surgical interventions.

2. Specialized hospital

Types of specialized hospitals treat certain disease categories such as cardiac, oncology, or orthopedic problems, and so forth. A specialized hospital may have smaller volumes, but they are considered to have an excellent know-how in their field.

3. Central or regional hospital

A central hospital is typically the major health care facility in its region, with a fairly large numbers of beds for intensive care and many specialized facilities (for example surgery, plastic surgery, childbirth, bioassay laboratories, and so forth).

4. General/local hospital

General hospital is set up to deal with many kinds of disease and injury, and it has an emergency department to deal with immediate and urgent threats to health. These hospitals have usually only the basic specialties such as surgery, internal medicine, deliveries and gynecology, ear, nose and throat disease etc.

5. Rehabilitation

Here we include all rehabilitation given in special rehabilitation hospitals/clinics as well as all other hospitals if this can be separated from the acute care using diagnoses, procedures, DRGs, or the department level information. Thus if rehabilitation is given e.g. in a university hospital and it can be separated from the acute care, the state variable is coded to give information about this.

6. Geriatric and general care

Care given in geriatric wards and care given in general medicine departments, independent of the hospital type (any of the above accepted care).

7. Psychiatric care

Care given in psychiatric specialties, or having ICD-10 code F* as main diagnosis.

8. Long term care

All inpatient care given in nursing homes and other long-term institutions.

4. Description of indicators

The EuroHOPE project aims at constructing a number of indicators describing the performance of the health care system in treatment of AMI/ACS. With the national comparison data a number of national-, regional- and hospital-level indicators are produced. The calculation of indicators and the reporting of the data are based on a common script, executed in Stata on the national comparison data. Below in Table 1, the indicators that are published on the national- and regional-level in the EuroHOPE website in the ATLAS tool are described. Here we give indicators only for AMI patients. The name of the indicator, a short description of the indicator, and the factors used in risk-adjustment are given in Table 1.

Table 1. EuroHOPE indicators on AMI publicly available on www.eurohope.info.

Indicator	Description	Risk-adjustment
Number of patients	Number of patients included in the national comparison data.	
Number of patients per 100 000 inhabitants	Number of patients included in the national comparison data per 100 000 inhabitants.	
Age	Average and median age of the patients. Age in years at the start of the hospital care for stroke.	
Males	Share of males.	
PCI rate within two days	The share of AMI patients received percutaneous coronary intervention (PCI) during the first two days	
PCI or CABG rate within 30	The share of patients received either percutaneous coronary	Age * , sex

days	intervention (PCI) or coronary artery bypass surgery (CABG) during the first 30 days	
Length of stay, first hospital episode	The number of days in acute hospital treatment during the first hospital episode. Consecutive hospital stays are taken into account when constructing the first hospital episode.	Age*, sex
Length of stay, first year	The number of days in hospital treatment during 365 days after the start of the acute hospital treatment due to AMI.	Age*, sex
7-, 30-, 90-day and 1-year mortality	The share of AMI patients who died within the given period of time after the start of the first hospital admission because of ischaemic stroke.	Age*, sex
Readmission in 30 days	Readmission to acute hospital care within 30 days after the end of acute care in the first hospital episode.	Age*, sex

* Classified: 18-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-.

Baseline patient characteristics

In addition to the publicly reported indicators given in Table 1, a number of other indicators are produced in EuroHOPE. The indicators can be classified as indicators related to the baseline patient characteristics, process, and outcome.

As baseline patient characteristics the following information is gathered:

- Age and gender
- Type of ACS/AMI
- Comorbidities (see Excel file on variable definitions)
    o Hypertension
    o Coronary artery disease
    o Atrial fibrillation

- Cardiac insufficiency (heart failure)
- Diabetes mellitus
- Atherosclerosis
- Cancer
- COPD and asthma
- Dementia
- Depression
- Parkinson's disease
- Mental disorders
- Renal insufficiency (failure)
- Alcoholism
- Stroke

Co-morbidities are defined from various register sources according to two different approaches:

1. Based on the main and secondary diagnoses of all hospital inpatient and outpatient records during the 365 days preceding the index admission

2. Based on medicine purchases and the main and secondary diagnoses of all hospital inpatient and outpatient records during the 365 days preceding the index admission.

