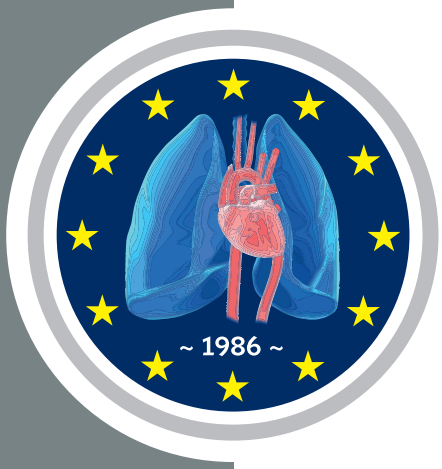
The European Association for Cardio-Thoracic Surgery



Fourth EACTS Adult Cardiac Surgical Database Report 2010

Towards global benchmarking

Compiled by

Ben Bridgewater & Jan Gummert
on behalf of the European Association for Cardio-Thoracic Surgery

Peter K.H. Walton & Robin Kinsman
Dendrite Clinical Systems Ltd

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Fourth
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Adult Cardiac Surgical Database Report

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Message from the President

For me, as a congenital cardiac surgeon, the EACTS congenital database is one of the most valuable assets of the Association. Many centres undertaking congenital cardiac surgery across Europe contribute fully to this database. The degree of participation and the size of the database provide a powerful tool that allows us to generate many meaningful analyses of current practice, trends and outcomes in the specialty. This has given us great credibility.

I am very pleased to see that the Adult Cardiac Surgery Database has grown over the years as well. The data presented in this current report are overwhelming, and the level of analysis and presentation is outstanding, and a credit to all the surgeons, hospitals and professional societies who have contributed data. We now need to attract the same level of participation in the EACTS Adult Cardiac Surgery Database as we already have for the congenital database; we have new initiatives in place to encourage countries to contribute their data.

Broad representation and complete contributions add strength to the database and as such we are delighted with the contributions from outside Europe, especially those from China (including Hong Kong). A robust adult cardiac surgery database will help to improve quality, enhance research opportunities, and provide an up-to-date overview of cardiac surgical activities across Europe and beyond.

I congratulate the database committee on this tremendous achievement and I wish them every success for the future.

Pascal Vouhé

President, European Association for Cardio-Thoracic Surgery

Executive summary

This EACTS Adult Cardiac Surgery Database Report contains information on over one million patients undergoing adult cardiac surgery in the period up to the end of December 2008. The submissions are from 366 hospitals in 29 countries across Europe and China, including Hong Kong.

The data include analyses of patient characteristics, the type of surgery, operative risk factors and post-operative outcomes including in-hospital mortality and length-of-stay. We have analysed the pooled data to show overall trends over time and compared the incidence of risk factors and outcomes between countries. We have set these analyses against data on populations, health status and economic statistics from the World Health Organisation.

Overall trends

- The major contributors of data are England (344,342), Germany (244,216), Belgium (78,739), Poland (64,191), Norway (62,123), Italy (58,524) and Scotland (31,209).
- New contributors to the database include Armenia (85), China (including Hong Kong, 25,108) and Sweden (6,819).
- Overall the proportion of isolated coronary artery bypass graft (CABG) surgery has decreased over time from 69.4% in 1999 to 51.6% in 2008.
- There are marked variations between countries in the proportion of isolated coronary artery bypass surgery, isolated valve and combined valve & CABG surgery.
- The proportion of female patients in the database has increased from 26.2% in 1999 to 30.4% in 2008, and there are significant variations in the incidence of female gender between countries.
- All counties have submitted operation type, age and gender data, but there is variation in the completeness of other fields. We have shown a detailed analysis of this, which we hope will help to drive improvements in data quality in future.
- The overall in-hospital mortality rates reported to the database are: isolated CABG surgery 2.2% (4,908 deaths out of a total of 219,053 procedures), isolated valve surgery 3.4% (2,533 / 75,247) and for combined CABG & valve surgery 6.2% (2,345 / 37,721)

Coronary artery surgery

- There are marked differences in the proportion of the cardiac surgery workload that is isolated coronary surgery between countries, from 30% up to 80%.
- There are also marked differences in the reported length of post-operative hospital stay between countries, from a median of 5 days up to 11 days.
- The average age of patients coming to coronary surgery ranges from 58 years up to 67 years between countries. Average age has increased over time in all the major contributing countries.
- The overall mortality for patients under 56 years of age undergoing CABG surgery is 0.9% (308 / 34,429) and 6.7% (577 / 8,577) for those over 80.
- The mortality for women at 3.1% (1,501 / 48,164) is significantly higher ($p<0.001$) than for men at 2.0% (3,406 / 170,881).
- There has been a marked increase in the proportion of patients undergoing CABG surgery with a diagnosis of diabetes, from 17.6% in 1999 to 31.2% in 2008.
- There has been a decrease in the proportion of CABG operations that are repeat operations from 4.0% in 1999 to 3.1% in 2008 ($p<0.001$).
- There are marked differences in the rates of elective surgery between the major contributing countries, suggesting differences in the ways in which acute coronary syndromes are managed by routine, early-interventional strategies.
- There are large variations in the use of multiple arterial grafts between countries, from a negligible proportion up to 35%, with an overall rate of 5.3%.

- Overall, 21% of those patients undergoing coronary artery surgery in which the technique is described had off-pump surgery. This varies between countries from 0.8% up to 91.4%.
- There is considerable variation in the quality (completion rate) of the data-items required to generate a pre-operative prediction of mortality risk as determined by the ***EuroSCORE***. After making some assumptions about handling missing data-items, a logistic ***EuroSCORE*** was calculated for a sub-set of the isolated CABG surgery patients, which demonstrated that the observed mortality rate was significantly lower than that predicted, suggesting the ***EuroSCORE*** should no longer be used without applying an appropriate re-calibration.
- We have analysed the variation in observed outcomes against predicted risk between countries, and we offer a confidential feedback service of benchmarked data-quality and mortality reports to all contributors.

Aortic valve surgery

- There has been an increase in the average age of patients undergoing aortic valve (AV) surgery in most of the major contributing countries over time. There is variation in the average age between countries and for some contributors more than 20% of patients are now over the age of 80.
- The overall mortality for isolated AV surgery is 3.0% (1,255 / 41,917). Increasing age is strongly associated with increasing mortality, with rates following isolated AV surgery of 1.2% for patients under the age of 56 increasing up to 6.1% for those over 80.
- There are major variations in the incidence of all risk factors between countries, and of particular importance are the differences in incidence of those factors such as NYHA class IV symptoms and impaired left ventricular (LV) function, which are strongly associated with worse short- and longer-term outcomes following surgery.
- There have been large increases in the proportion of patients undergoing biological rather than mechanical aortic valve implantation over time, from 60.5% in 2003 up to 77.7% in 2008 for isolated AV surgery and from 68.5% up to 86.5% for combined AV & CABG surgery. This change has been most marked in patients between 61 and 70 years of age, where the proportion of patients undergoing mechanical AV implantation has fallen from 50.8% to 26.9% over that time across the major contributing countries.

Mitral valve surgery

- The overall mortality rate for isolated mitral valve surgery is 3.6%, ranging from 1.5% for patients under 56 years of age up to 8.9% for those aged over 80.
- The mortality for mitral repair is significantly lower than for replacement (2.1% *versus* 6.8% respectively for isolated valve surgery), particularly for the elderly: 1.4% for isolated repair *versus* 1.6% for replacement for those under 56, rising to 5.7% and 11.9% respectively for those aged over 80.
- There are major variations in the average age of patients between countries, presumably reflecting the different incidence of the aetiologies of rheumatic disease, degeneration and ischaemia.
- The incidence of missing data on valve pathology is high, and drawing conclusions about mitral surgery in the absence of these data is difficult. However, we feel that this is an important finding in its own right in that for mitral valve registry data to be more useful, it must be more complete.
- We have seen marked variations between countries in the proportion of patients coming to mitral valve surgery with significant impairment of left ventricular function, and NYHA class 3 and 4 symptoms.
- There are also big variations in the ratio of mitral valve repair to valve replacement across countries, which again need to be interpreted against a local understanding of valve pathology data.

Preface

The application of the mathematics of probability in medicine has changed the basis of cardiac surgery. For the disorders the cardiac surgeon has to deal with, it is now possible to define contemporary optimum management of the disease in terms of the probability of a defined outcome. The probabilities are usually based on evidence from clinical trials, but also on observational studies.

The EACTS Adult Cardiac Surgical Database is a kind of enormous *observational study* that offers a wealth of information about the common conditions that allow for a definition of optimum management. The Council of EACTS is therefore extremely pleased with this Fourth EACTS Adult Cardiac Surgical Database Report, and hopes that it can serve the membership to understand the differences and the similarities in the practice of cardiac surgery across many countries in, and now also outside, Europe.

There are, of course, limitations to the database and its ability to report complete outcomes of treatment. Ideally one would like to impose an independent system where all data collected on all patients undergoing cardiac surgery are validated and corrected by independent personnel. This process would be costly and difficult to achieve within the constraints of the currently available resources. However, the congenital cardiac surgery database has already implemented such a system, and it would be desirable to have an audit system that could be used for the adult database as well.

Reporting on outcomes is a sensitive issue as well, and for this casemix adjustment is indispensable. Hopefully the updated ***Euroscore*** 2010 will help in this regard.

The EACTS will continue to support database activities, and hopes that at the same time more countries will submit data to the central database in order to strengthen the knowledge that can be derived from it.

Finally, I want to thank the Database Committee, and especially Jan Gummert, Ben Bridgewater, Robin Kinsman & Peter Walton for their tremendous efforts and the wonderful results they have achieved with this report.

Pieter Kappetein

General Secretary, European Association for Cardio-Thoracic Surgery

General introduction

The European Association for Cardio-Thoracic Surgery (EACTS) exists to promote and support all aspects of care given to patients suffering from cardiothoracic surgical disease. This encompasses surgical training, education, research and quality improvement. EACTS has established a database project (founded by Sir Bruce Keogh & Peter Walton) in which data on patients can be collated and analysed to provide information for all stakeholders. In line with the EACTS membership policy being not constrained by geographical barriers, we have also encouraged submission of data from hospitals outside Europe.

We have produced this Fourth EACTS Adult Cardiac Surgery Database Report based upon data on the most recent cohort of patients undergoing adult cardiac surgery, and we have contributions from 29 countries, and 366 hospitals, comprising over one million patients records, including patients undergoing surgery up to the end of December 2008. We would like to thank all contributors for their willingness to support this very important project.

The report has steadily evolved and has reached a high standard; however, it is still a work in progress due to the cumbersome data collection process and difference in data-quality across the contributor countries. Future development of this database will depend on the continued support of national cardio-thoracic organizations and individual surgeons to further increase data quality.

The current report has been configured to provide information on the following areas:

- Geographical variations in the epidemiology of valve disease.
- Summary statistics on healthcare from the World Health Organisation.
- Specific analyses of patient demographics, risk factors, activity trends and clinical outcomes from the EACTS database, including an analysis of international variation.
- An analysis of variation in predicted risk across countries and a framework to allow international mortality benchmarking.

We hope that this will report will provide interesting and useful information to those who define and develop Health Policy (both inside and outside the European Community) , the individual countries, commissioners and regulators of healthcare, as well as the professional societies that support cardiac surgery, the hospitals who provide care and the patients who need it.

Jan Gummert

Chairman of the EACTS database committee

Geographical variation in the epidemiology of heart disease

Cardiovascular disease is the leading cause of mortality across Europe (more than 4 million deaths *per* annum) and a major source of morbidity and reduced quality-of-life. New methods of prevention and treatment have delayed the onset of symptoms and improved immediate outcomes and overall survival, resulting in an increasing (and ageing) patient-population that requires subsequent treatment. However, differences exist across Europe with respect to population infrastructure, socio-economic development and healthcare resources, which are responsible for wide variation in the burden and outcome of cardiovascular disease.

The factors determining the epidemiology of cardiovascular disease are complex, but increasingly understood. As well as the classical risk factors (smoking, obesity, *diabetes mellitus*, hypertension), international comparisons are potentially confounded by varying age distributions of the national populations, differing genetic & racial pools and the effects of migration, and other non-biological variables, including cultural differences in symptom presentation and healthcare-seeking behaviour, ease-of-access to specialist care (and its quality), healthcare expenditure & resources. Turning to cardiac surgery, a further range of factors may influence these comparisons: variation in the number of surgeons, their experience and training, and access to modern technology, advanced intensive care and specialist nursing. In many nations, increasing public expectation and scrutiny have had an impact on the speciality that may result in more conservative practice but better results. Similarly, advances in percutaneous technology (*e.g.*, complex coronary angioplasty and transcatheter aortic valve implantation) that are offered as alternatives to high-risk surgery, have differing penetration between nations.

Data from a variety of sources already provide insight into the epidemiology and outcomes of cardiovascular disease in Europe. Analysis of the WHO European *Health for All* database, the WHO mortality database, Eurostat databases, and the United States Consensus Bureau International database confirm the large burden of disease, particularly affecting the increasingly elderly population, and variation of mortality across Europe with lower mortality in the Southern and Western Zones and higher mortality in Eastern Europe.

To try to address this imbalance, the Euro Heart Survey programme was established in 1999 by the European Society of Cardiology, to provide a cycle of quality improvement to reduce the burden of cardiovascular disease. Sequential enrolment of large patient populations with specific sub-sets of cardiovascular disease from a wide range of hospitals in different geographical settings has permitted description of presentation, management, outcome, adherence to guidelines and geographical variations in both practice and outcomes. Dissemination of the results along with a rolling clinical guidelines programme provides continuing medical education. Consistent themes identified across the range of cardiovascular disease include:

- Clinical practice varies significantly across Europe as a result of differing disease patterns and patient characteristics, varying burdens of disease and marked variation in healthcare resources and access to specialist care. These factors contribute to higher overall morbidity and mortality in Eastern Europe.
- Adherence to guidelines for the prevention and management of cardiovascular disease has improved over time.
- There is systematic under-provision of care for the elderly, who form the majority of patients with cardiovascular disease.
- Patients enrolled in randomised trials are unrepresentative of those in day-to-day practice.

