European Heart Journal (2004) **25**, 1880–1890

Clinical research

The prevalence of abnormal glucose regulation in patients with coronary artery disease across Europe

The Euro Heart Survey on diabetes and the heart

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Received 6 April 2004; revised 8 July 2004; accepted 20 July 2004

See page 1865 for the editorial comment on this article (doi:10.1016/j.ehj.2004.07.027)

KEYWORDS
Coronary artery disease;
Diabetes mellitus;
Impaired glucose tolerance;
Oral glucose tolerance test

Aim The objective behind the Euro Heart Survey on diabetes and the heart was to study the prevalence of abnormal glucose regulation in adult patients with coronary artery disease (CAD).

Methods and results The survey engaged 110 centres in 25 countries recruiting 4196 patients referred to a cardiologist due to CAD out of whom 2107 were admitted on an acute basis and 2854 had an elective consultation. Patient data were collected via a web-based case record form. An oral glucose tolerance test (OGTT) was used for the characterisation of the glucose metabolism.

Thirty-one per cent of the patients had diabetes. An OGTT was performed on the 1920 patients without known diabetes, of whom 923 had acute and 997 had a stable manifestation of CAD, respectively. In patients with acute CAD, 36% had impaired glucose regulation and 22% newly detected diabetes. In the stable group these proportions were 37% and 14%.

Conclusion This survey demonstrates that normal glucose regulation is less common than abnormal glucose regulation in patients with CAD. OGTT easily discloses the glucometabolic state and should be a routine procedure. The knowledge of glucometabolic state among these patients should influence their future management because it has great potential to improve the outcome.

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0195-668X/$ - see front matter
doi:10.1016/j.ehj.2004.07.027

Introduction

Type 2 diabetes, a presently rapidly expanding disease,[1] is a major risk factor for cardiovascular morbidity and mortality.[2] The increased risk for coronary artery disease is apparent already at modestly elevated levels of blood glucose still below the present threshold for diabetes.[3–5] Established diabetes is associated with impaired prognosis after myocardial infarction (MI).[2] Newly detected abnormal glucose tolerance is one of the strongest prognostic factors following an MI.[6] Although evidence based management in acute and stable coronary artery disease[7–9] seems to be at least as effective in diabetic as in non-diabetic patients with MI, it is less well utilised in the former patient category.[10–12] Moreover strict insulin-based glucometabolic control improves survival in patients with diabetes and acute MI.[13] Identification and appreciation of glucometabolic abnormalities in patients with acute coronary syndromes would therefore have the potential to identify patients in whom established management strategies may improve the outcome. A substantial proportion of adults, meeting the diagnostic criteria for diabetes do, however, remain undiagnosed, as made evident by the Glucose Tolerance in Patients with Acute MI (GAMI) study.[14]

A survey on diabetes and the heart was initiated within the framework of the European Society of Cardiology Euro Heart Survey (EHS) programme.[15] The main objectives were: (1) to assess the prevalence of diabetes mellitus and impaired glucose regulation in adult patients with coronary artery disease; (2) to compare diagnostic and therapeutic strategies in patients with coronary artery disease in relation to glucose metabolism; (3) to identify opportunities to improve patient management by improving established or developing new guidelines and tools for their implementation. The present report from the Diabetes and Heart survey focuses on the first of these objectives.

Materials and methods

The Diabetes and Heart survey is a multi-centre European prospective observational study involving 110 centres in 25 countries. Participating countries and centres are presented in Appendix A. Each centre was asked to recruit at least 20 patients. Consecutive patients at an age >18 years were screened for a diagnosis of coronary artery disease (CAD) when admitted to the hospital wards or visiting the outpatient clinics. The hospital admissions were labelled as acute or elective. All patients were assessed, investigated and treated at the discretion of their physicians in charge according to the usual institutional practice.