Process indicators

The patients' first hospital episode and the whole follow-up of one year are tracked for a number of aspects that convey information about the care given to the patient. The process indicators produced in the project are the following:

- Length of stay (LoS) of first hospital admission, days per patient
- Length of stay of the first hospital episode, days per patient, in four categories
    - Total LoS
    - Days in acute care
    - Days in non-acute care
    - Days due to ACS/AMI (days with main diagnosis of ACS/AMI)

- The number of inpatient days per patient over the first year after ACS/AMI

    - Total LoS
    - Days in acute care
    - Days in non-acute care
    - Days due to ACS/AMI (days with main diagnosis of ACS/AMI)

- Number and share of patients who received percutaneous coronary intervention (PCI) during the first two days
- Number and share of patients who received coronary artery bypass surgery (CABG) during the first two days
- Number and share of patients who received percutaneous coronary intervention (PCI) during the first hospital episode

- Number and share of patients who received coronary artery bypass surgery (CABG) during the first hospital episode
- Number and share of patients who received percutaneous coronary intervention (PCI) during the first 30 days
- Number and share of patients who received coronary artery bypass surgery (CABG) during the first 30 days
- Number and share of patients who received either percutaneous coronary intervention (PCI) or coronary artery bypass surgery (CABG) during the first 30 days
- Number and share of patients who used drugs (outside hospitals) based on ATC classification (anatomic therapeutic classification) one year before and one year after hospitalisation (these will be grouped later):

    - Beta blockers (C07*)
    - Diuretics (C03*, C07BB*, C09BA*, C09DA*)
    - ACE inhibitors (C09A*, C09B*)
    - Angiotensin receptor blockers (AT II antagonists) (C09C*, C09D*)
    - Calcium channel blockers (C08*, C07FB*, C09BB*)
    - Insulin (A10A*)
    - Blood glucose lowering drugs, excluding insulins (oral diabetes medication) (A10B*)
    - Statins (C10AA*)
    - ADP receptor inhibitors (clopidogrel, prasugrel, ticagralor) (B01AC04, B01AC22, B01AC24)
    - Dipyridamole (B01AC07, B01AC30)
    - Warfarin (B01AA03)
    - Antidepressants (N06A*)
    - Anti-dementia drugs (N06D*)
    - Antiepileptics (N03A*)
    - Acenokumarol (B01AA07)
    - Ticlopidin (B01AC05)
    - Dabigatran (B01AE07)
    - Apixaban (B01AF02)
    - Rivaroxaban (B01AF01)

Outcome indicators

The project aims at constructing measures to be used for performance monitoring and assessing the outcomes of care given to the patients. As outcome indicators, the following measures are included:

- Mortality in 30, 90, and 365 days from the index admission day
- Readmission (due to recurrence of ACS or AMI) to hospital within
    - 30 days
    - 90 days
    - 365 days from the index admission

- Readmission to acute hospital care within 30 days after end of the first hospital episode

- Readmission to acute hospital care within 30 days after end of the acute hospital care in the first hospital episode
- Complications during the first hospital episode:
    o pulmonary embolism
    o stroke

Adjusting for patient mix

Comparisons of health outcomes between countries need to take into account differences in the patient mix. In addition, countries may differ in the degree to which the relevant information is recorded, the availability of patient information, or variables being very differently defined across countries. In order to the performance indicators to be comparable, the indicators have to be adjusted for confounding factors.

In EuroHOPE this problem was tried to solve by using all relevant registry data available for everyone with a specified health problem, by collecting available information on disease specific comorbidities, length of hospital stay and medication use prior to the occurrence of the health problem studied - variables potentially having an effect on health outcomes. However, this does not alleviate the problem arising from the potential existence of differences between countries in registering this information.

Three different risk-adjusted outputs are produced for each outcome:

1. adjusted for sex and age, and unstable angina pectoris (UAP)[8]
2. adjusted for sex, age, disease-specific comorbidities based on primary and secondary diagnoses[9], the number of hospital days (LOS) the year prior to index admission and unstable angina pectoris (UAP)[8]
3. adjusted for sex, age, disease-specific comorbidities based on primary and secondary diagnoses and medication purchases, LOS the year prior to index admission and unstable angina pectoris (UAP)[8].