The population of Europe has been ageing rapidly since the early 1980s, and approximately 15% are now aged >65 years (twice the proportion worldwide). At the same time, life-expectancy at birth has advanced and now approaches 80 years for both men and women in most European nations. These trends will continue. There is significant variation between nations, with prolonged life-expectancy and a higher proportion of elderly citizens in Western Europe compared with nations of the former USSR & central Asia. Concomitantly low birth rates in nations with a high proportion of elderly inhabitants are producing an ever-increasing old-age dependency ratio and economic pressures on the younger population. This has obvious implications for cardiovascular disease.

The average age-standardised mortality ratio for cardiovascular disease in Europe is 5.1 *per* 1,000 inhabitants in men and 3.4 in women. However, these statistics hide a sharp East-West gradient with highest mortality ratios observed in Kazakhstan, Russian Federation, Ukraine and the Republic of Moldova (all ~8 *per* 1,000 inhabitants) and lowest ratios in France, Israel, Spain and Switzerland (all <2 *per* 1,000 inhabitants). This disparity has been progressive since serial observations began in 1980, and is likely to relate to a combination of factors including:

Smoking: Cigarette smoking is in decline throughout Europe, but cultural factors underlie persistently high rates in isolated nations.

Obesity: Whilst yet to match the United States of America, the average body mass index in Europe is 26.5 and over half of adults are overweight. In total, at least 130 million people in Europe are obese. Although more common in some countries than others, no nation is exempt and there are rising rates of obesity in children and young adults.

Diabetes mellitus: There are approximately 50 million people with *diabetes mellitus* in Europe (8% of the adult population) and this number is projected to rise steadily as the obesity epidemic unfolds. Again there is considerable variation between nations.

Hypertension: This is relatively rare in France, Spain & Belgium (prevalence <4%), but more frequent in Germany & Finland (~15%). Trend data from the WHO-MONICA project demonstrate a steady fall in the average population systolic & diastolic blood pressure over time.

Resources: Expression of healthcare expenditure as a percentage of GDP reveals a steep contrast between Eastern and Western Europe. Whilst the overall average is approximately 8%, this is higher in nations of the EU (9.5%), but lower in the former USSR nations (5%). Analysis of individual nations demonstrates further differences as shown on pages 32 to 43 of this report. These variations in expenditure and healthcare organisation result in varying access to specialist care and differing availability of technology.

These inter-national variations across Europe are confirmed and emphasised in this EACTS report, which also highlights important trends over time and specific variations in cardiac surgery and its outcomes. The age of patients undergoing surgery is steadily increasing (though this now appears to have plateaued in some nations such as England and Germany) and elderly patients have higher mortality and prolonged post-operative hospital stay. Surgery is more likely to be undertaken in octogenarians in N. Europe than in other European regions and Asia. Conversely, the proportion of younger patients is highest in poorer nations where rheumatic valve disease remains. There is also a steady increase in the proportion of women (though data may be skewed by imbalance across the submitting nations) who experience higher mortality, possibly as a result of delayed presentation and referral. *Diabetes mellitus* is increasing in the surgical cohort (and particularly common in S. Europe and Asia where a third of patients are affected) and associated with increased surgical mortality. There is an accompanying rise in the incidence of obesity (with the exception of Asia) although mortality is greatest in those with a **low** body mass index. Finally, smoking is, at last, on the decline in most nations.

These variations account for differences in casemix. Valve surgery is rising and more common where the legacy of rheumatic disease persists (particularly in Asia where it accounts for almost 50% of cases) and in nations where elderly patients with degenerative valve disease predominate. The rate of isolated coronary surgery varies as a function of risk factor distribution (70% overall in Northern Europe) and is highest in poorer nations. Wide variation (34-97%) and progressive reduction in the proportion of patients undergoing elective surgery may be explained by differences in disease presentation, care pathways and working patterns. Optimistically, it may also represent a decrease in waiting times, which are a surrogate for the burden of cardiovascular disease.

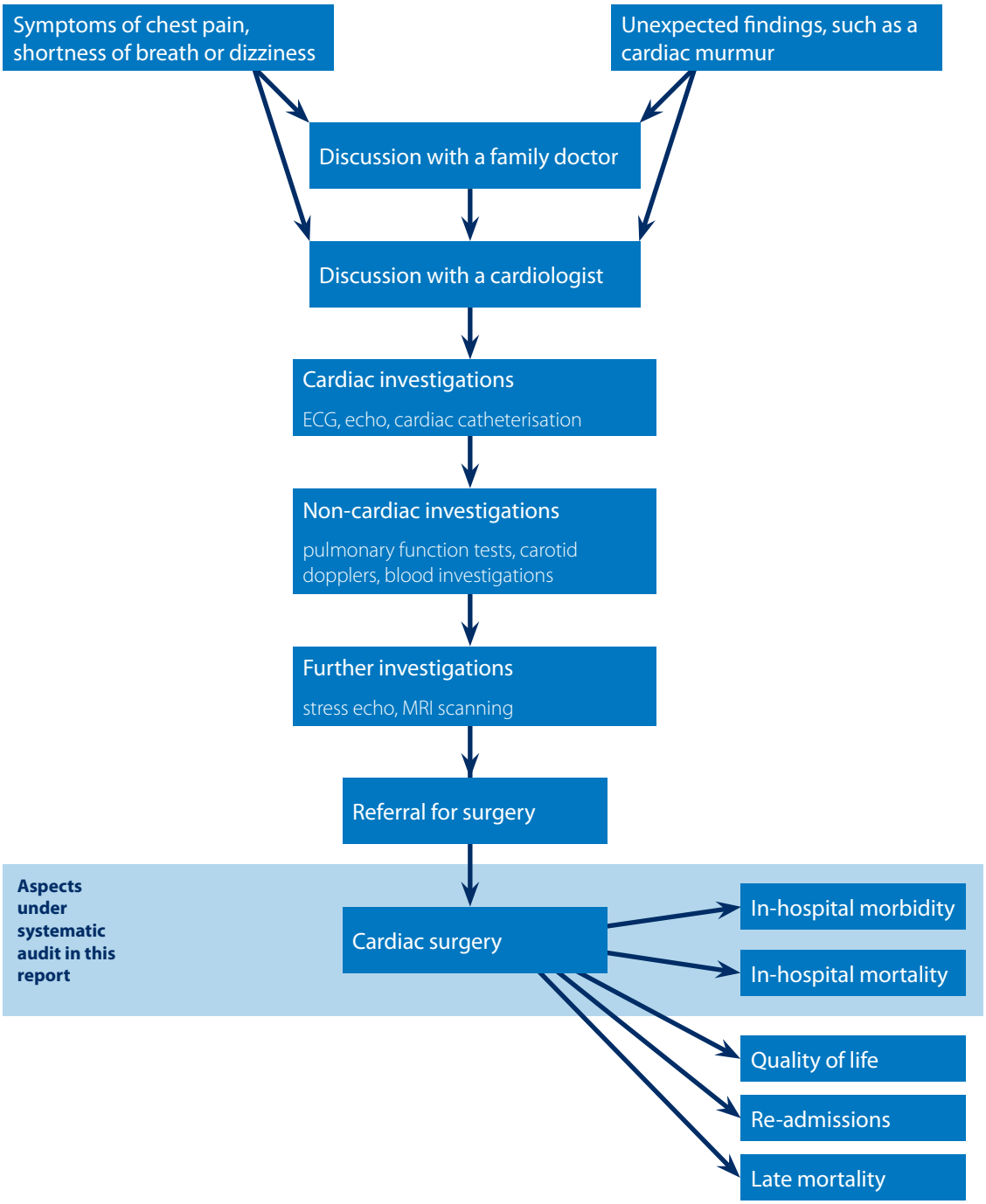
Technical variations noted in relation to coronary artery surgery include differing proportions of patients with left main stem disease (either reflecting disease burden or differing application of percutaneous techniques), and varying use of arterial revascularisation and off-pump techniques. With regard to valve surgery, aortic valve replacement is the most frequent procedure overall, though mitral valve surgery is more common in China. Valve surgery (particularly for aortic stenosis) is frequently undertaken in the very elderly and growing synergy with transcatheter aortic valve implantation is inevitable in this group. Use of mechanical valves is in decline (aortic 30%, mitral 40%) and being superseded by bioprostheses and mitral valve repair. Mortality is strikingly related to age, ejection fraction and symptom class, and lower in patients undergoing mitral repair rather than replacement, supporting the move towards earlier surgery in carefully-selected patients with minimal or no symptoms.

As always there are imperfections. The report contains data from only 19 of 27 European nations and is further skewed by relatively high representation of countries with established systems of surgical data accrual and follow up (England and Germany alone account for over 50% of included patients). Confounding trends, including the constantly changing ratio of percutaneous to open revascularisation, varying enthusiasm of surgeons to operate on the highest risk sub-groups, and bias related to selective or incomplete data submission are not systematically excluded. Nevertheless, this publication, which examines trends and outcomes of more than 1 million surgical procedures over a 13-year period, demands our attention and reveals some fascinating findings.

Bernard Prendergast, Consultant Cardiologist, John Radcliffe Hospital Oxford, United Kingdom

Disease pathways and clinical audit

Patients with heart disease who require cardiac surgery usually have symptoms of chest pain, shortness-of-breath, palpitations or dizziness. Sometimes patients have no symptoms at all but undergo surgery on the promise of increased life-expectancy. Cardiac surgery is a highly specialised undertaking and is only provided in a relatively small number of *high tech* hospitals. Most patients will not initially present to these hospitals, but will find their way into the hands of cardiac surgeons after a journey that requires identification and diagnosis of a problem, full investigation of the cardiac disease and other pathologies, and referral to an appropriate hospital and surgeon. A possible pathway from initial presentation to healthcare services to definitive treatment for a patient presenting with symptoms or asymptomatic severe aortic stenosis is given below:



Obviously, only a small proportion of patients presenting with symptoms of shortness-of-breath will end up with a diagnosis of severe aortic stenosis and need aortic valve surgery. The data presented throughout this report show that a small part of this patient-pathway is subject to close audit in the countries & units listed on pages 22-30.

The objective of cardiac surgery audit is to help to understand:

- which patients come to surgery?
- what are the changes in number and type of patients over time?
- what are the clinical outcomes?
- how are outcomes changing over time?
- how do outcomes in one unit or country compare to those in another (after making appropriate adjustments)?

Some national cardiac surgery audits have evolved from simply looking at in-hospital mortality as an outcome to studying in-hospital morbidity (such as new neurological events, re-exploration for bleeding and new renal intervention) and late mortality [1]. Some programmes are working to measure quality-of-life after surgery, and re-admission rates. Comprehensive audit should give reassurance for patients, hospitals and commissioners of healthcare when good quality is demonstrated and provide data for ongoing quality improvement for all. Benchmarking aspects of quality-of-care and access to surgery across hospitals and countries should also help identify areas for improvement, and interventions to close these gaps can be tracked using the data. We hope that this report will be used in this way.

The ultimate aim of audit programmes must be to collect data to analyse and improve the quality-of-care right across the entire patient-pathway: patients suffer with a disease and it seems wrong that only one small part of the possible treatment of that disease should be subject to detailed scrutiny. The most common diagnosis facing patients requiring cardiac surgery is ischaemic heart disease, and this group of patients may suffer chest pain, shortness-of-breath, lethargy, tiredness, palpitations and sudden death. They may never present to healthcare services, or they may be treated by medications or percutaneous coronary interventions. Only a relatively small proportion will ever undergo coronary artery surgery.

In some countries there have been efforts to monitor aspects of primary care for risk-factor detection and risk-factor modification, primary and secondary prevention [2, 3], the treatment of myocardial infarction [4], delivery of percutaneous coronary interventions [5] and coronary artery surgery [1]. To date it has not usually been possible to routinely link the audits of the various aspects of this pathway due a number of issues, including financial constraints, organisational boundaries, IT infrastructure, data protection legislation and political obstacles; for example, in the graph shown on page 54 on the proportion of overall cardiac surgery that is isolated coronary artery surgery, the most important determinants will be the relative burden of coronary to valvular disease **and** the proportion of coronary artery disease that is treated by coronary artery surgery rather than percutaneous coronary intervention. It may be that these figures are telling us more about the latter than the former.

It must be the aim of professional groups to work together to deliver comprehensive and joined-up audit right across the disease pathway and there will be a need for the audit enthusiasts, who have driven the programmes that are included in this report, to collect more comprehensive data and to link with professional groups caring for other aspects of the relevant diseases. This type of data should allow better understanding of the disease process and the related interventions, which should inform optimum management strategies, and drive improvements in quality of care for patients. Linking clinical audit data with information from commissioning or purchasing databases should also enable a better economic understanding of the disease, which should support delivery of the most cost-effective interventions at the right time in the disease process, as well as allowing benchmarking to help drive down the costs of the specific interventions.

1 Demonstrating quality: The Sixth National Adult Cardiac Surgery database report: Bridgewater B, Kinsman R, Walton P and Keogh B. Published by Dendrite Clinical Systems Ltd. Henley-on-Thames. ISBN 1-903968-23-2.

2 NSF: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4094275

3 QUOF: http://www.qof.ic.nhs.uk/

4 MINAP: http://www.rcplondon.ac.uk/clinical-standards/organisation/partnership/Pages/MINAP-.aspx

5 BCIS: http://www.bcis.org.uk/pages/page_box_contents.asp?pageid=697&navcatid=11

The EACTS database report, the European Union and globalisation

The European Union (EU) was formed in the aftermath of the Second World War, largely in an effort to embed peaceful unity across the continent. As events have unfolded, particularly with a need for effective European trade and more latterly the fall of the Berlin wall and the break up of the former Soviet Union, the community has increased from the original 6 founding members, up to the current total of 27. In addition Croatia, Macedonia and Turkey are *candidate countries* that are working towards membership. These countries are listed along with the countries submitting to the EACTS database below. This report contains data on cardiac surgery from 19 of the 27 member countries of the European Union.

As well as acting to create peace and stability, the European Union has developed a major economic role, initially through trade and agricultural agreements, and more recently through the institution of a single currency across much of the area. Together, the countries form a world trading power in an era of increased globalisation, and the current European Union annual budget is around 120 Billion Euros.

The current EU structure manages and influences regional aid, the common agricultural policy, environmental protection, technological innovation, energy policies and more recently there has been an increasing focus on a *Citizen's Europe* where a consistent sets of values and rights are being adopted across the member states. This includes rights to be able to travel, work and live across the European countries, and guarantees all citizens of member states access to healthcare services within the public sector at the same level as nationals of the country being visited.