Data were collected by means of a web based electronic case record form (CRF; www.euroheartsurvey.com). The CRF included demography, conventional risk factors for cardiovascular disease and diabetes, family history of premature CAD (first degree relatives before the age of 55 in men and 65 years in women), family history of diabetes mellitus, medical history, performed or scheduled investigations, treatment and results of tests requested by the protocol. The specific reason for hospital admission was recorded together with pertinent information on the clinical status and the final diagnosis. The following data were obtained: weight, height, waist and hip circumferences, blood pressure, plasma glucose on enrolment (recorded as random (RPG) or fasting (FPG)), serum creatinine, blood lipids (total-, LDL- and HDL-cholesterol, triglycerides), glycated haemoglobin A1c (HbA1c), urine sample for albumin: creatinine ratio, outcome of echocardiography and coronary angiography if performed. Treatment was recorded as used prior to, and recommended after, the consultation and included diagnostic and revascularization procedures (PCI or CABG).

The National Survey co-ordinators ascertained that requirements for ethical approval were adhered to in each country. Based on local rules, the patients were enrolled following oral and/or written informed consent. The patients were informed that they would be followed up after one year.

Definitions

Character of admission

Acute admissions were defined as not prescheduled hospital admissions due to, or part of, acute coronary syndromes, aggravated symptoms of heart failure or arrhythmias due to CAD. Elective consultations were all visits in an outpatient clinic and scheduled hospital admissions for diagnostic procedures, treatment adjustments or elective interventions related to CAD.

Cardiovascular diagnoses

CAD was defined on clinical grounds supported by at least one objective finding including ischaemic changes or previous MI in the ECG, abnormal stress tests (ECG, scintigraphy or echocardiography) indicating MI or a coronary angiogram revealing stenosis >50% of the lumen diameter in any major coronary artery. Acute MI was defined according to the European and American consensus guidelines.[16] Angina pectoris was graded according to criteria established by the Canadian Cardiovascular Society.[17] Heart failure was diagnosed according to the criteria established in the ESC Guidelines for heart failure.[18] Grading of heart failure was performed according to criteria established by the New York Heart Association.[19]

Glucometabolic parameters

Previously known diabetes mellitus was defined as a diagnosis established according to routines at the participating centres based on the WHO classification.[20] To assess the status of glucose metabolism, investigators were asked to provide a measurement of fasting blood glucose in all patients on enrolment or in the morning of the day following hospital admission. For acutely admitted patients a repeated measurement of fasting blood glucose was to be taken in stable conditions prior to hospital discharge. The protocol recommended that all patients without previously diagnosed diabetes should undergo a standard oral glucose tolerance test (OGTT; 75 g anhydrous glucose in 250–300 ml water; 20) as soon as they were in stable condition prior to hospital discharge, or within less than two months following the index consultation.

Glucose concentrations were measured according to local routines if possible in venous plasma but otherwise in capillary plasma or capillary whole blood. Glucose concentrations derived

from different types of samples were all converted to venous plasma glucose, expressed in mmol/l, before final data analysis by means of conversion factors established by the European Diabetes Epidemiology Group working at the DECODE study:[5]

Plasma glucose = 0.558 + 1.119 * venous whole blood glucose (mmol/l)

Plasma glucose = 0.102 + 1.066 * capillary whole blood glucose (mmol/l)

HbA_{1c} was analysed by high-performance liquid chromatography in a core laboratory (Department of Clinical Chemistry, Karolinska University Hospital, Solna, Sweden) on capillary blood applied to filter paper with an upper normal limit less than 5.2% (Boehringer Mannheim Scandinavian AB, Bromma, Sweden).[21]

Classification of glucometabolic state was made based on Fasting Plasma Glucose (FPG) measured in a stable condition or OGTT when available. According to FPG patients were categorised as FPG <6.1 = Normal Fasting Glycaemia (NFG); FPG $\geqslant$6.1 but <7.0 = Impaired Fasting Glycaemia (IFG), FPG $\geqslant$7.0 = Diabetes mellitus (DM). When OGTT was available glucose regulation was divided into the following four categories:

Normal Glucose Regulation (Normal) = OGTT (0 min) <6.1 and OGTT (2 h) <7.8

Impaired Fasting Glycemia (IFG) = OGTT (0 min) $\geqslant$6.1 but <7.0 and OGTT (2 h) <7.8

Impaired Glucose Tolerance (IGT) = OGTT (0 min) <7.0 and OGTT (2 h) $\geqslant$7.8 but <11.1

Diabetes Mellitus (DM) = OGTT (0 min) $\geqslant$7.0 or OGTT (2 h) $\geqslant$11.1

In the text, impaired glucose regulation (IGR) refers to both IFG and IGT whilst abnormal glucose regulation includes IGR and diabetes.