Based on the experiences in the PERFECT project (Peltola et al., 2011), the observed/expected approach described by Ash et al. (2003) is used - this roughly corresponds to indirect standardization. Specifically, the method uses regression modelling for the risk adjustment. For mortality outcomes up to one year, logistic regression is used, while for the LOS outcomes, negative binomial regression is used. In each country, a common indicator-specific set of coefficients for each factor included in the risk-adjustment is used for calculation the predicted values for the outcome in question. The coefficients applied for calculating the predicted values for each outcome are based on the estimates acquired from the Finnish national comparison data

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[8] UAP is only used in risk adjustment for ACS.
[9] Hypertension, coronary heart disease, atrial fibrillation, cardiac insufficiency, diabetes mellitus, cancer, chronic obstructive pulmonary disease and asthma, dementia, depression, Parkinson's disease.

covering the years 2006 to 2013. The coefficients will be updated as data from other countries is available. The method is described in greater detail in Moger and Peltola (2014).

Each country will apply a standardized, centrally-constructed, Stata syntax code to the national comparison database for calculating the country and regional level indicators. The national files were processed with a common script in order to enable standardized reporting of the data from all countries with minimum workload and minimized possibility of human error in processing the data. This Stata do-file is available upon request from the researchers.

Case-mix standardisation will be used when comparing countries, regions, hospitals, or years. Variables which are considered potential prognostic factors (and thus confounders) are used for adjustment. These will be derived from primary and secondary diagnoses of previous discharge data and from data on previously prescribed medicines. We will use the following variables:

- age (in years, classified)
- gender
- type of ACS/AMI: unstable angina pectoris (UAP)[8]
- comorbidity as defined in separate file (only the comorbid diseases with at least 1% prevalence in the study population in each country of the EuroHOPE partners' data in the year 2007 were included in the risk adjustment as confounding factors)
- inpatient hospital stay days during one year prior to ACS/AMI in acute inpatient hospital care.

Levels of analysis

Indicators are produced at national and also regional level within countries and later at hospital level. Regional information is based on patients' place of residence. The definitions for regions have been made in each country according to the local preferences (Appendix 3).

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Appendix 1. National registers and data sources used in national databases

Hospital discharge register for inpatient care	
Denmark	2005-2014
Finland	2005-2014
Italy	
Hungary	2005-2015
Norway	2008-2015
Spain	
Sweden	2005-2014

Register on use of outpatient services in hospitals and/or other specialist units	
Denmark	2005-2014
Finland	2005-2014
Italy	
Hungary	2005-2015
Norway	
Spain	
Sweden	

Register on prescribed medication	
Denmark	2005-2014
Finland	2005-2014
Italy	
Hungary	2005-2015
Norway	2004-2015
Spain	
Sweden	2005-2014

Causes of death	
Denmark	2005-2013
Finland	2005-2014
Italy	
Hungary	NA (dates of death available for 2005-2015)
Norway	2004-2015
Spain	
Sweden	2005-2014

Appendix 2. Procedure codes used in countries to identify procedures in treatment of ACS/AMI

ACS and AMI	Codes						
OPE	**Procedure**	**Denmark**	**Finland**	**Hungary**	**Italy**	**Norway**	**Spain**	**Sweden**
ANG	Angiography	(UXAC85)	FN1AC, FN1BC, FN1CC, XFN00, 61*, 81*, AN1**, AP1**	33300, 33304, 33305, 33306, 33307, 33308, 33340, 33341, 33345, 33346, 33347, 33348, 33351, 33353, 33360, 33361, 33362, 33400		TFC00, TFC10, XF911, XF913, FYDB12, FYDB13		AF001, AF002, AF003, AF004, AF005, AF006, AF037
CABG	Coronary artery bypass surgery	KFNA*, KFNC*, KFNE*, KFNF*	FNA, FNB, FNC, FND, FNE, 11***, 25***, 111****, 112****, 113****, 119****, AA1**, AA2**, AA3**, AAX**	53611, 53612, 53613, 53614, 53615, 53616, 53617		FNA, FNB, FNC, FND, FNE		PDH10, PDH30, PEH10, PEH11, PEH12, PEH20, PEH30, PCH10, PCH20, PCH30, PCH40, PCH99, PBH10, PBH20, PBH99, PAH10, PAH20, PAH21, PAH25, PAH30, PAH99, FAD00, FAD10, FAD96, FCC70, FCC76, FCD70, FDH40, FJD20, FNC10, FNC20, FNC30, FNC40, FNC50, FNC60, FNC96, FND10, FND20, FND96, FNE00, FNE10, FNE20,