European Health policy sits within the Directorate General for Health and Consumers. Their mission statement is to:

> … *make Europe's citizens healthier, safer and more confident.*

They have an aim to *protect and improve human health* by developing policies, laws and programmes to influence both the safety and the quality of healthcare across Europe. Currently about 8% of European Gross Domestic Product is spent on healthcare. In addition to supporting health in young people by education and protection, and developing effective strategies for protecting against major threats to public health, they are also looking to improve quality and minimise variations by:

> *Better Member State cooperation to improve the effectiveness and the efficiency of European healthcare systems by enabling proper assessment and use of emerging health technologies, the sharing of expertise, clinical excellence and specialised equipment, to provide a solid evidence base for healthcare management across Europe and promote effective investment in health infrastructure.*

According to their estimates, the economic costs of the cardiovascular disease to the European Union is 135 billion Euros each year, and as such, this must be a major focus for improvement for both patient-focused and economic reasons. There is a current acknowledgement that sensible policy must be informed by robust information, and that has been the focus of considerable attention. Indeed they aim to provide:

> *EU-wide collation and analysis of health data to provide objective, comparable, and timely information on which to base more effective health policies, strategies and actions at Member State and EU levels and to provide citizens and health professionals with the information they seek.*

We believe that this EACTS database report provides an interesting contribution to this agenda. Through the EACTS council's leadership and the relationships & trust that have developed between EACTS and the various national professional organisations & other partners, we have been successful in acquiring data on cardiac surgical operations from 19 of the 27 member states. An additional 3 countries from the continent of Europe who are currently not member states of the European Union have also contributed. The analyses show marked variations in the types of surgery undertaken along with the incidences of risk factors at surgery (which are strongly associated with social and economic factors) and we hope it will act as a useful benchmark and focus for improvement.

Cardiac surgery, as with most modern endeavours, has long since evolved from being a local or national pursuit, to involve networks across larger geographical regions. Indeed, as stated on the EACTS website [1]:

> *EACTS was founded as a European organisation. However, its membership is now spread all over the world in all continents representing some 70 countries.*

1 www.eacts.org

In line with this approach, we have included in this report data submitted from countries outside Europe, and we are delighted to have important contributions from China, including Hong Kong. We believe the comparisons between European and Asian data bring out some interesting themes and we hope that this is an important step towards truly worldwide benchmarking that will be mutually beneficial to all involved.

Countries submitting data that are members of the European Union:

- Austria
- Belgium
- Cyprus
- Czech Republic
- Denmark
- France
- Germany
- Greece
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- The Netherlands
- Poland
- Portugal
- Spain
- Sweden
- United Kingdom

Countries submitting data that are candidate countries for membership of the European Union:

- Croatia
- Turkey

Countries submitting data that are European countries but are not members of the European Union:

- Armenia
- Norway
- Switzerland

Non-European countries submitting data:

- China
- Hong Kong, China

Countries that are members of the European Union which are yet to submit data:

- Bulgaria
- Estonia
- Finland
- Hungary
- Malta
- Romania
- Slovakia
- Slovenia

2 http://ec.europa.eu/dgs/health_consumer/general_info/mission_en.html#vision

3 http://ec.europa.eu/commission_barroso/vassiliou/speeches/s09_Prague_Ministerial_Conference_en.pdf

4 European health data at: http://ec.europa.eu/health/ph_information/dissemination/echi/echi_en.htm

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Isolated CABG

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~ 1986 ~

Prelude

Should cardiac surgery results be published?

The final verdict on the benefits of routine and open publication of cardiac surgical mortality results remains unproven. Some believe that publishing mortality rates for named hospital / surgeons enables patients to choose the best hospital or surgical team for them, & that the process of publication itself helps to drive improvements in quality. Critics of the initiative think it encourages surgeons to turn away the highest risk patients, because of concerns over the over-interpretation or mis-interpretation of apparently *high* mortality rates. Many within the cardiac surgical community agree that publishing results is reasonable, but believe that the comparative data need to be complete, validated & appropriately risk-adjusted before being presented.

The information presented later in this report on pages 152-155 shows that for many countries the submitted data are not yet of sufficient quality for open publication of risk-adjusted mortality. For the purposes of this report, we have therefore chosen to give feedback to submitting countries about their data quality compared to others, along with confidential feedback of crude and partially risk-adjusted mortality rates (see page 151).

Two regions where cardiac surgical mortality rates have been published for some time now include New York state & the United Kingdom. The process started much earlier in the United States, but there have been many shared experiences in their respective journeys: initially data were not published willingly by the surgeons, media organisations drove the process forward & the legal lever of *Freedom of Information* was eventually responsible for bringing results into the public domain. Subsequently there were professionally-led data collection & governance initiatives, associated with reports that the process of publication coincided with improvement in outcomes, but concerns were raised over risk-averse behaviour. The debate continues still. However, it is now generally accepted that collecting, collating, benchmarking and feeding back surgical results is beneficial to care.

It also seems that imposed publication of results drives the process of robust data collection; whether there are further derived benefits purely from publication remains unclear. Overall, the publication of results makes little difference to a patient's choice of hospital or surgeon, and any effect that is seen is small, transient and probably influences only a minority of patients. However, anecdotal reports from individual patients and from patient organisations suggest that they value the dissemination of results and find it reassuring that data collection and presentation, with super-imposed governance scrutiny, will ensure care is satisfactory overall.

The data presented later in this report show large variability in data completeness between countries. There seems, to many, to be an inevitable progression in the era of accessible information: more data of all types will be made available to consumers and cardiac surgery is probably just another example of this process. If results are to be published, using crude, unadjusted mortality rates has the greatest chance of encouraging significant risk-averse behaviour. To mitigate against this, continuing professionally-led data collection and benchmarking is essential. There is also an important need for effective risk adjustment algorithms (that are responsive to overall improvements in quality with time) and innovative techniques of data use and presentation, to maximise the positive quality improvement and clinical governance aspects of the database agenda, whilst at the same time minimising or eradicating any unintended negative consequences.

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4 Kaiser Family Foundation and Agency for Health Care Research and Quality. National Survey on Consumer's Experiences with Patient Safety and Quality Information. Washington DC: Kaiser Family Foundation, 2004.

5 Werner RM, Asch DA, and Polsky D. Racial profiling: the unintended consequences of CABG report cards. *Circulation*. 2005; **111:** 1257-1263.

6 Werner RM and Asch DA. The unintended consequences of publicly reporting quality information. *JAMA*. 2005; **293:** 1239-1244.

7 Guru V et al. Public versus private institutional performance reporting: what is mandatory for quality improvement. *American Heart Journal*. 2006; **152:** 573-578.

8 Bridgewater B, et al. Has the publication of cardiac surgery outcome data been associated with changes in practice in northwest England: an analysis of 25,730 patients undergoing CABG surgery under 30 surgeons over eight years. *Heart*. 2007; **93:** 744-748.

9 Bridgewater B, Keogh B. Surgical "league tables": ischaemic heart disease. *Heart*. 2008; **94(7):** 936-42.

Contributors to the EACTS database

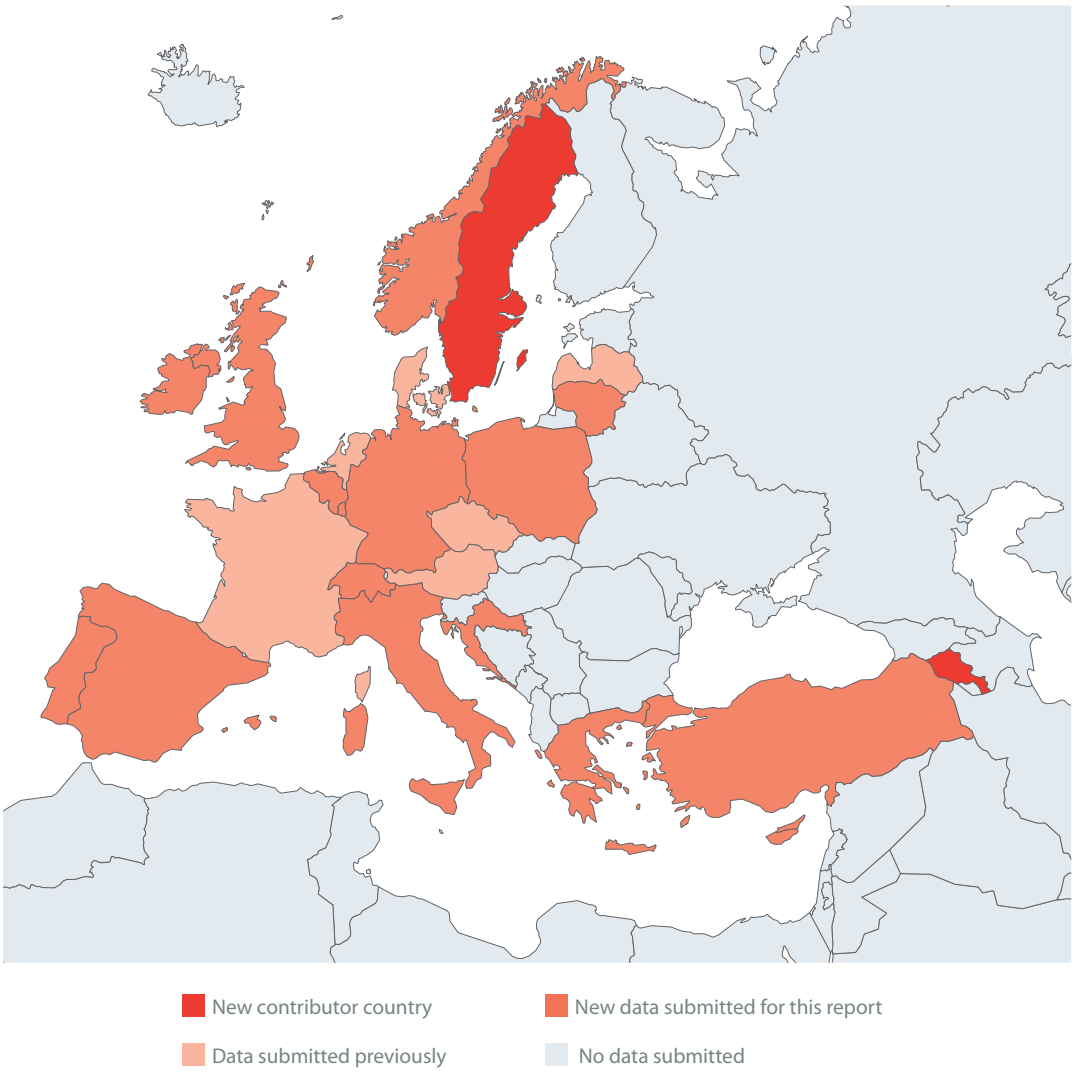
Countries and Specialist Societies

We would like to thank all the contributors to the EACTS database. The following lists all the countries and hospitals that contributed to the latest edition of the EACTS Adult Cardiac Surgical Database, detailing, where available, the country's:

Cardiac Surgical Society's name

The name of the Cardiac Surgical Society's President

The Cardiac Surgical Society's website



Hospital lists (overleaf) are in alphabetical order with the exception of the German listing, which is in the order of the name of the city in which each heart surgery centre is located.

Hospitals contributing to the EACTS database by country

Armenia

www.nmmc.am

Nork Marash Medical Center, Yerevan

Austria

Landeskrankenhaus Klagenfurt Abteilung für Herz-, Thorax- und Gefäßchirurgie
Medizinische Universität Innsbruck Klinische Abteilung für Herzchirurgie
Salzburger Landeskliniken, St Johanns-Spital , Universitätsklinik für Herzchirurgie

Belgium

Belgian Association for Cardio-Thoracic Surgery
Frank Van Praet
www.bacts.org

Algemeen Stedelijk Ziekenhuis, Aalst
Algemeen Ziekenhuis Maria Middelares, Gent
Algemeen Ziekenhuis Sint-Jan, Brugge
Centre Hospitalier Regional de la Citadelle, Liège
Centre Hospitalier Regional de Namur
Centre Hospitalier Brugmann Huderf, Brussel
Centre Hospitalier Universitaire de Charleroi – Hôpital Civil
Centre Hospitalier Universitaire de Liège Sart Tilman, Liège
Centre Hospitalier Universitaire de Tivoli, La Louvière
Centre Hospitalier Universitaire St.-Pierre, Brussel
Clinique Saint-Luc Bouge
Clinique St. Jean, Brussel
Cliniques Universitaires de Mont-Godinne, Yvoir
Cliniques Universitaires Saint-Luc, Brussel
Europa Ziekenhuizen St. Elisabeth, Brussel
Heilig Hartziekenhuis, Roeselare
Hôpital de Jolimont, Haine St. Paul
Hôpital Erasme, Brussel
Hôpital Saint-Joseph, Gilly
Imelda Ziekenhuis, Bonheiden
Onze Lieve Vrouwziekenhuis, Aalst
Universitair Ziekenhuis Antwerpen, Edegem
Universitair Ziekenhuis Brussel
Universitair Ziekenhuis Gent
Universitair Ziekenhuis Leuven
Virga Jesse Ziekenhuis, Hasselt
ZNA Middelheim, Antwerpen
Ziekenhuis Ooost-Limburg Campus Sint-Jan, Genk

China

Collaboration Association of Cardiovascular Surgeons in China
Shengshou Hu
www.cvs-china.com

Affiliated Hospital of Jining Medical College, Jining
Beijing Chao-Yang Hospital, Beijing
Beijing Friendship Hospital, Beijing
Beijing Hospital, Beijing
Beijing Tongren Hospital, Beijing
Changhai Hospital of The Second Military Medical University, Shanghai
China-Japan Friendship Hospital, Beijing
Fujian Medical University Union Hospital, Fuzhou
Fujian Provincial Hospital, Fuzhou
Fuwai Hospital, Beijing
Guangdong Cardiovascular Institute, Guangzhou
Guangdong Gaozhou People's Hospital, Gaozhou