Risk factors

Conventional risk factors such as smoking, level of physical activity and family history were recorded according to information given by the patients. Smoking was reported as never, former (if quitted <1 month) or current.

Vascular disease

Peripheral artery disease (PAD) was defined as characteristic symptoms (intermittent claudication or pain at rest) or documented aortic aneurysm or a history of interventional procedures or amputation due to vascular reasons.

Cerebrovascular disease was defined as the presence of previous or current stroke, persistent or transient neurological deficit, known carotid stenosis or prior carotid intervention.

Hyperlipidaemia

Hyperlipidaemia was recognised in the case of a lipid profile exceeding the reference limits recommended in European guidelines for cardiovascular disease prevention[22] (total cholesterol $\geqslant$5.0, HDL-cholesterol $\leqslant$1.0 in men, or $\leqslant$1.1 in women, triglycerides $\geqslant$2.0 mmol/l) or ongoing lipid-lowering treatment.

Chronic renal failure

Chronic renal failure was diagnosed if the serum creatinine was >200 μmol/l or the patient was on chronic dialysis or had undergone kidney transplant.

Statistics

The data analysis was performed using SAS statistical software (release 8.2, SAS Institute, Cary, NC, USA). The results for continuous variables are presented as median and lower and upper quartiles. Categorical variables are presented as counts or proportions (%). Proportions relate to all patients enrolled, if not stated otherwise, and may therefore not always add up to 100% due to incomplete answers or missing values. Formal statistical comparisons between groups have not been performed since this was a descriptive investigation.

Results

Sites of enrolment — participating centres

Enrolment of patients was initiated on February 10, 2003 and continued until January 16, 2004 with starting time varying between countries. Each centre collected patients during 2—6 weeks. A total of 5377 patients were enrolled (Fig. 1) out of whom 416 were excluded due to protocol violations (diagnosis of CAD not confirmed = 75; patients selected primarily for having diabetes mellitus = 341). The current database comprises 4961 patients with previously (72%) or newly (28%) diagnosed coronary artery disease. The geographical distribution was relatively well balanced between the Western (27%), Central (28%) and Mediterranean (39%) European regions while the proportion from Northern Europe (6%) was limited (Table 1).

Most of the centres enrolled patients on hospital admission (47%) and/or during outpatient visit (45%) while some based their recruitment on the outpatient clinic only (8%). Thirty-eight percent of the centres were University hospitals. Other recruiting sites were district or regional (34%), community or private centres (21%) or other specialist cardiology centres (7%). In all the centres there were specialists in cardiology and usually in internal medicine (77%) or diabetology (58%) as well. The participating centres are listed in Appendix A.

Patients

Out of the 4961 patients 2107 (42.5%) were acute hospital admissions (Acute) and 2854 (57.5%) were consulted on an elective basis (Elective) as presented in Fig. 1. Patient characteristics are summarized in Table 2. A majority of patients were males both in the Acute (70%) and the Elective (71%) groups. Previous medical diagnoses are summarized in Table 3. The diagnosis of coronary artery disease was previously known in half of patients admitted due to acute symptoms and in 89% of those consulted on an elective basis. Diabetes mellitus, mostly of type 2 (93%), was known in 1524 patients (31%) with a similar distribution in the Acute (32%) and the Elective (30%) groups. Pharmacological treatment as used by the patients at the time of enrolment is detailed in Table 3.