								FNE96, FNH20, PFH10, PFH20, PFH21, PFH22, PFH23, PFH24, PFH25, PFH26, PFH27, PFH28, PFH29, PFH99
PCI	Percutaneous coronary intervention	KFNG02, KFNG05, KFNG05A - only acute	FN1AT, FN1BT, FN1YT, TFN40, TFN50, 82*, 83*, 84*, AN2**, AN3**, AN4**, ANA**	01100, 33970, 33971, 33972, 53963, 53966			FNF00, FNF10, FNF20, FNF30, FNF96, FNG00, FNG02, FNG10, FNG20, FNG22, FNG30, FNG96, FNG05	FNG02
PCIST	PCI + stent	KFNG05, KFNG05A	TN1YT, TFN50, AN3**, AN4**	01344, 33974, 33975, 33976, 33981, 33982, 33983, 33984, 33985, 33986, 33987, 33988, 33989, 3398A				FNG05
PCISTm	PCI + metal stent	As above	AN3**	01339				
PCISTd	PCI + drug eluting stent	As above	AN4**					
			*HDR/Data file on coronary patients -2005 **HDR/Data file on coronary patients 2006- ***HDR/Data file on coronary patients -2002 ****HDR/Data file on coronary patients 2003-2005					

Appendix 3. Regions used in reporting of indicators in EuroHOPE countries

Country	Description	Number of regions	Average population size
Finland	Hospital districts and hospital regions responsible for providing specialised health care. Smallest districts combined.	19	280 000
Denmark	Administrative regions.	5	1 000 000
Hungary	19 counties and Budapest area providing self-governmental administrative duties (not health care).	20	500 000
Italy	Counties of the Friulia-Venezia Giulia autonomous region. Counties responsible for providing health care.	4	300 000
Norway	Hospital trusts responsible for providing specialist health care in their geographical areas.	20	250 000
Spain			
Sweden	Counties responsible for providing health care.	21	450 000

Appendix 4. Guidelines and steps for building the National ACS/AMI database

This example shows how the Finnish database is formed. However, there will certainly be differences in each country and thus these steps have to be modified accordingly.

1st step: screening inpatient database for patients

Screen hospital database (hospital discharges/hospital department discharges, inpatient social care), from the year 2004 onwards for records with ACS/AMI as main diagnosis in all hospital stays (hospital departments).

2nd step: screening mortality register database for ACS patient treated at hospitals

Take patient IDs from the first step and gather their information on date of death and causes of death and place of death.

3st step: screening mortality register database for ACS patients not having hospital care (not possible in all countries)

Screen national mortality database from the year 2006 onwards for records with main diagnosis (ICD-10: I20-I25, I46, R96, R98, R99; ICD-9: 410, 411, 413, 414, 427, 798.1, 798, 799). Take patient ID and main diagnosis of death, date of death and place of death.

4th step: merge data

Merge data from steps 1, 2 and 3 together with patient id in order to create an ACS ID data that includes four elements:

  i.   patient ID
  ii.   main diagnosis of death (if available)
  iii. place of death (in hospital / outside hospital)
  iv.   date of death
  v.   other reasons of patient drop out (eg. moving from the country).

5th step: 1st data set, ACS/AMI (prevalence) (1)

Take patient IDs from the fourth step and gather their **all records** from hospital records.

6th step: 2nd data set, all patients in hospital care due to ACS/AMI (2)

Exclude all patients that have not been in hospital care in the year under consideration due to ACS/AMI.

7th step : National comparison data (3)

Make the exclusions given in section 2.