Hospitals contributing to the EACTS database by country

China continued …

Henan Anyang People's Hospital, Anyang
Henan Provincial People's Hospital, Zhengzhou
Jiangsu People's Hospital, Nanjing
Nanjing Firtst Hospital, Nanjing
Peking University First Hospital, Beijing
Peking University People's Hospital, Beijing
Prince of Wales Hospital, Hong Kong SAR
Ruijin Hospital of Shanghai Jiao Tong University, Shanghai
Shandong Provincial Hospital, Jinan
Shandong University Qilu Hospital, Jinan
Shanghai Chest Hospital, Shanghai
Shanghai First People's Hospital, Shanghai
Shanghai Renji Hospital, Shanghai
Shanxi Cardiovascular Hospital, Taiyuan
Teda International Cardiovascular Hospital, Tianjin
The Affiliated Hospital of Medical College Qingdao University, Qingdao
The First Affiliated Hospital of Wenzhou Medical College, Wenzhou
The First Hospital of China Medical University , Shenyang
The General Hospital of Jinan Military region, Jinan
The Second Affiliated Hospital of Harbin Medical University, Harbin
The Second Hospital of Hebei Medical University, Shijiazhuang
The Second Xiangya Hospital of Central South University, Changsha
Tianjin Chest Hospital, Tianjin
Tongji Medical College of Huazhong University of Science & Technology Union Hospital, Wuhan
Wuhan Asia Heart Hospital, Wuhan
Xijing Hospital of The Fourth Military Medical University, Xian
Xinqiao Hospital of The Third Military Medical University, Chongqing
Xuanwu Hospital, Beijing
Xuzhou Central Hospital, Xuzhou
Zhongda Hospital, Southeast University, Nanjing
Zhongshan Hospital Fudan University, Shanghai

Croatia

Klinicka bolnica Dubrava Odjel za kardijalnu kirurgiju Zagreb

Cyprus

American Heart Institute, Nicosia

Czech Republic

Centrum Kardiovaskulární a Transplantační Chirurgie Brno
Nemocnice Ceské Budejovice
Fakultní Nemocnice -Hradec Králové
Fakultní Nemocnice Královské Vinohrady
Fakultní Nemocnice Motol
Fakultní Nemocnice Olomouc
Fakultní Nemocnice Plzen Lochotín
Fakultní Nemocnice s Poliklinikou Ostrava
Institut Klinické a Experimentální Medicíny, Praha
Nemocnice Na Homolce
Nemocnice Podlesí, Trinec
Všeobecná Fakultní Nemocnice, Praha

Hospitals contributing to the EACTS database by country

Denmark

Ålborg Sygehus, Ålborg
Amtssygehuset i Gentofte, København
Hjertecenter Varde
Odense Universitets-hospital, Odense
Rigshospitalet, København
Skejby Sygehus, Århus

France

Société Française de Chirurgie Thoracique et Cardio-Vasculaire
Francine L Leca
www.fstcvs.org

Centre Chirurgical Marie Lannelongue, le Plessis-Robinson
Centre Hospitalier Universitaire d'Angers, Angers
Clinique la Sauvegarde, Lyon
Clinique Protestante, Lyon
Hopital Bon Secours (CH), Metz
Hopital Charles Nicolle (CHU), Rouen
Hopital Civil (CHU), Strasbourg
Hopital de Mulhouse (CH), Mulhouse
Hopital de Rangueil (CHU), Toulouse
Hopital Gabriel Montpied (CHU), Clermont Ferrand
Hopital Henri Mondor (CHU), Créteil, Paris
Hopital Jean Minjoz (CHU), Besancon
Hopital La Meynard (CHU), Fort de France
Hopital Michallon (CHU), Grenoble
Hopital Ponchaillou (CHU), Rennes
Institut Arnault Tzanck, Saint Laurent du Var
Polyclinique Du Bois, Lille

Germany

Deutsche Gesellschaft für Thorax-, Hertz- und Gefäßchirurgie
Friedhelm Beyersdorf
www.dgthg.de

Aachen, RWTH Aachen, Campus, Klinik für Thorax-, Herz- und Gefäßchirurgie
Augsburg, Klinikum Augsburg, Herzchirurgische Klinik
Bad Berka, Rhön-Klinikum AG, Zentralklinik Bad Berka GmbH, Herzzentrum: Klinik für Kardiochirurgie
Bad Bevensen, Herz- und Gefäßzentrum Bad Bevensen, Klinik für Herz-Thorax-Chirurgie
Bad Krozingen, Herz-Zentrum Bad Krozingen, Herz- und Gefäßchirurgie
Bad Nauheim, Kerckhoff-Klinik GmbH, Abteilung für Herz- und Thoraxchirurgie
Bad Neustadt, Herz- und Gefäß-Klinik GmbH, RHÖN-KLINIKUM AG, Abteilung für Kardiochirurgie
Bad Oeynhausen, Universitätsklinik der Ruhr-Universität Bochum, Herz- und Diabeteszentrum NRW, Thorax- und Kardiovaskularchirurgie
Bad Rothenfelde, Schüchtermann-Klinik, Herzchirurgie
Bad Segeberg, Segeberger Kliniken GmbH, Herzchirurgie
Bayreuth, Klinikum Bayreuth GmbH, Klinik für Herzchirurgie
Berlin, Deutsches Herzzentrum Berlin, Klinik für Herz-, Thorax- und Gefäßchirurgie
Berlin, Charité - Universitätsmedizin Berlin
Bernau, Ev.-freikirchliches Krankenhaus und Herzzentrum Brandenburg in Bernau
Bonn, Rheinische Friedrich-Wilhelms-Universität Bonn, Klinik und Poliklinik für Herzchirurgie
Braunschweig, Städtisches Klinikum Braunschweig, Klinik für Herz-, Thorax- und Gefässchirurgie
Bremen, Klinikum Links der Weser gGmbH, Klinik für Thorax-, Herz- und Gefäßchirurgie
Coswig, Herz-Zentrum Coswig, Herz-, Gefäß- und Thoraxchirurgie
Cottbus, Sana-Herzzentrum Cottbus GmbH, Klinik für Herzchirurgie
Dortmund, Klinikum Dortmund gGmbH, Klinikzentrum Mitte, Thorax-, Herz- und Gefäßchirurgie
Dortmund, St.-Johannes-Hospital, Klinik für Herz-, Thorax- und Gefäßchirurgie
Dresden, Herzzentrum Dresden GmbH, Universitätsklinik, Klinik für Kardiochirurgie
Duisburg, Herzzentrum Duisburg, Klinik für Thorax- und Kardiovaskularchirurgie

Hospitals contributing to the EACTS database by country

Germany continued

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Erlangen, Friedrich-Alexander-Universität, Zentrum für Herzchirurgie
Essen, Universitätsklinikum Essen, Westdeutsches Herzzentrum Essen, Klinik für Thorax- und kardiovaskuläre Chirurgie
Frankfurt, Johann Wolfgang-Goethe-Universität, Klinik für Thorax-, Herz- und thorakale Gefäßchirurgie
Freiburg, Universitätsklinikum Freiburg, Herz-Kreislauf Zentrum, Abt. Herz- und Gefäßchirurgie
Fulda, Klinikum Fulda gAG, Klinik für Herz- und Thoraxchirurgie
Gießen, Universitätsklinikum Gießen und Marburg, Standort Gießen / Zentrum für Chirurgie
Göttingen, Georg-August-Universität Göttingen, Thorax-, Herz- und Gefäßchirurgie
Halle, Martin-Luther-Universität Halle-Wittenberg, Universitätsklinik und Poliklinik für Herz- und Thoraxchirurgie
Hamburg, Albertinen-Krankenhaus, Abteilung für Kardiochirurgie
Hamburg, Universitäres Herzzentrum Hamburg, Ein Unternehmen des UKE, Klinik und Poliklinik für Herz- und Gefäßchirurgie
Hannover, Medizinische Hochschule Hannover, Klinik für Herz-, Thorax-, Transplantations- und Gefäßchirurgie
Heidelberg, Universitätsklinikum und Medizinische Fakultät Heidelberg, Chirurgische Klinik, Abteilung Herzchirurgie
Homburg, Universitätsklinikum des Saarlandes, Klinik für Thorax- und Herz-Gefäßchirurgie
Jena, Klinikum der Friedrich-Schiller-Universität, Klinik für Herz- und Thoraxchirurgie
Kaiserslautern, Westpfalz-Klinikum GmbH, Thorax-, Herz- und Gefäßchirurgische Klinik
Karlsburg, Klinikum Karlsburg, Herz- und Diabeteszentrum Mecklenburg-Vorpommern, Klinik für Herz-, Thorax- und Gefäßchirurgie
Karlsruhe, Klinik für Herzchirurgie Karlsruhe GmbH
Kassel, Klinikum Kassel GmbH, Klinik für Herz-, Thorax- und Gefäßchirurgie
Kiel, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Klinik für Herz- und Gefäßchirurgie
Koblenz, Bundeswehrzentralkrankenhaus, Abteilung XVII, Herz- und Gefäßchirurgie
Köln, Klinikum der Universität zu Köln, Klinik und Poliklinik für Herz- und Thoraxchirurgie
Konstanz, Herzzentrum Konstanz GmbH, Klinik für Kardiovaskuläre Chirurgie
Krefeld, Klinik für Herz- und Thoraxchirurgie, Klinikum Krefeld
Lahr, MediClin Herzzentrum Lahr / Baden, Herzzentrum Lahr / Baden
Leipzig, Herzzentrum Leipzig GmbH, Klinik für Herzchirurgie
Lübeck, Universitätsklinikum Schleswig-Holstein, Campus Lübeck, Klinik für Herzchirurgie
Ludwigshafen, Klinikum der Stadt Ludwigshafen am Rhein GmbH, Klinik für Herzchirurgie
Magdeburg, Otto-von-Guericke-Universität Magdeburg, Medizinische Fakultät, Klinik Herz- und Thoraxchirurgie
Mainz, Johannes-Gutenberg-Universität, Klinik und Poliklinik für HTG-Chirurgie
Marburg, Universitätsklinikum Giessen und Marburg Standort Marburg, Klinik für Herz- und thorakale Gefäßchirurgie
München, Herzchirurgische Klinik und Poliklinik der Ludwig-Maximilians-Universität München, Klinikum Großhadern
München, Deutsches Herzzentrum München des Freistaates Bayern, Klinik für Herz- und Gefäßchirurgie
Münster, Medizinische Einrichtungen des UKM, Klinik und Poliklinik für Thorax-, Herz- u. Gefäßchirurgie
Nürnberg, Klinik für Herzchirurgie
Oldenburg, Klinikum Oldenburg gGmbH, Klinik für Herzchirurgie
Passau, Klinikum Passau, Klinik für Herzchirurgie
Regensburg, Universität Regensburg, Klinik für Herz-, Thorax- und herznahe Gefässchirurgie
Rostock, Universität Rostock, Medizinische Fakultät, Klinik und Poliklinik für Herzchirurgie
Rotenburg, Herz- und Kreislaufzentrum Rotenburg a .d. Fulda, Klink für Herz- und Gefäßchirurgie
Siegburg, HELIOS Klinikum Siegburg
Stuttgart, Robert-Bosch-Krankenhaus, Klinik für Herz- und Gefäßchirurgie
Stuttgart, Sana Herzchirurgische Klinik Stuttgart GmbH
Trier, Krankenhaus der Barmherzigen Brüder Trier, Herz- und Thoraxchirurgische Abteilung
Tübingen, Eberhard-Karl-Universität, Universitätsklinikum Tübingen, Klinik für THG-Chirurgie
Ulm, Universitätsklinikum, Zentrum für Chirurgie, Klinik für Herzchirurgie
Völklingen, SHG-Kliniken Völklingen, Klinik für Herz- und Thoraxchirurgie

Hospitals contributing to the EACTS database by country

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Würzburg, Universitätsklinikum Würzburg, Klinik und Poliklinik für Thorax-, Herz- und Thorakale Gefäßchirurgie

Greece

Geniki Kliniki, Thessaloniki

Onassis Cardiac Surgery Center, Athens

Italy

Società Italiana di Cardio Chirurgia
Alessandro Mazzucco
www.sicch.it

AO Ospedale L. Sacco, Milano (MI)
AO Ospedale Niguarda Ca'Granda, Milano (MI)
AO Santa Maria, Terni (TR)
AO Santa Maria Misericordia (UD)
Casa di Cura Villa Azzurra SRL (GE)
Istituto Clinico Humanitas, Rozzano (MI)
PO Vito Fazzi, San Cesario di Lecce, Campi Salentina (LE)
AO Fondazione Macchi, Varese (VA)
AO Ospedale Civile, Legnano (MI)
AO Ospedali Riuniti, Bergamo (BG)
AO San Sebastiano Caserta (CE)
AO Spedali Civili, Brescia (BS)
A.R.N.A.S. Ospedale Civico di Cristina E Ascoli (PA)
AO, Ospedale S. Martino E Cl. Univ. Conv. (GE)
AO Policlinico Bari (BA)
AO- San Camillo, Forlanini (RM)
AO Universitaria, Ospedali Riuniti di Trieste (TS)
AO Universitaria Policlinico Tor Vergata (RM)
AO Santa Croce E Carle (CN)
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AO Santi Antonio e Biagio e Cesare Arrigo (Al)
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AO Ordine Mauriziano di Torino (TO)
AO San Guiseppe Moscati (AV)
AO Sant'andrea (RM)
AO Universitaria Integrata, Verona (VR)
AO Vincenzo Monaldi (NA)
AO Vittorio Emanuele (CI)
C.B.H. Presidio Villa Bianca (BA)

Casa di Cura Anthea (BA)
Casa di Cura Citta' di Alessandria (Al)
Casa di Cura Citta di Lecce (LE)
Casa di Cura Mediterranea (NA)
Casa di Cura San Gaudenzio (NO)
Casa di Cura Sant'Anna Hospital (CZ)
Casa di Cura Villa Maria Eleonora (PA)
Casa di Cura Villa Maria Pia (TO)
Casa di Cura Villa Torri (BO)
Cliniche Gavazzeni SPA, Bergamo (BG)
Centro Cardiologico Monzino, Milano (MI)
Hesperia Hospital Casa di Cura (Mo)
Iscas Morgagni Nord SRL (CT)
Istituto Clinico S. Ambrogio Spa, Milano (MI)
Istituto Policlinico San Donato SPA, Milanese (MI)
Multimedica Holding SPA, Sesto San Giovanni (MI)
Ospedale Maggiore Della Carita' (NO)
Ospedale Dell'ulss Veneziana (VE)
Ospedale Mazzini (TE)
Ospedale Santa Maria Dei Battuti (PN)
Ospedale Sant'Antonio (PD)
Poliambulanza, Brescia (BS)
Policlinico Universitario Campus Bio Medico (RM)
Policlinico Agostino Gemelli e CIC (RM)
Policlinico di Monza, Casa di Cura Privata (MI)
Sant'Orsola, Malpighi, Bologna (BO)
Strutture Ospedaliere Ulss 13, Mirano (VE)
Azienda Sanitaria Ulss. 6 Vicenza (VI)
Villa Maria Beatrice (FI)
Villa Maria Cecilia (RA)