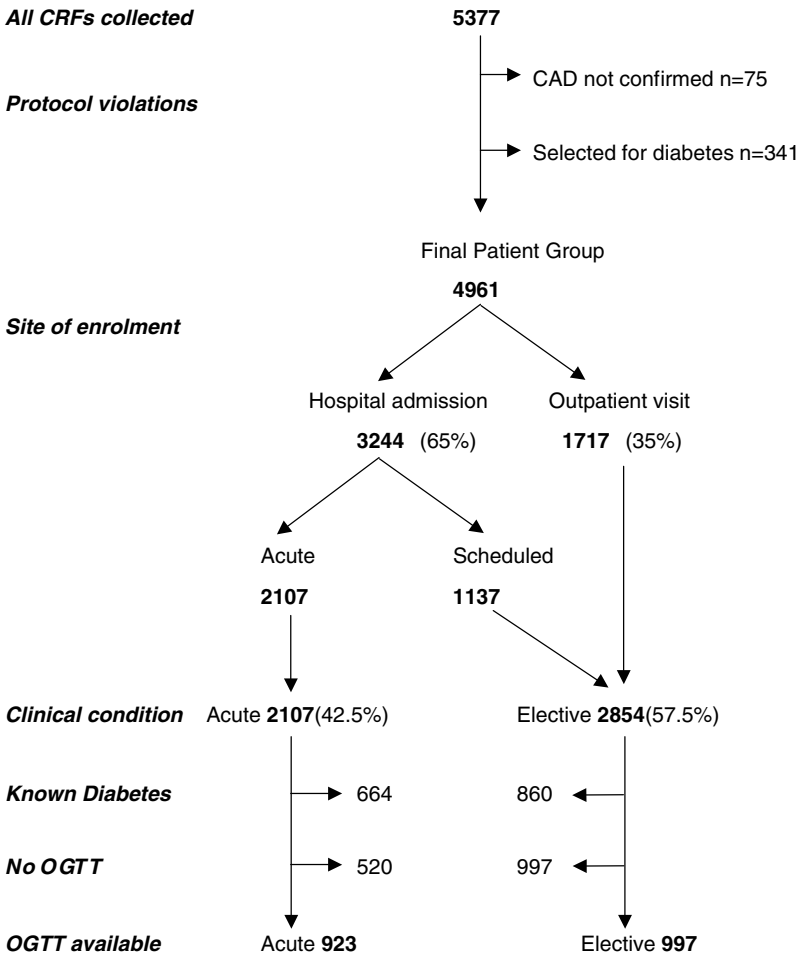

Fig. 1 The patient cohort in the Euro Heart Survey on diabetes and the heart.

Table 1 Geographical distribution of enrolled patients

Region[a]	Countries	Centres	Patients	Acute[b]	Diabetes[c]	OGTT[d]
Total count	25	110	4961	2107	1524	1920
Northern	3	6	272	51%	27%	87%
Central	11	39	1381	52%	30%	75%
Western	5	23	1359	29%	24%	21%
Mediterranean	6	42	1949	44%	36%	65%

Data are presented as count and proportion (%) of patients enrolled in each region.
[a] Regions = defined following a modified demographic model proposed by Kaa[42]: Northern (Finland, Sweden and UK), Central (Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Lithuania, Macedonia, Poland, Romania and Slovenia), Western (Austria, France, Germany, the Netherlands and Switzerland) and Mediterranean (Cyprus, Greece, Italy, Portugal, Spain and Egypt).
[b] Acute = proportion of acute admissions.
[c] Diagnosis of diabetes mellitus established before enrolment.
[d] Proportion of patients without previously known diabetes in whom an oral glucose tolerance (OGTT) was performed as recommended in the study protocol.

Reason for consultation

The majority of patients in the Acute group were admitted for acute coronary syndromes (n = 1897, 91%) including acute MI with (36%) and without (19%) ST-segment elevation or unstable angina pectoris (36%). A small group was admitted for cardiac arrest or arrhythmia (7%) and/or heart failure (13%).