Constructing the Finnish databases

Figure A1 describes the construction of Finnish ACS data from the year 2013. Total prevalence of ACS was 21 129. Of these 9514 (45 %) had not been in hospital because of ACS in 2013.

The Finnish Care Register for Health Care (FCRC) includes data from various hospitals (e.g. rehabilitation hospitals, health centers). In order to make the patients more comparable with hospital register in other countries we have excluded patients that had been only in health centers and other hospitals in departments without specialty code or whose specialty code is general medicine. This further decreased the number of patients by 737.

Table A1 describes development (2006-2013) of the structure of ACS data. The structure has been rather stable during time period. The main change has been in the type of AMI. The share of NSTEMI patients has increased from 32 % to 45 % whereas the share of unstable angina has decreased from 22 % to 16 %, mainly because extended use of diagnostic procedures has increased the share of NSTEMI patients (earlier defined as UAP patients). The total share of NSTEMI and UAP patients has increased from 54 % to 61 %. Extended use of diagnostic procedures may have also affected to the decrease of undefined AMI patients.

Figure A2 and Table A2 describe similar information on AMI patients in Finland.

1st data set (prevalence). All persons in institutional care due to **ACS** or died due to **coronary artery disease** [1)] in 2013
n = 21 129 (1)

Number of persons who died because of coronary artery disease and had no hospital care due to ACS in 2013 [2)]
n = 9 514 (1a)

Number of persons who were in long term care or had hospital care but no acute hospital care due to ACS and did not die
n = 737 (1b)

2nd data set All patients in acute hospital care due to ACS in 2013
n = 10 878 (2)

Number of persons who had no hospital care or long term care [3)] during the previous 365 days
n = 2 970 (1a1)

Number of persons who had acute hospital care due to ACS during the previous 365 days
n = 404 (1a2)

Number of persons who had non-acute hospital care [4)] or long term care due to ACS during the previous 365 days
n = 191 (1a3)

Number of persons who had hospital or long term care only due to other diagnosis than ACS during the previous 365 days
n = 5 949 (1a4)

Acute hospital care
n = 4 549 (1a4a)

No acute hospital care
n = 1 400 (1a4b)

Exclusion 1:
Hospital admission due to ACS during the previous 365 days [5)]
n = 604 (2a)

Exclusion 2:
Persons under 18 years at the time of first index admission in 2013
n = 0 (2b)

Exclusion 3:
Foreigners [6)] and patients with incomplete ID
n = 180 (38=incomplete ID) (2c)

National comparison data. Number of ACS patients in the comparison database after exclusion
n = 10 094 (3)

Stemi
n = 2 893 (3a)

Recurrent AMI
n = 43 (3b)

Undefined AMI
n = 991 (3c)