Latvia

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Seaman's Hospital, Klaipeda
Vilnius University Hospital

Luxembourg

Cercle des Chirurgiens Thoraciques et Cardio-Vasculaire du Grand Duché de Luxembourg
Khaled Chalabi
www.incci.lu

Institut National de Chirurgie Cardiaque et de Cardiologie Interventionelle, Luxembourg

The Netherlands

Nederlandse Vereniging Voor Thoraxchirurgie
Michel IM Versteegh
www.nvtnet.nl

Universitair Medisch Centrum Utrecht

Norway

Feiringklinikken, Feiring
Haukeland Universitetssykehus, Bergen
Hjertesenteret i Oslo
Rikshospitalet-Radiumhospitalet HF,Oslo
St Elisabeth Sykehus, Trondheim
Ullevaal Universitetssykehus, Oslo
Universitetssykehuset i Nord-Norge, Tromsø

Poland

Polski Rejestr Operacji Kardiochirurgicznych
Bohdan Maruszewski
www.krok.org.pl

I Klinika Kardiochirurgii, Instytut Kardiologii, Warszawa
II Klinika Kardiochirurgii, Instytut Kardiologii, Warszawa
Oddział Kardiochirurgii Katedry i Kliniki Chorób Wewnętrznych i Kardiologii Akademii Medycznej, Warszawa
Klinika Kardiochirurgii Centralnego Szpitala Klinicznego Ministerstwa Spraw Wewnętrznych i Administracji, Warszawa
Klinika Kardiochirurgii Śląskiego Centrum Chorób Serca, Zabrze
I Klinika Kardiochirurgii Śląskiego Ośrodka Kardiologii Akademii Medycznej, Katowice – Ochojec
II Klinika Kardiochirurgii Śląskiego Ośrodka Kardiologii Akademii Medycznej, Katowice – Ochojec
Klinika Chirurgii Serca i Naczyń Instytutu Kardiologii Akademii Medycznej, Kraków
Klinika Kardiochirurgii Instytutu Kardiologii Akademii Medycznej, Łódź
Oddział Kardiochirurgii 11-go Szpitala Miejskiego im. J.Strusia, Poznań
Klinika Kardiochirurgii Katedry Kardio-Torakochirurgii Akademii Medycznej, Poznań
Katedra i Klinika Chirurgii Serca Akademii Medycznej, Wrocław
Klinika Kardiochirurgii 14-go Wojskowego Szpitala Klinicznego, Wrocław
Dolnośląskie Centrum Chorób Serca "Medinet" Niepubliczny Zakład Opieki, Wrocław
Klinika Kardiochirurgii Instytutu Chirurgii Akademii Medycznej, Gdańsk
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Klinika Chirurgii Klatki Piersiowej Instytutu Chirurgii Akademii Medycznej, Lublin
Katedra i Klinika Kardiochirurgii Państwowego Szpitala Klinicznego Akademii Medycznej, Bydgoszcz
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Hospitals contributing to the EACTS database by country

Poland continued ...

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Oddział Kardiochirurgii Publicznego Samodzielnego Zakładu Opieki Zdrowotnej Wojewódzkie Centrum Medyczne, Opole
Oddział Kardiochirurgii Wojewódzkiego Szpitala Specjalistycznego, Radom
Oddział Kardiochirurgii Szpitala Wojewódzkiego, Olsztyn
Klinika Kardiochirurgii 10-go Wojskowego Szpitala Klinicznego z Poliklinika, Bydgoszcz

Portugal

Hospital de Vila Nova de Gaia
Hospital de São João
Hospital da Cruz Vermelha
Hospital de Santa Maria
Hospital de Santa Marta

Republic of Ireland

The Society for Cardiothoracic Surgery in Great Britain & Ireland
David Taggart
www.scts.org

Cork University Hospital
Galway Clinic
Mater Misericordiae Hospital, Dublin
St James's Hospital, Dublin

Spain

Sociedad Española de Cirugia Torácica - Cardiovascular
Miguel Josa Garcia-Tornel
www.sectcv.es

Centro Médico Teknon, Barcelona
Clínica Recoletas , Albacete
Clínica Universitaria de Navarra, Pamplona
Complejo Hospitalario de Toledo
Hospital Clínic y Provincial, Barcelona
Hospital Clínico de Valencia
Hospital Clínico Universitario San Carlos, Madrid
Hospital de Basurto, Bilbao
Hospital de Cruces, Bilbao
Hospital Universitario 12 de Octubre, Madrid
Hospital Universitario Germans Trías i Pujol, Badalona
Hospital Universitario Son Dureta, Palma de Mallorca

Sweden

Svenska Hjärkirurgiregistret
www.ucr.uu.se/hjartkirurgi

Akademiska sjukhuset, Uppsala
Blekingesjukhuset, Karlskrona
Karolinska Universitetssjukhuset, Stockholm
Norrlands Universitetssjukhus, Umeå
Sahlgrenska Universitetssjukhuset, Göteborg
Universitetssjukhuset, Linköping
Universitetssjukhuset, Lund
Universitetssjukhuset, Örebro

Switzerland

Inselspital, Bern
UniversitätsSpital, Basel
UniversitätsSpital, Zürich

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Turkey

Türk Kalp ve Damar Cerrahisi Derneği
Serap Aykut Aka
www.tkdcd.org

Acıbadem Üniversitesi Tıp Fakültesi, Acıbadem Bakırköy Hastanesi, İstanbul
Acıbadem Üniversitesi Tıp Fakültesi, Acıbadem Kadıköy ve Maslak Hastaneleri, İstanbul
Afyon Kocatepe Üniversitesi Tıp Fakültesi, Afyon
Amerikan Hastanesi, VKV, İstanbul
Ankara Atatürk Eğitim ve Araştırma Hastanesi, Ankara
Ege Üniversitesi Tıp Fakültesi, İzmir
İnönü Üniversitesi Tıp Fakültesi, Malatya
Memorial Hastanesi, İstanbul
Sakarya Adatıp Tıp Merkezi, Sakarya

United Kingdom

The Society for Cardiothoracic Surgery in Great Britain & Ireland
David Taggart
www.scts.org

England

Barts and The London
Bristol Royal Infirmary
Cardiothoracic Centre Liverpool
Castle Hill Hospital, Cottingham
Chalybeate Hospital, Southampton
Derriford Hospital, Plymouth
Essex Cardiothoracic Centre, Basildon
Freeman Hospital, Newcastle
Glenfield Hospital, Leicester
Guy's & St Thomas's Hospitals, London
Hammersmith Hospital, London
Harefield Hospital, London
James Cook University Hospital, Middlesbrough
John Radcliffe Hospital, Oxford
King Edward VII Hospital, Midhurst
King's College Hospital, London
Leeds General Infirmary
London Bridge Hospital, London
Manchester Heart Centre
New Cross Hospital, Wolverhampton
North Staffordshire Royal Infirmary
Northern General Hospital, Sheffield
Nottingham City Hospital
Papworth Hospital, Cambridge
Queen Elizabeth Hospital, Birmingham
Royal Brompton Hospital, London
Royal Sussex County Hospital, Brighton
Southampton General Hospital
St Anthony's Hospital, London
St George's Hospital, London
St Mary's Hospital, London
The Harley Street Clinic, London
The Heart Hospital, London
University Hospital of South Manchester
Victoria Hospital, Blackpool
Walsgrave Hospital, Coventry
Wellington Hospital, London

United Kingdom continued …

Northern Ireland

Royal Victoria Hospital, Belfast

Scotland

Aberdeen Royal Infirmary
Glasgow Royal Infirmary
Golden Jubilee National Hospital, Glasgow
Royal Infirmary of Edinburgh
Western Infirmary, Glasgow

Wales

Morriston Hospital, Swansea
University Hospital of Wales, Cardiff

We would also like to thank Mark Jones for his helpful comments on this report, and his assistance with proof reading.

Countries grouped into zones

For the sake of some of the analyses presented in this report, the contributing countries have been grouped into four zones, based largely on geographical location:

Northern zone:

- Denmark
- Latvia
- Lithuania
- Norway
- Sweden

Central zone:

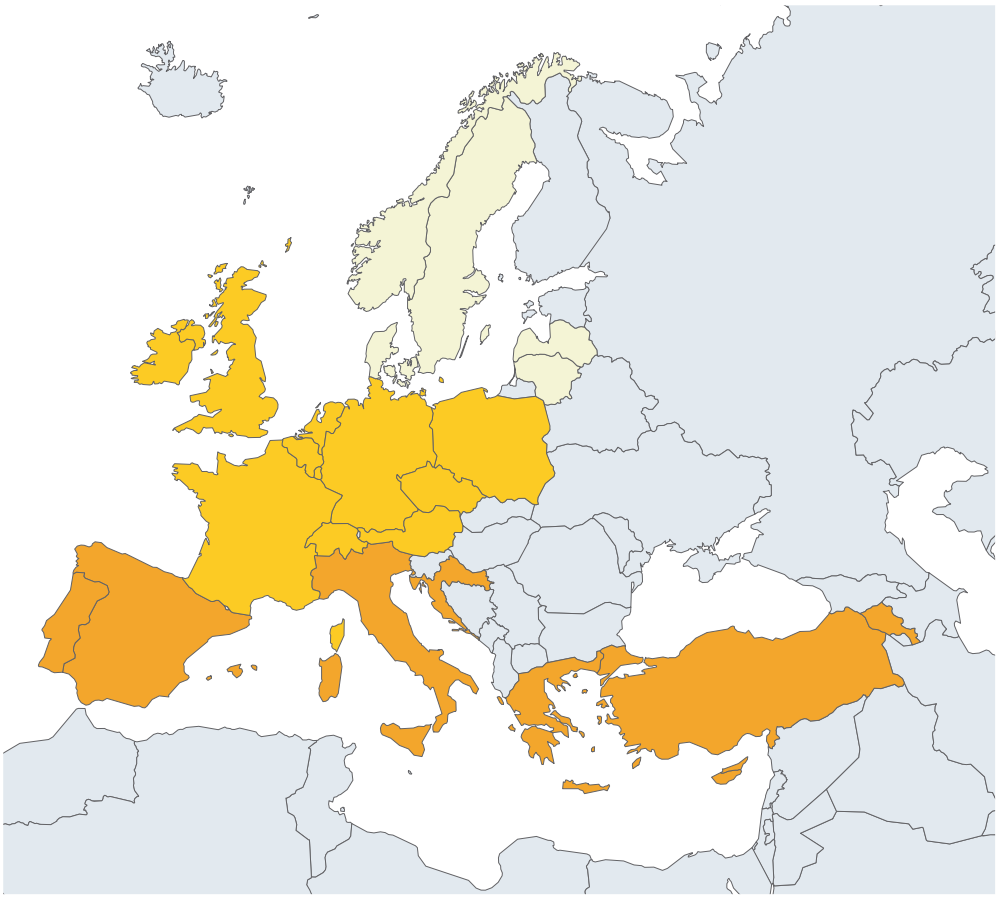
- Austria
- Belgium
- Czech Republic
- England
- France
- Germany
- Luxembourg
- The Netherlands
- Northern Ireland
- Poland
- Republic of Ireland
- Scotland
- Switzerland
- Wales

Southern zone:

- Armenia
- Croatia
- Cyprus
- Greece
- Italy
- Portugal
- Spain
- Turkey

Asian zone:

- China
- Hong Kong, China



World Health Organisation statistics

The burden of cardiovascular disease

The following tables are taken from the World Health Organisation (WHO) statistics website. They have been compiled here to give an overview of population numbers, life-expectancy, mortality rates and risk factors for cardiovascular disease for the countries submitting data to the EACTS database.

We have also added in a number of additional countries worldwide to enable benchmarking of the countries listed in this report against others.

These data show huge variations between the countries submitting data to the EACTS database in every measure:

- The total populations range from 470,000 up to 1.3 billion.
- There are large variations in life-expectancy, from 61 up to 75 years.
- There is a three-fold difference in adult age-standardised cardiovascular mortality rates.
- There is nearly a two-fold variation in the proportion of the population over the age of 60 years, ranging from 27% up to 43%.
- Obesity rates range from less than 5% up to more than 25%.
- Smoking rates range from 22% up to 52%.
- There is variation in available hospital beds from 22 up to 83 *per* 10,000 population.
- There is variation in the number of hospital physicians from 14 up to 50 *per* 10,000 population.
- Gross National Income *per* capita ranges from $5,300 US up to $63,000.
- Total spend on health ranges from $94 US up to $6,506 *per capita*.