Patients within the Elective group were either seen at the outpatient clinic (n = 1717; 60%) or hospitalised

Table 2 Basic demography

	All $n = 4961$	Males (71%) $n = 3500$	Females (29%) $n = 1461$
Age (years)	66 (57, 74)	64 (56, 73)	70 (63, 76)
Weight (kg)	79 (70, 87)	80 (73, 90)	72 (65, 81)
BMI (kg/m^2)	27.4 (25.0, 30.3)	27.2 (25.0, 29.9)	27.7 (25.0, 31.2)
Waist (cm)	98 (90, 106)	99 (91, 107)	95 (86, 105)
Waist—hip ratio	0.96 (0.91, 1.02)	0.98 (0.94, 1.03)	0.91 (0.85, 0.97)
Systolic BP (mmHg)	137 (120, 150)	134 (120, 150)	140 (125, 160)
Diastolic BP (mmHg)	80 (70, 90)	80 (70, 90)	80 (70, 90)
Smoking (%)			
Never/former/current	35/40/22	23/48/26	64/21/12
Physical activity (%) (at least 30min *n*-times per week)			
No regular/<3/$\geqslant$3	57/12/21	54/13/23	65/10/15
Fasting plasma glucose (mmol/l)			
Known diabetes ($n = 1180$)	7.8 (6.6, 10.6)	7.8 (6.4, 10.3)	7.8 (6.7, 11.0)
No prior diabetes ($n = 2370$)	5.7 (5.1, 6.5)	5.7 (5.1, 6.5)	5.6 (5.0, 6.4)

Data are presented as median (lower, upper quartiles) unless otherwise stated; BP = blood pressure.

Table 3 Medical history and pharmacological treatment at enrolment

Parameters	Patient group	
	Acute 2107 (42.5%)	Elective 2854 (57.5%)
Medical history		
Coronary artery disease	1044 (50)	2577 (89)
Myocardial infarction	685 (33)	1505 (53)
Coronary intervention (PCI, CABG)	451 (21)	1318 (46)
Heart failure	404 (19)	704 (25)
Hypertension	1329 (63)	1917 (67)
Hyperlipidaemia	1022 (49)	2057 (72)
Stroke	136 (7)	140 (5)
Peripheral artery disease	233 (11)	513 (18)
Diabetes mellitus previous diagnosis	664 (32)	860 (30)
Type 1; type 2; other type (%)[a]	36 (5); 625 (94); 3 (1)	59 (7); 796 (93); 5 (1)
Medication		
β-Blockers	795 (38)	2006 (70)
ACE-inhibitors or ARBs	961 (46)	1729 (61)
Calcium antagonists	509 (24)	802 (28)
Diuretics	541 (26)	958 (34)
Lipid-lowering drugs	735 (35)	1933 (68)
ASA	926 (44)	2062 (72)
Clopidogrel or Ticlopidine	183 (9)	448 (16)
Diabetes treatment(%)		
No drugs/Insulin/OAH/Combined	16/29/50/5	13/25/56/6

Data are presented as count (%); Hyperlipidaemia = a lipid profile outside the recommended reference limits (total cholesterol $\geqslant$5.0, HDL-cholesterol $\leqslant$1.0 in men, or $\leqslant$1.1 in women, triglycerides $\geqslant$2.0) or ongoing lipid-lowering treatment; OAH = Oral Anti-Hyperglycaemic agents.
[a] Proportion out of patients with prior diagnosis of diabetes.

on a scheduled basis ($n = 1137$; 40%) (Fig. 1). About 25% of them had a history of acute admission due to CAD within the preceding three months. In some patients the reason for consulting a cardiologist was to establish the diagnosis of CAD either in the course of a scheduled hospitalisation ($n = 158$; 14%) or investigations performed while visiting the outpatient ($n = 169$; 10%). A total of 51% of the Elective patients had a history of chest pain classified according to the CCS 1 to 4 in 31%, 45%, 20% and 4% respectively. Thirty percent of those recruited when hospitalised had symptoms of angina during the last month compared with 13% of those seen as outpatients. In addition 38% were dyspnoeic out of whom 18%, 53%, 24% and 4% were scored in the NYHA functional classes I—IV.