Non-stemi
n = 4 544 (3d)
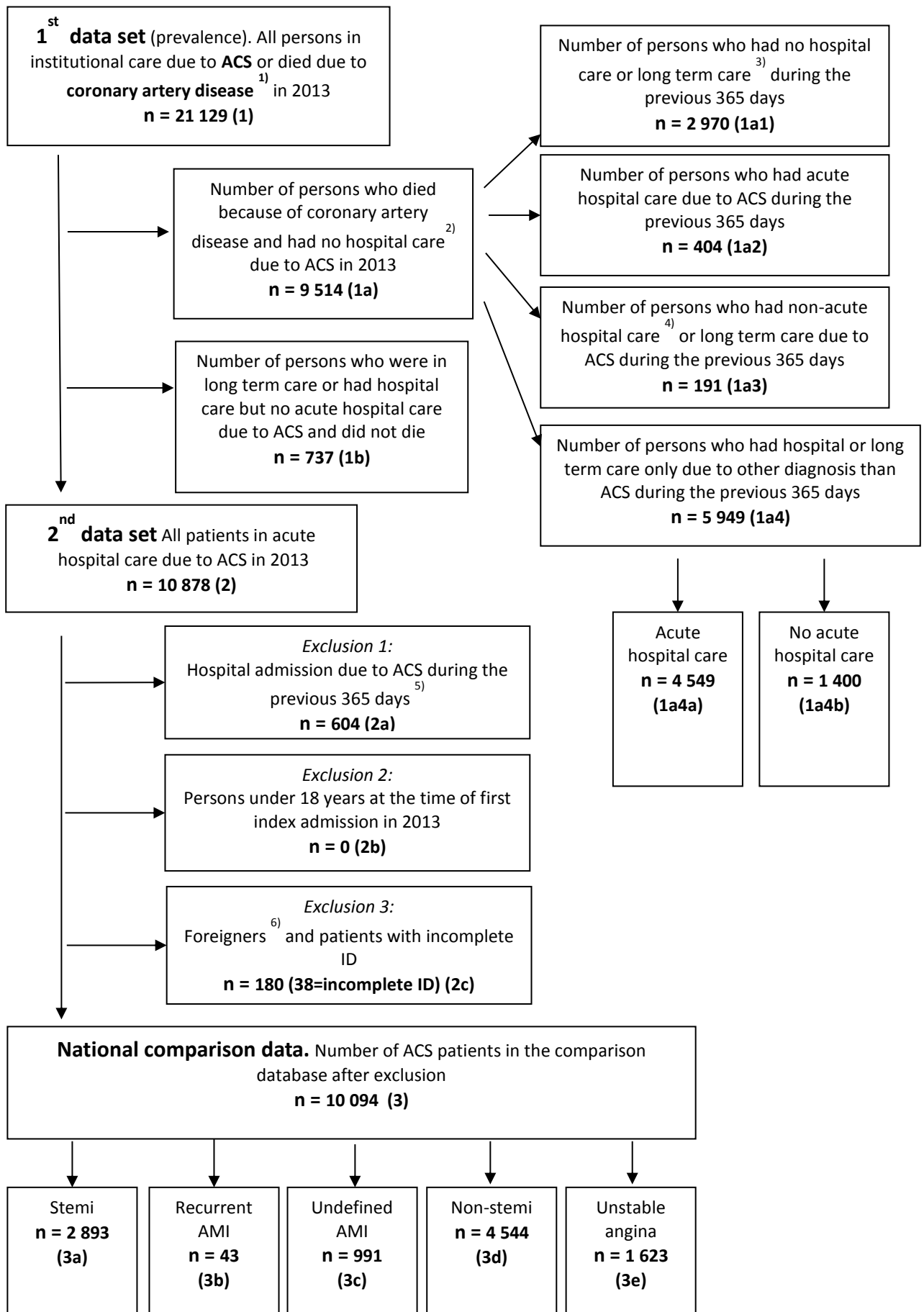
Unstable angina
n = 1 623 (3e)

Figure A1. Creation of the Finnish comparison database for ACS in 2013

1. Coronary artery disease is defined according to the following causes of death codes: **'I20' , 'I21' , 'I22' , 'I23' , 'I24' , 'I25' , 'I46' , 'R96' , 'R98' , 'R99'** .
2. Hospital care is defined as inpatient hospital care only. Hospital data is based on the Finnish Care Register for Health Care (FCRC)
3. Data on long-term care is based on the Care Register for Social Welfare
4. Non acute hospital care includes care given in health centers and other hospitals (included in FCRC) in departments without specialty code or specialty code is general medicine.
5. Counting starts from the first index admission in 2013.
6. In Finland all the ACS patients whose home municipality is Åland or unknown are excluded from the comparison database

Table A1. Construction of ACS data bases in Finland 2006-2013

Data	2006	2007	2008	2009	2010	2011*	2012	2013
1	**23 304**	**23 150**	**22 642**	**22 255**	**22 118**	**18 978**	**21 570**	**21 129**
1a	10 032	10 197	10 306	10 142	10 424	7 305	9 883	9 514
1a1	3 240	3 283	3 381	3 167	3 296	1 554	3 060	2 970
1a2	597	554	542	440	514	439	416	404
1a3	212	206	220	218	189	189	182	191
1a4	5 983	6 154	6 163	6 317	6 425	5 123	6 225	5 949
1a4a	4 769	4 909	4 854	4 871	4 877	3 976	4 744	4 549
1a4b	1 214	1 245	1 309	1 446	1 548	1 147	1 481	1 400
1b	719	741	834	844	774	739	711	737
2	**12 553**	**12 212**	**11 502**	**11 269**	**10 920**	**10 934**	**10 976**	**10 878**
2a	877	768	732	740	691	612	648	604
2b	2	1	1	3	0	0	0	0
2c	104	144	148	164	120	132	132	180
2c1	16	10	4	2	1	1	1	38
3	**11 570**	**11 299**	**10 621**	**10 362**	**10 109**	**10 190**	**10 196**	**10 094**
3a	2 891	2 940	3 061	2 803	2 750	2 890	2 840	2 893
3b	308	237	189	166	114	68	63	43
3c	2 101	2 047	1 917	1 939	1 632	1 351	1 238	991
3d	3 729	3 583	3 278	3 309	3 614	3 925	4 263	4 544
3e	2 541	2 492	2 176	2 145	1 999	1 956	1 792	1 623