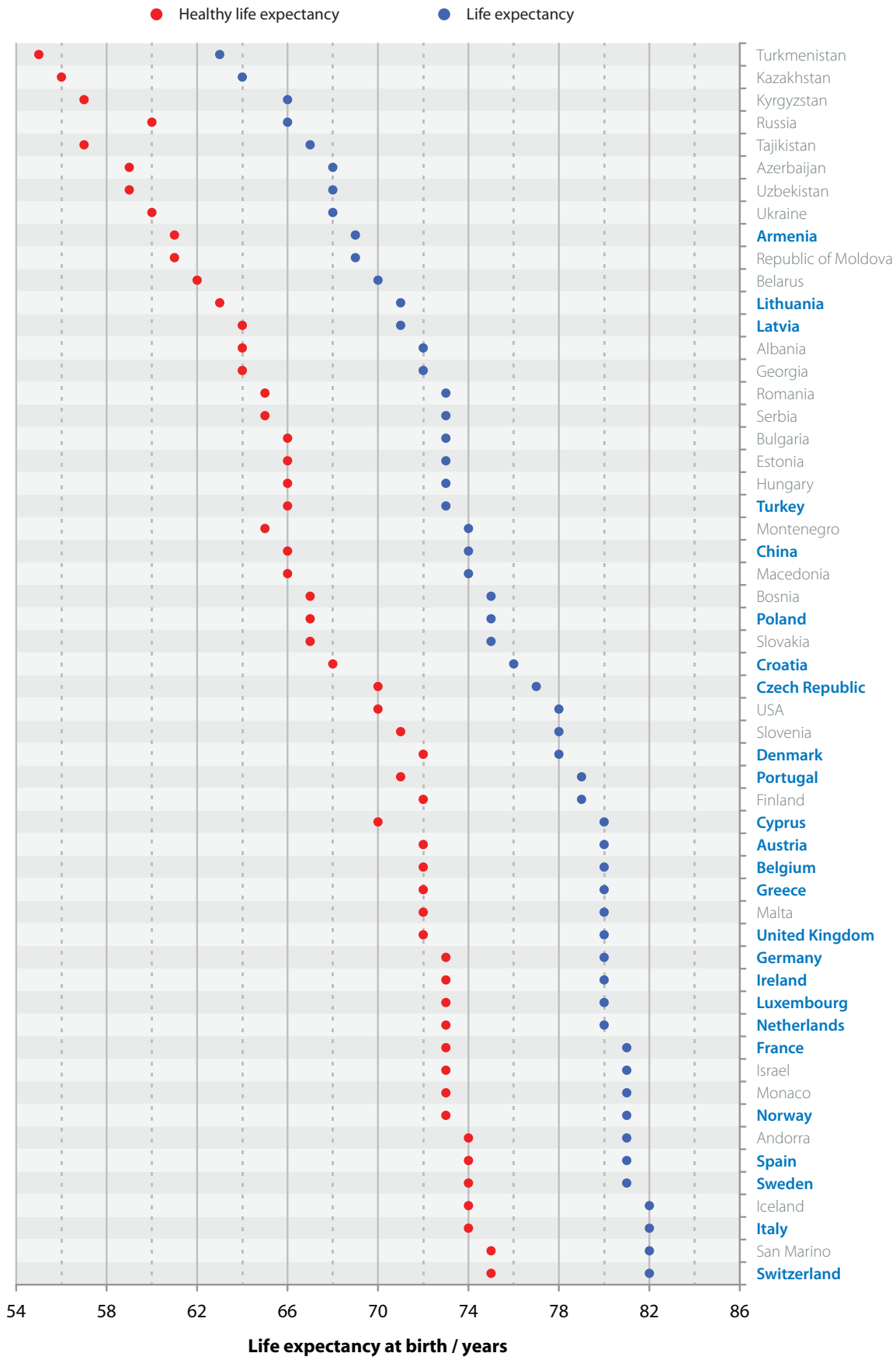
All the observations made on data quality, incidence of risk factors and outcomes presented from the EACTS database later in this report need to be seen and interpreted against these large variations.

We have, at the relevant places in later analyses, included some correlations between summary data from the WHO and data from the EACTS database.

For all the following WHO graphs, the countries that have submitted data to the EACTS Adult Cardiac Surgical Database are marked in bold, blue text for easy identification.

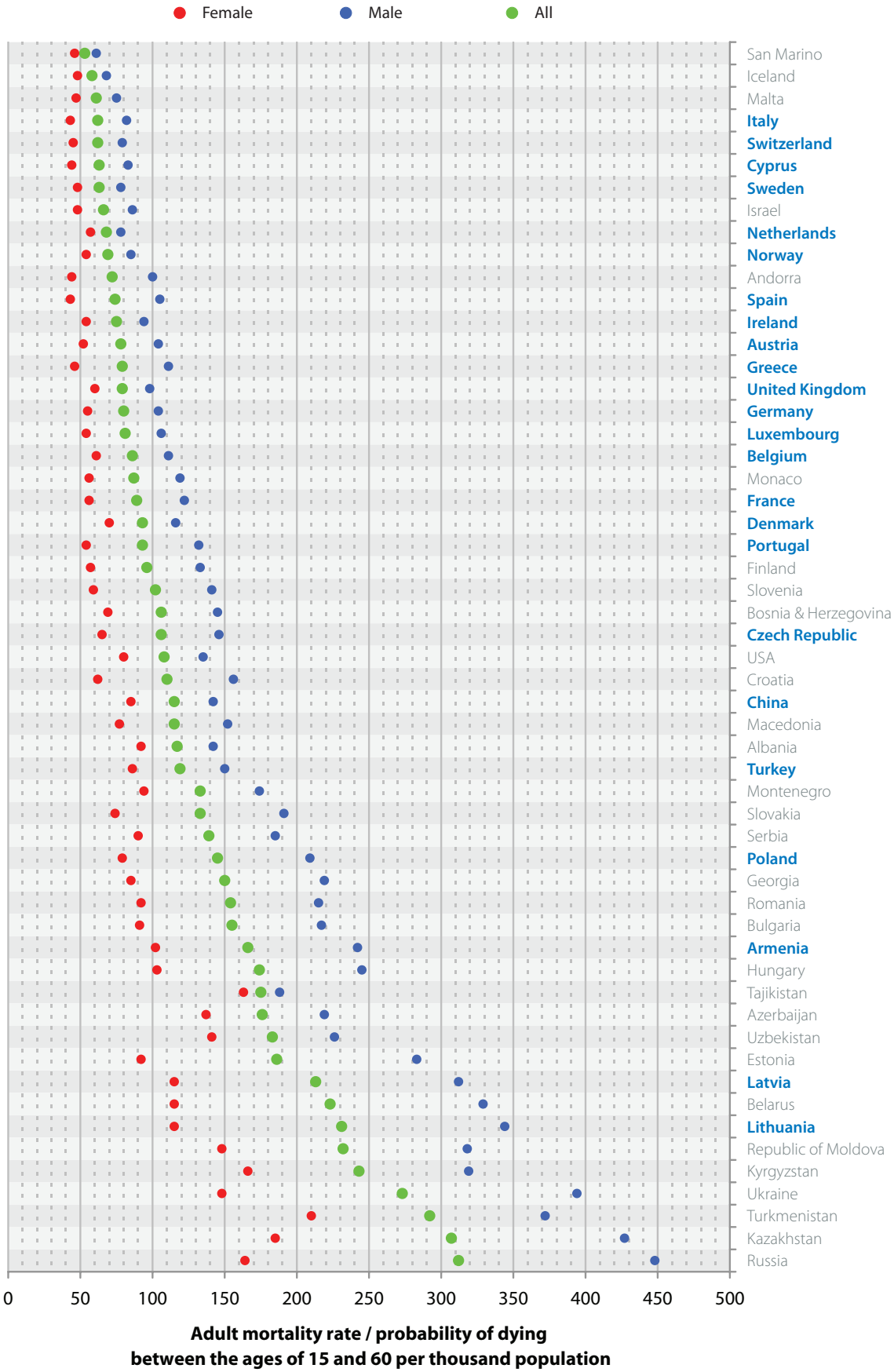
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Life expectancy at birth; calendar year 2007



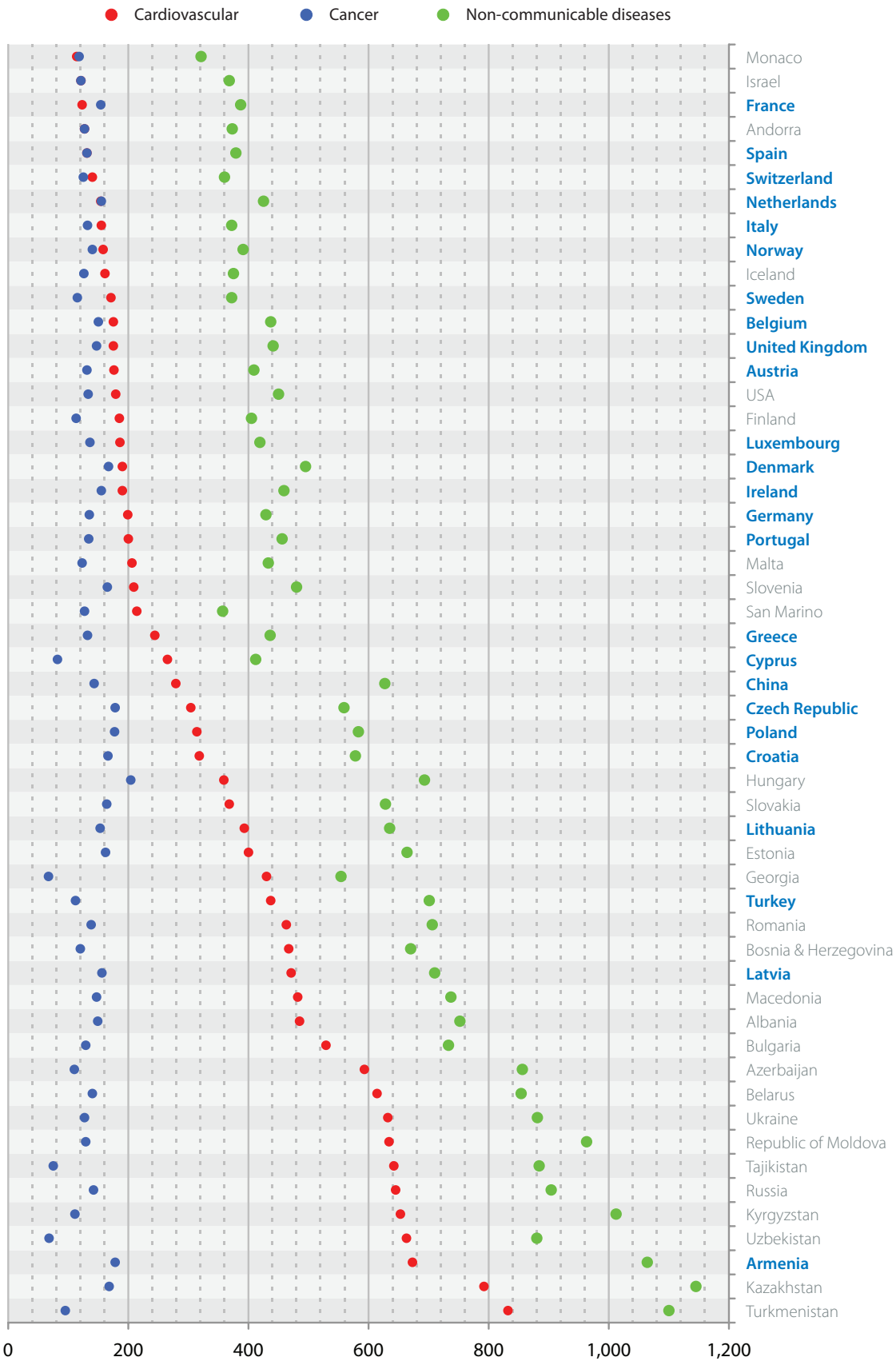
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Adult mortality rates; calendar year 2007



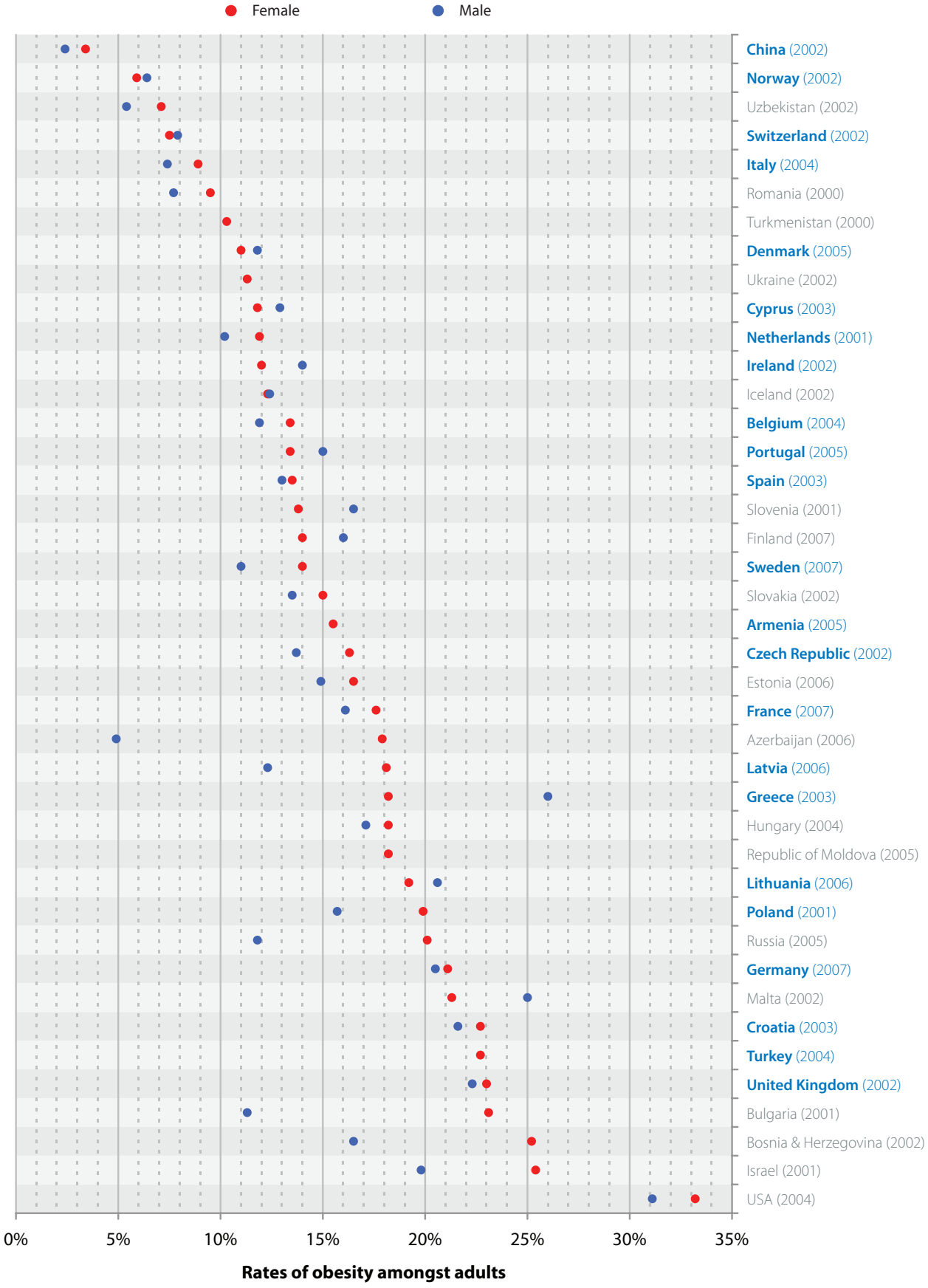
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Age-standardised mortality rates; calendar year 2004