Following hospital admission or consultation in the outpatient clinic, the final cardiovascular diagnoses were established based on symptoms, clinical assess-

Table 4 Final cardiovascular diagnoses

Final diagnosis	Patient group	
	Acute 2107 (42.5%)	Elective 2854 (57.5%)
Coronary artery disease		
Previously diagnosed	1044 (50)	2527 (89)
Q-wave MI[a]	288 (14)	632 (22)
Non-Q-wave MI[a]	216 (10)	242 (9)
Unstable angina pectoris[a]	369 (18)	441 (16)
Stable angina pectoris[a]	138 (7)	1088 (38)
Newly diagnosed	1063 (50)	327 (11)
Q-wave MI[a]	559 (27)	11 (<1)
Non-Q-wave MI[a]	283 (10)	14 (<1)
Unstable angina pectoris[a]	176 (8)	65 (2)
Stable angina pectoris[a]	30 (1)	235 (8)
Heart failure	554 (26)	745 (26)
Previously diagnosed	404 (19)	704 (25)
Newly diagnosed	150 (7)	41 (1)
Cerebrovascular disease	223 (11)	431 (15)
Peripheral artery disease	261 (12)	563 (20)
Hyperlipidaemia	1471 (67)	2231 (78)
Previously diagnosed	1022 (49)	2057 (72)
Newly diagnosed	449 (21)	174 (6)
Chronic renal failure	168 (8)	289 (10)

Data are presented as count (%); MI = myocardial infarction; Hyperlipidaemia = a lipid profile outside the recommended reference limits (total cholesterol $\geqslant$5.0, HDL-cholesterol $\leqslant$1.0 in men, or $\leqslant$1.1 in women, triglycerides $\geqslant$2.0) or ongoing lipid-lowering treatment.
[a] Data do not match up to 100% due to incomplete answers.

ment and diagnostic investigations as presented in detail in Table 4.

Classification of glucometabolic state

In the entire cohort 1524 (31%) patients had a diagnosis of diabetes mellitus established prior to inclusion leaving the remaining 3437 patients as eligible for further glucometabolic classification. A fasting plasma glucose was measured in 2370 (69%) and an OGTT in 1920 (56%) of these patients respectively. Classification of glucometabolic state based on the OGTT is presented in Table 5. The proportion of patients within either the Acute or Elective groups who had a normal glucose regulation was low with 42% and 49% respectively. When glucometabolic classification was assessed by a fasting plasma glucose only (OGTT (0 min)) the proportion of patients with abnormal glucose regulation was substantially lower than when the post-load plasma glucose (OGTT (2 h)) was considered (Fig. 2). Without the use of post-load glycaemia (OGTT), two thirds of patients with abnormal glucose regulation would have remained undiagnosed in the Acute (n = 338 out of 534) and the Elective (n = 327 out of 511) groups respectively.

Discussion

The main finding of the Euro Heart Survey on diabetes and the heart is that a majority of patients with coronary artery disease have abnormal glucose metabolism and

Table 5 Glucose regulation classified by OGTT in patients with coronary artery disease without any previously known diabetes (n = 1920)

Classification	Normal	IFG	IGT	Diabetes
OGTT (0 min) (mmol/l)	<6.1	$\geqslant$6.1 and <7.0	<7.0	$\geqslant$7.0
OGTT (2 h) (mmol/l)	<7.8	<7.8	$\geqslant$7.8 and <11.1	or $\geqslant$11.1
Group (n)				
Acute (923)	389 (42%)	39 (4%)	294 (32%)	201 (22%)
Elective (997)	486 (49%)	50 (5%)	320 (32%)	141 (14%)

Concentrations of plasma glucose refer to venous plasma (mmol/l).
In all categories a conjunction of both conditions for OGTT (0 min) and OGTT (2 h) are to be met except from Diabetes (or).
IFG = Impaired fasting glucose; IGT = Impaired glucose tolerance; Diabetes = newly detected diabetes mellitus by means of an OGTT.
OGTT (0 min) = Fasting plasma glucose before ingestion of the 75 g glucose load; OGTT (2 h) = plasma glucose exactly 2 h after oral intake of glucose challenge.