* Some deaths are missing

1st data set (prevalence). All persons in institutional care due to **ACS** or died due to **coronary artery disease** [1] in 2013
n = 21 129 (1)

Number of persons who died because of coronary artery disease and had no hospital care [2] due to ACS in 2013
n = 9 514 (1a)

Number of persons who were in long term care or had hospital care but no acute hospital care due to ACS and did not die
n = 737 (1b)

Number of persons who had no hospital care or long term care [3] during the previous 365 days
n = 2 970 (1a1)

Number of persons who had acute hospital care due to ACS during the previous 365 days
n = 404 (1a2)

Number of persons who had non-acute hospital care [4] or long term care due to ACS during the previous 365 days
n = 191 (1a3)

Number of persons who had hospital or long term care only due to other diagnosis than ACS during the previous 365 days
n = 5 949 (1a4)

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n = 1 400 (1a4b)

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n = 604 (2a)

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Persons under 18 years at the time of first index admission in 2013
n = 0 (2b)

Exclusion 3:
Foreigners [6] and patients with incomplete ID
n = 180 (38=incomplete ID) (2c)

National comparison data. Number of ACS patients in the comparison database after exclusion
n = 10 094 (3)

Stemi
**n = 2 893
(3a)**

Recurrent AMI
**n = 43
(3b)**

Undefined AMI
**n = 991
(3c)**

Non-stemi
**n = 4 544
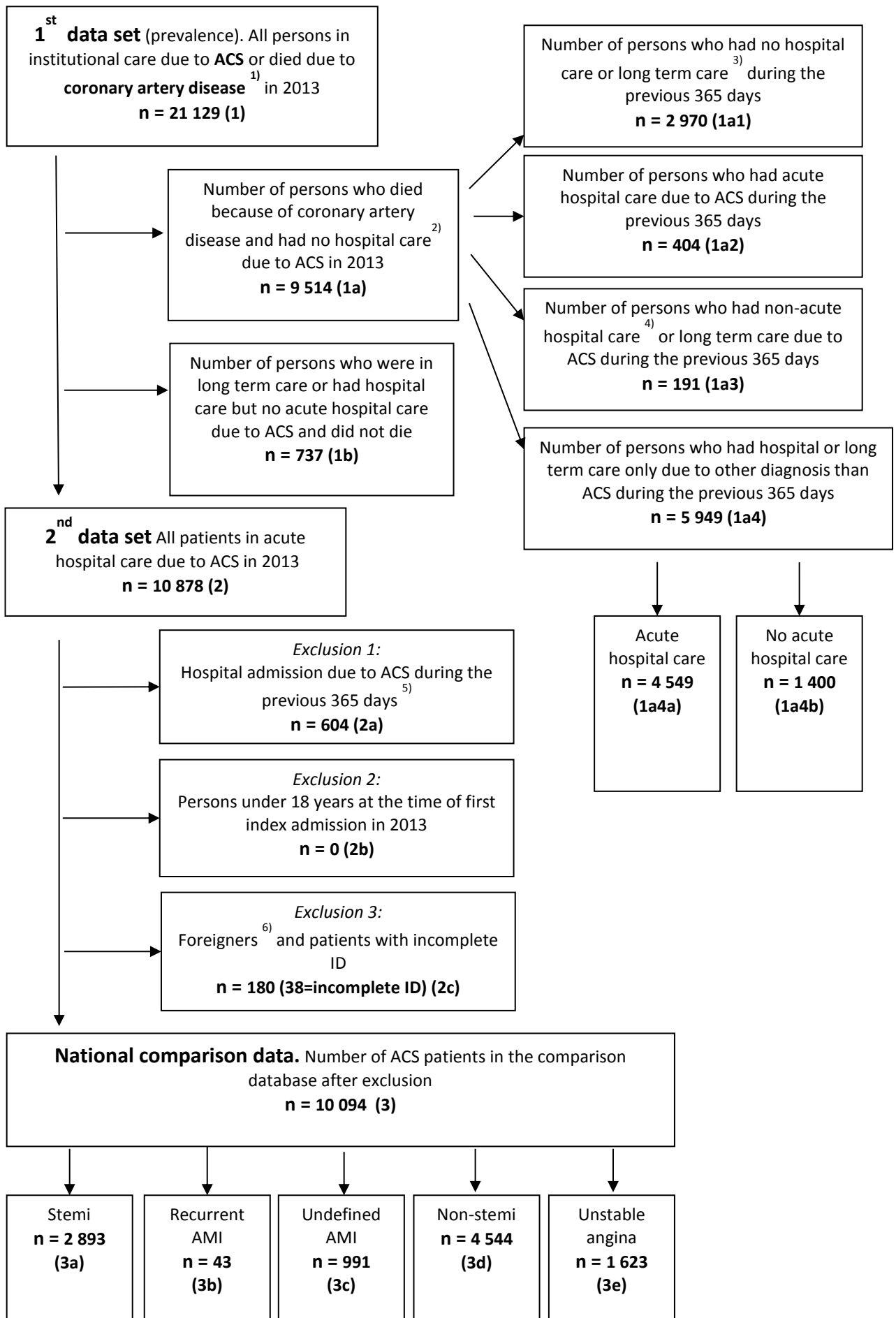(3d)**

Unstable angina
**n = 1 623
(3e)**

Figure A2. Creation of the Finnish comparison database for AMI in 2013