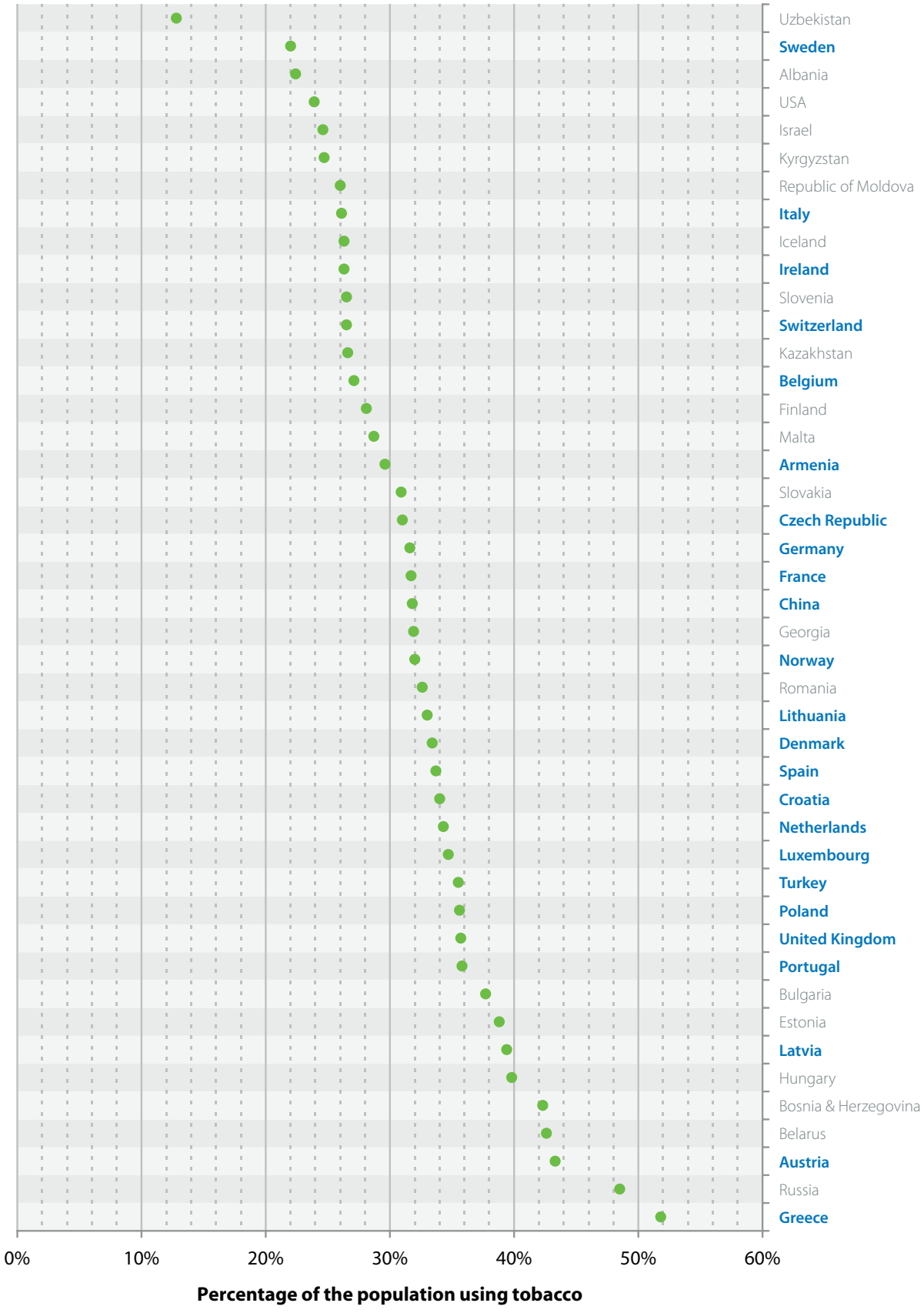
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Adult obesity



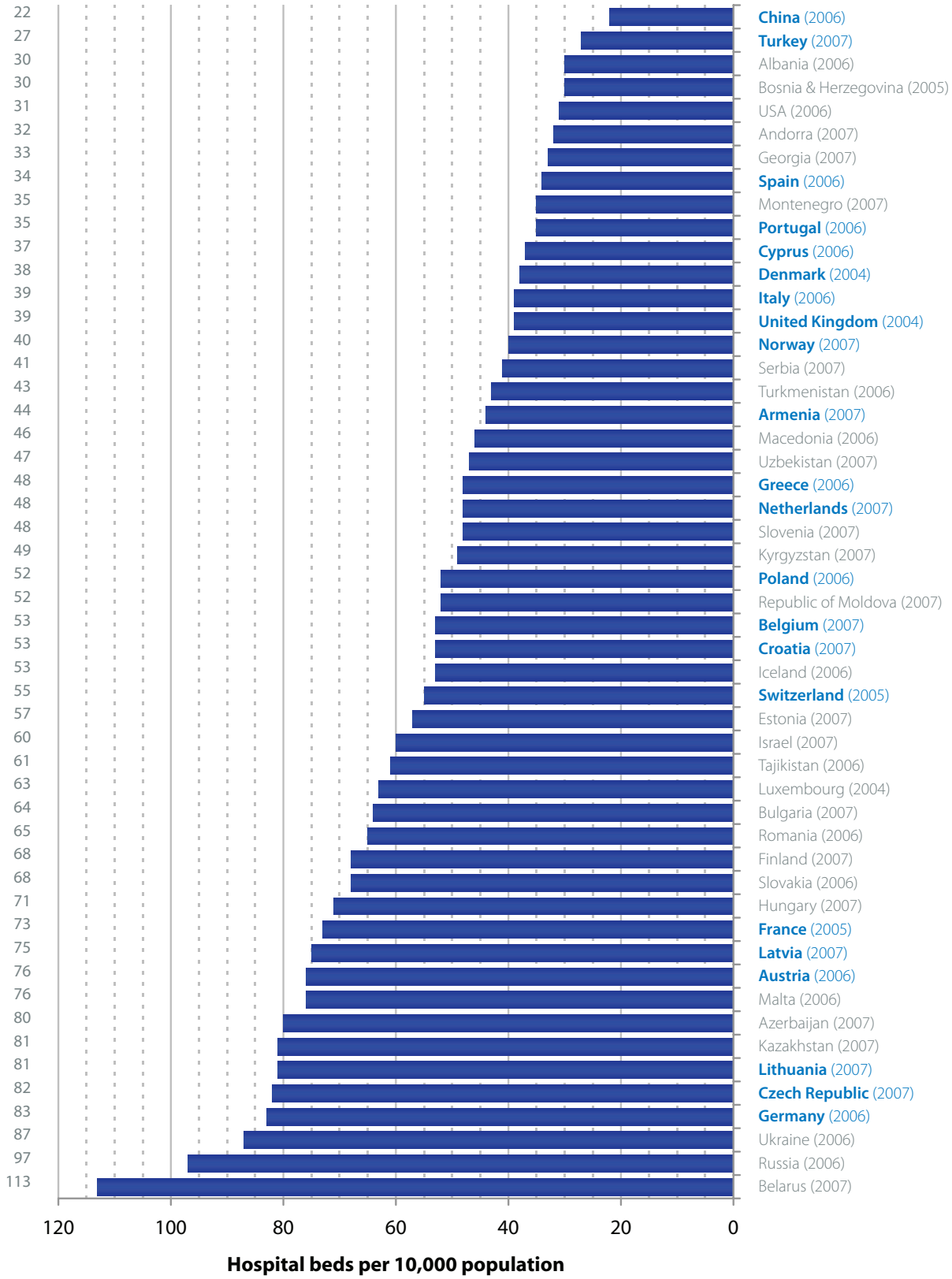
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Tobacco use

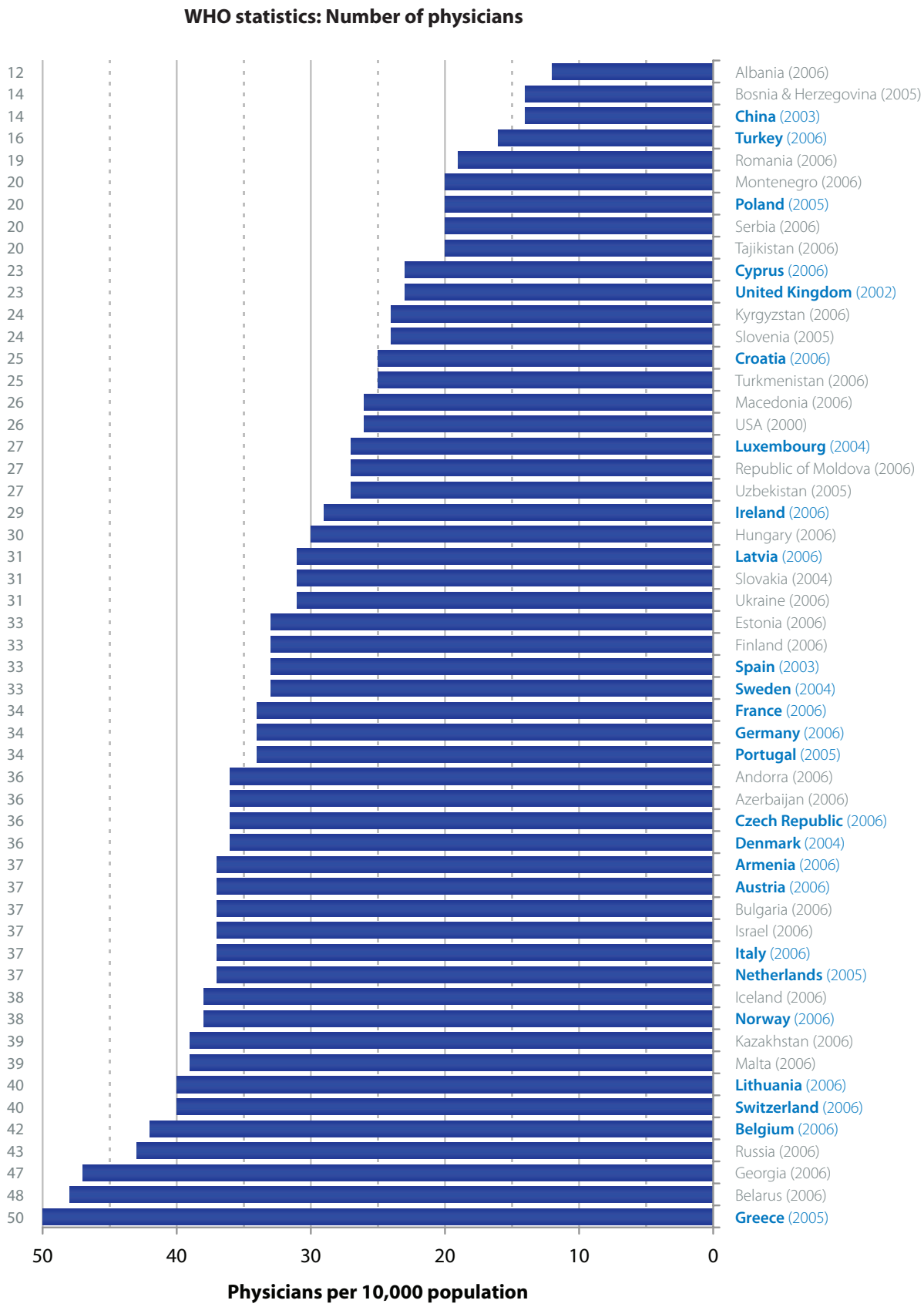


Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Hospital beds

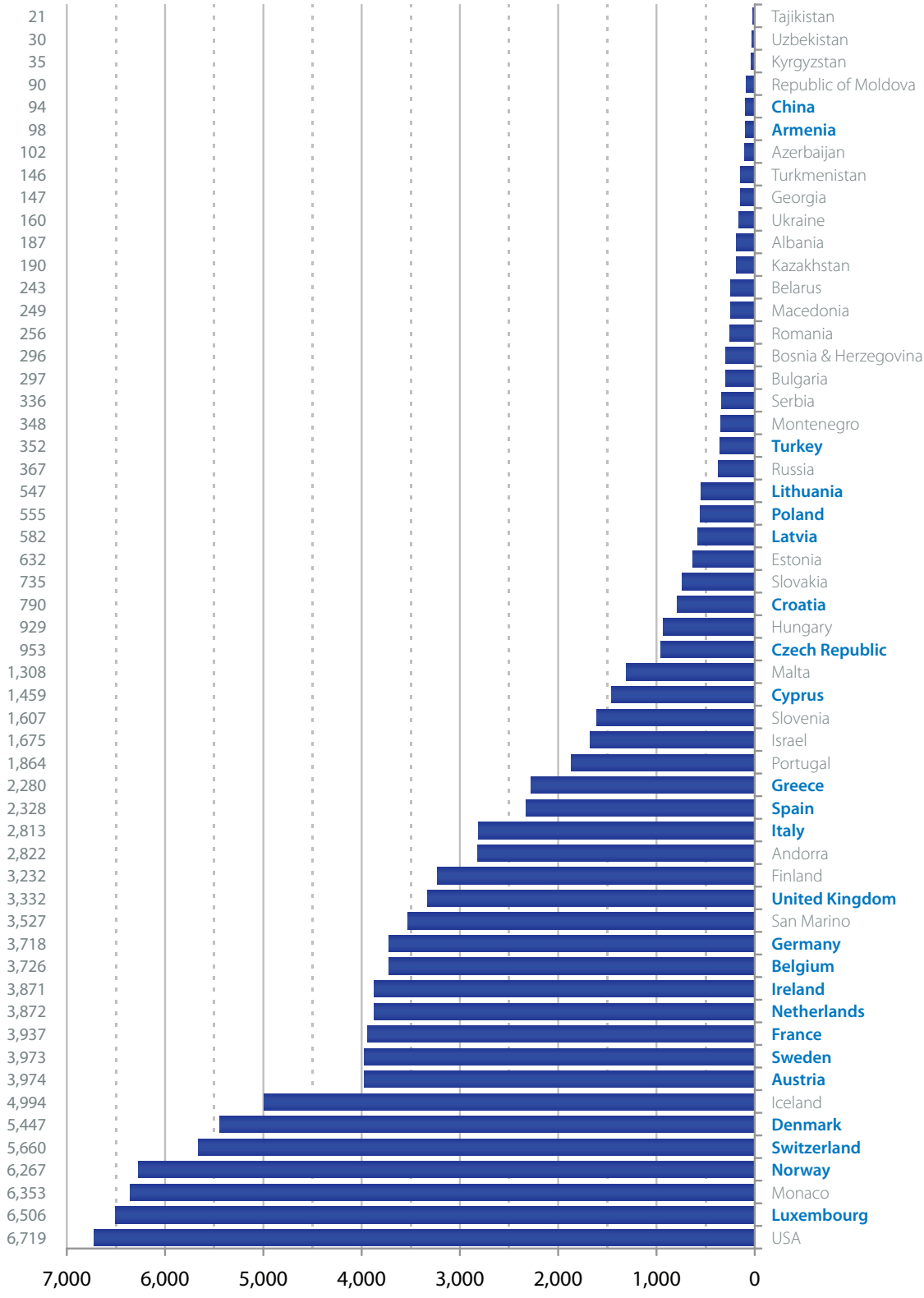


Data in this section are taken from the WHO website: http://apps.who.int/ghodata/