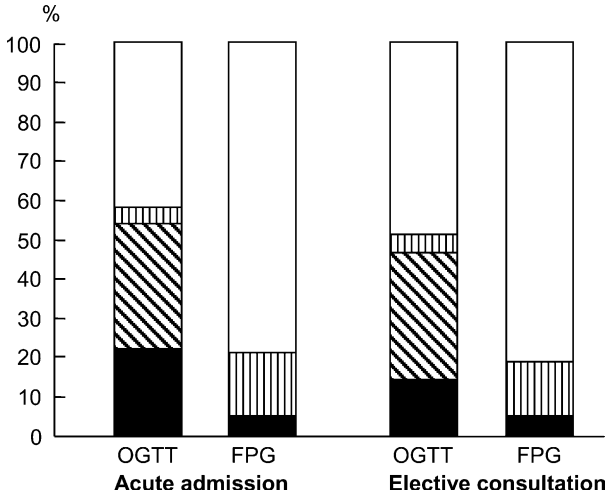

Fig. 2 Comparison of glucometabolic characterisation by means of an oral glucose tolerance test (OGTT) or fasting plasma glucose (FPG) only. Data from patients without previously known diabetes in whom an OGTT was performed giving the opportunity to either express glucometabolic state based either on the FPG represented by OGTT (0 min) or the full information from the OGTT including both OGTT (0 min) and the 2 h post-load plasma glucose OGTT (2 h) See text for further information. □ = normal; ▥ = impaired fasting glucose; ▧ = impaired glucose tolerance; ■ = newly detected diabetes.

that an OGTT is needed to accurately disclose these patients.

A relevant question is whether the patients are representative of a general population of patients with CAD. Surveys have a more limited possibility than clinical trials to monitor the inclusion process ensuring enrolment of consecutive patients. On the other hand a survey recruits patients as seen in all day clinical practice free from exclusion criteria commonly applied in clinical trials. Still most patients were recruited in a hospital-based setting. Accordingly it has to be acknowledged that patients attending these centres may not be representative for those cared for entirely by their general practitioner. Anyhow the size of the current survey, comprising almost 5000 individuals with a wide spectrum of various manifestations of CAD makes it reasonable to assume that patterns disclosed indeed represent a true picture of the actual clinical situation.

The proportion of patients with diabetes already known at enrolment was 31%, which is somewhat higher than the proportions reported in previous Euro Heart Surveys involving patients with stable CAD such as the Euro Heart Survey on prevention (EUROASPIRE I or II: 18% or 20%)[23] and the Euro Heart Survey on Acute Coronary Syndromes (21%, 24% and 32% depending on the ECG pattern)[24] and population based registry.[10] A partial explanation may be that participation in the survey forced the investigators to raise specific questions concerning previously diagnosed diabetes including the use of hypoglycaemic agents. Another potential reason is that the overall prevalence of diabetes increases rather rapidly,[1] which will influence the proportion of diabetic patients with a cardiovascular disease, as does an increasing age among patient populations.

The main purpose of the Euro Heart Survey on diabetes and the heart was to describe the actual prevalence of abnormal glucose regulation in patients with CAD. That patients with an acute MI may present with elevated blood glucose was originally reported by Wahlberg in 1966.[25] This and subsequent findings of a similar kind were interpreted as a temporary reflection of stress-induced catecholamine release rather than a true disturbance of glucose metabolism.[26] These observations were based on small, selected patient samples without uniform definitions of the glucometabolic state, what combined with the absence of a systematic follow up may explain the interpretation of these early findings. More recent observations revealing that the glucometabolic state at admission is an important prognostic factor following an acute MI[27–29] increased the interest for further studies of the actual metabolic state in such patients. In the GAMI trial, OGTT was performed immediately before and after 3 and 12 months following hospital discharge in 181 patients with acute MI, no previously diagnosed diabetes and admission blood glucose <11.0 mmol/l. This study disclosed that newly detected diabetes and impaired glucose tolerance were very common (67%) and that the initial observation before hospital discharge was preserved during follow-up.[14,30] The present findings strongly support these observations. Moreover it extends the knowledge on the relation between abnormal glucose regulation and CAD by demonstrating a similar pattern not only in the setting of acute coronary syndromes but for the first time also in patients with stable CAD.