1. Coronary artery disease is defined according to the following causes of death codes: **'I20' , 'I21' , 'I22' , 'I23' , 'I24' , 'I25' , 'I46' , 'R96' , 'R98' , 'R99'** .
2. Hospital care is defined as inpatient hospital care only. Hospital data is based on the Finnish Care Register for Health Care (FCRC)
3. Data on long-term care is based on the Care Register for Social Welfare
4. Non acute hospital care includes care given in health centers and other hospitals (included in FCRC) in departments without specialty code or specialty code is general medicine.
5. Counting starts from the first index admission in 2013.
6. In Finland all the AMI patients whose home municipality is Åland or unknown are excluded from the comparison database

Table A2. Construction of AMI data bases in Finland 2006-2013

Data	2006	2007	2008	2009	2010	2011*	2012	2013
1	20 765	20 598	20 312	19 963	20 004	16 932	19 680	19 428
1a	10 122	10 294	10 398	10 226	10 509	7 383	9 946	9 584
1a1	3 242	3 289	3 384	3 168	3 298	1 557	3 061	2 971
1a2	563	524	516	412	490	407	400	388
1a3	207	197	215	210	183	183	178	184
1a4	6 110	6 284	6 283	6 436	6 538	5 236	6 307	6 041
1a4a	4 890	5 029	4 968	4 981	4 984	4 081	4 822	4 634
1a4b	1 220	1 255	1 315	1 455	1 554	1 155	1 485	1 407
1b	580	571	626	662	596	597	574	625
2	10 063	9 733	9 288	9 075	8 899	8 952	9 160	9 219
2a	609	557	494	507	484	410	455	432
2b	2	1	1	2	0	0	0	0
2c	86	116	119	131	103	112	118	159
2c1	13	10	3	2	1	0	1	35
3	9 366	9 059	8 674	8 435	8 312	8 430	8 587	8 628
3a	2 959	2 995	3 116	2 855	2 797	2 926	2 875	2 930
3b	321	248	198	171	117	69	64	44
3c	2 157	2 109	1 961	1 980	1 667	1 375	1 257	1 006
3d	3 929	3 707	3 399	3 429	3 731	4 060	4 391	4 648

* Some deaths are missing