The main tool for assessment of glucose regulation in this survey was OGTT following the recommendations by the WHO.[20] It is disappointing that this test was performed only in a proportion, 56%, of the patients without previously known diabetes. Moreover, and despite the fact that this survey asked for it, a fasting glucose was available only in 72%, a random plasma glucose on enrolment in a further 18% and 10% of the population did not have blood glucose measured at all. The major reason is that some Ethics Committees did not approve performance of an OGTT. Moreover survey participation was voluntary and not reimbursed. Finally, lack of local routines for performing an OGTT in a cardiology setting may have decreased the willingness to perform these tests. This assumption is supported by the knowledge that diabetic patients with acute coronary syndromes are less well managed than their non-diabetic counterparts[7–9] possibly reflecting a lack of knowledge or limited interest for diabetology among cardiologists. For the purpose of assessing the prevalence of glucometabolic perturbations in patients with CAD, 1920 completed OGTTS, reasonably well distributed across Europe, is sufficient.

Accumulating evidence does indeed reveal that abnormal glucose regulation is common among patients with CAD. In EUROASPIRE II recently reporting on 4489 retrospectively identified patients with stable CAD, the prevalence of already known diabetes was 20%. By including data from fasting blood glucose, 8.5% of these patients were diagnosed with previously unknown diabetes while 19% had impaired fasting glucose.[23] When fast-

ing and post-load glycaemia were analysed in 363 male patients without previously known diabetes, admitted for coronary angiography, 16% fulfilled the WHO criteria for diabetes and 36% had impaired glucose tolerance.[31] Meier et al.,[32] performed an OGTT on 129 of 562 consecutive patients with an acute MI. According to the WHO criteria, 19% were found to have previously undiagnosed diabetes while 35% had impaired glucose tolerance. Taubert et al.,[33] concluded that diabetes was previously unrecognised among 47% of a total of 1042 patients scheduled for coronary angiography, who had this diagnosis when it was specifically looked for.

The present survey showed a somewhat higher prevalence of glucose abnormalities in acute conditions than in the patients with stable CAD. Dissimilarities between the patient populations may have different explanations. The most obvious are perhaps discrepancies in age and gender distribution. However the important, in fact striking, information is that glucometabolic abnormalities are considerably more common in patients with any manifestation of CAD than in the general population[34,35] and this is true across Europe and in need of future attention. Moreover it is possible to identify the actual glucometabolic state by means of an OGTT performed as early as within a few days after the onset of MI and before hospital discharge, whatever increases the feasibility of the testing.[14,36]

The outcome of the Euro Heart Survey on diabetes and the heart strongly underlines the importance to include diagnostic testing of glucose abnormalities when investigating patients with CAD. It may be argued that it would be unethical not to look for such conditions considering their commonness and dismal prognostic influence.[2–5] An OGTT is needed for full disclosure of the actual glucometabolic state. One would have missed about two thirds of patients with abnormalities using fasting plasma glucose only (Fig. 2). In this respect the present data are in accordance with the findings by Qiao et al.,[37] and statements by Barret-Connor.[38]

Improved treatment has the potential to improve the prognosis.[10,11] For patients with stable CAD, the presence of glucometabolic disturbances should increase the strength of various secondary preventive efforts applying even more strict targets with regards to blood pressure and lipid control as outlined in the most recent European guidelines for CAD prevention.[22] In patients with impaired glucose tolerance it is possible to prevent or retard the onset of overt diabetes mellitus.[39–41] For those with either established or newly detected diabetes a meticulous control of hyperglycaemia have the potential to retard the atherothrombotic vascular disease by several mechanisms which goes beyond conventional cardiovascular risk factors and which improves survival.[13]

In conclusion, the Euro Heart Survey on diabetes and the heart clearly demonstrates that abnormal glucose regulation is in fact more common than normal glucose metabolism in patients with CAD. An OGTT is a feasible tool to disclose the glucometabolic status and should be included in the diagnostic routines for such patients. Information derived from fasting plasma glucose is, in this respect, insufficient.

Appendix A. Organisation of the survey

Diabetes and the Heart Expert Committee: L. Ryden *(Survey Chairman)*, Sweden; K. Malmberg *(Survey Co-Chairman)*, Sweden; M. Bartnik *(Research Fellow)*, Sweden; K. Pyörälä, Finland; E. Standl, Germany; R. Ferrari, Italy; M.L. Simoons, The Netherlands; J. Soler-Soler, Spain.

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