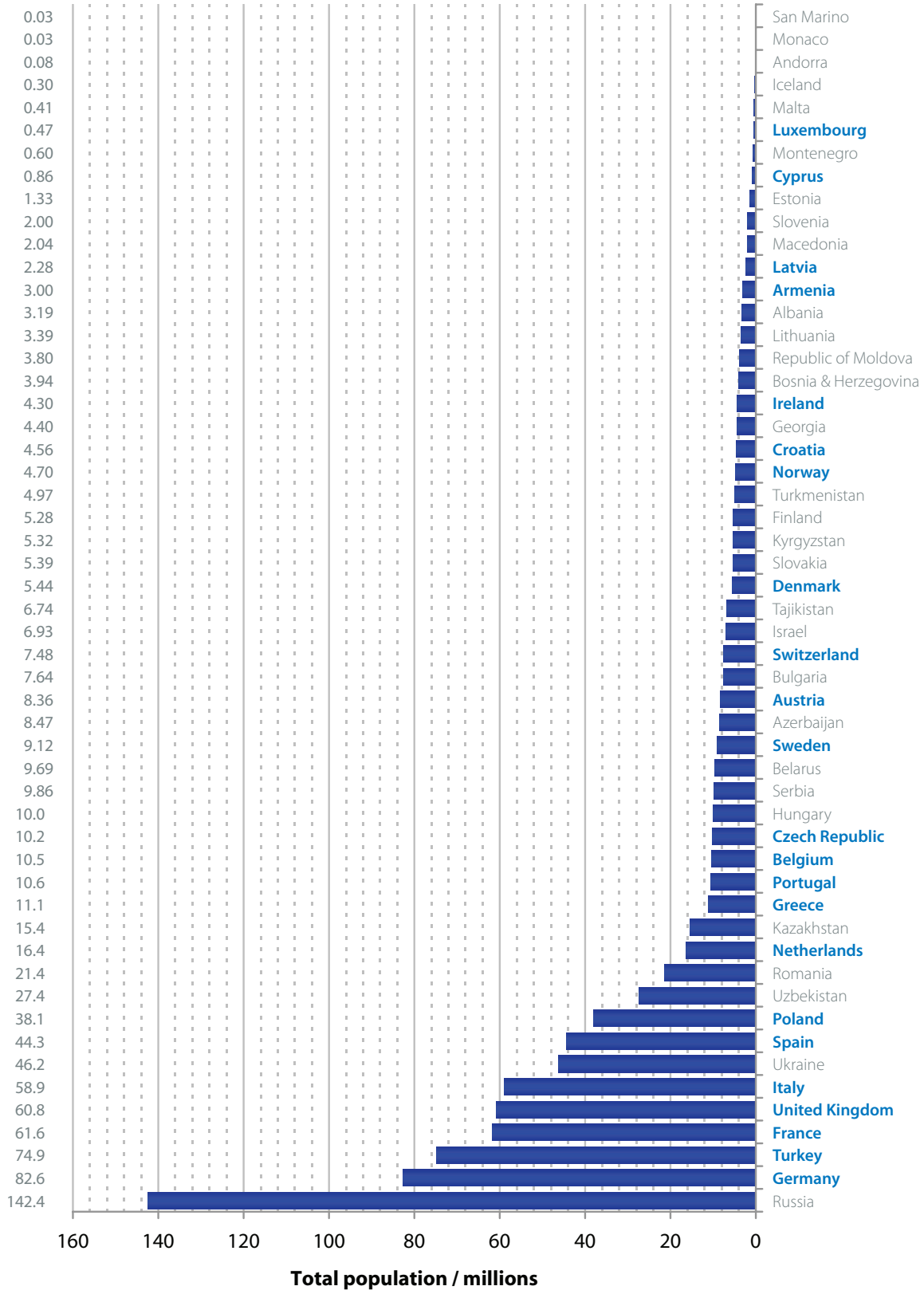
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Total health expenditure *per* capita; calendar year 2006



Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

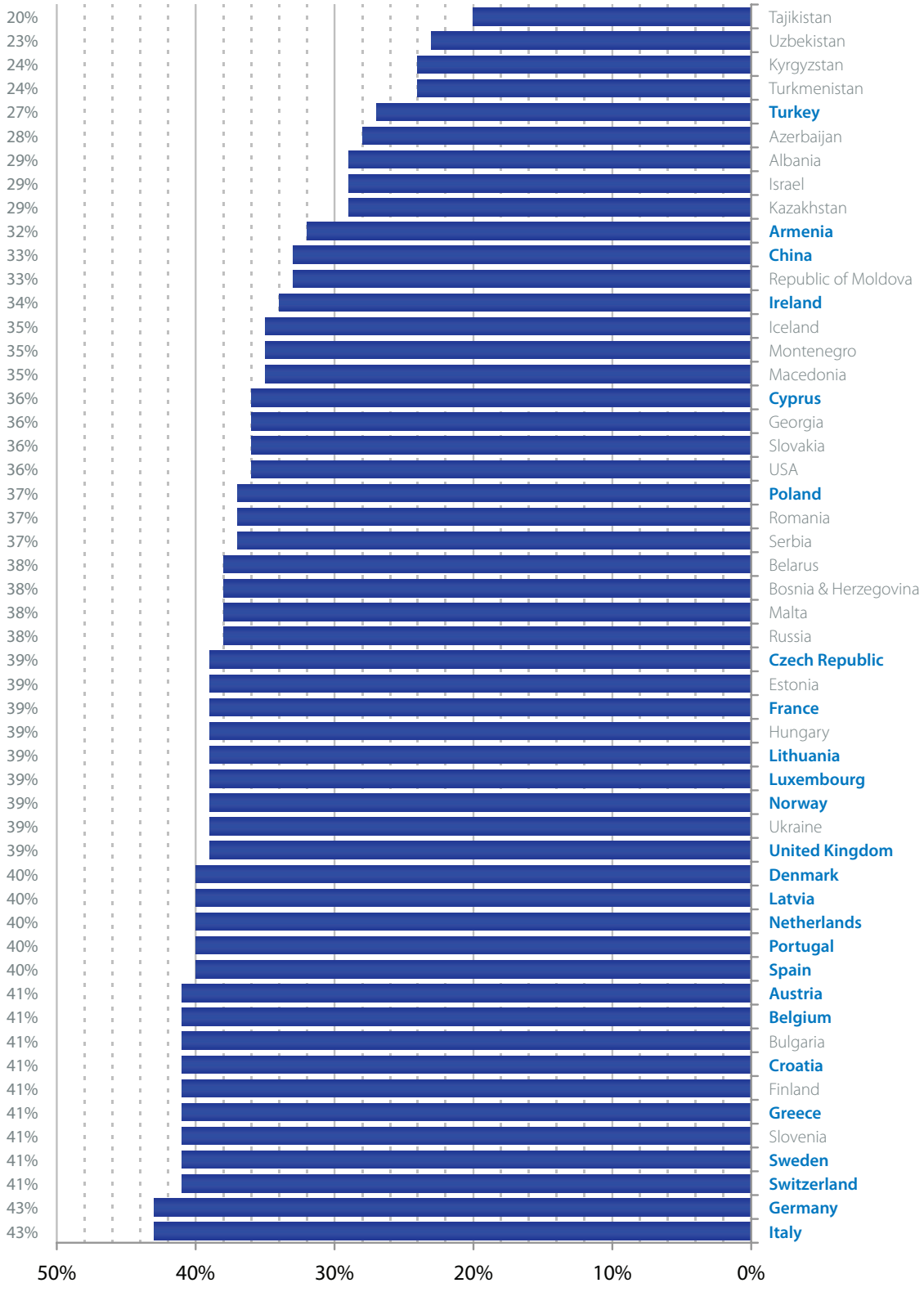
WHO statistics: Total population; calendar year 2007



USA = 305.8 million; China = 1,336.3 million

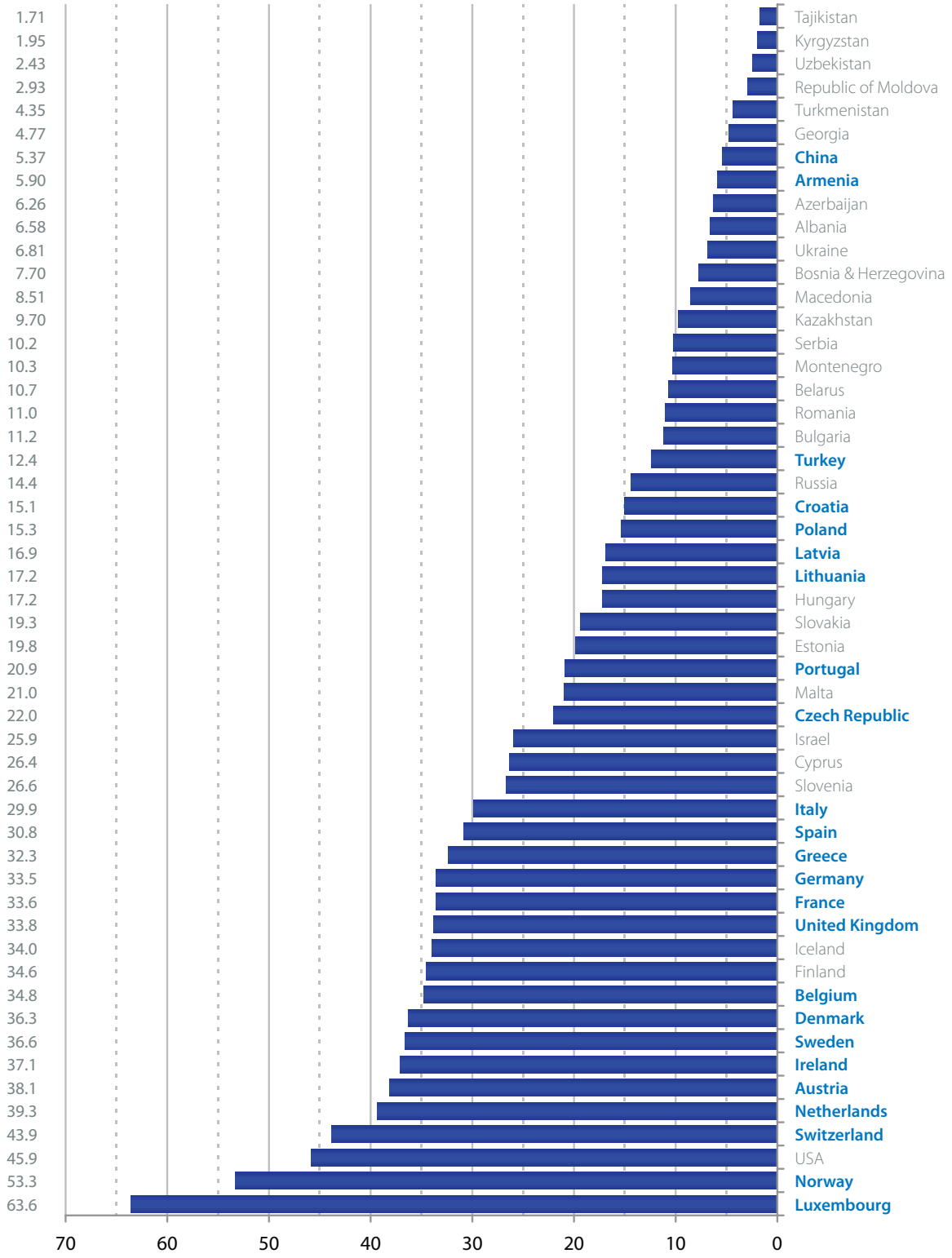
Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Proportion of the population aged >60; calendar year 2007



Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

WHO statistics: Gross National Income *per* capita; calendar year 2007



Data in this section are taken from the WHO website: http://apps.who.int/ghodata/

Import, merging and analysis methodology

Dendrite Clinical Systems provide the central registry software for the EACTS Adult Cardiac Surgical Database and this incorporates a sophisticated *Import Manager* system, which allows the Dendrite Data Analysts to import and merge data from a variety of disparate sources.

The schematic diagram opposite illustrates the data flow from the different countries to the central registry. Each contributor was sent a set of instructions on the required format for electronic data transfer (see the Appendix on page 228 for instructions on data submission), and data files were exported and sent to Dendrite's offices in the United Kingdom for processing. The process of data harvest and import was represented by two main scenarios:

1. Where the national registry uses Dendrite's database and analysis software for its central registry, *e.g*. the Italian, Spanish and Chinese National Cardiac Surgery Registries, the data were simply copied across to the EACTS Dendrite database as discrete databases ready for merging. The National Adult Cardiac Surgical Database of the Society for Cardiothoracic Surgery in Great Britain & Ireland also uses Dendrite for merging submissions and reporting, & this database has again been copied across to the EACTS Dendrite database.

   This same principle applied also to those individual hospitals that submitted their data provided that they were also using a Dendrite cardiac database system as their own local database, *e.g*., a number of individual hospitals in Cyprus, Greece, Hong Kong, Portugal, Switzerland and Turkey.

2. Where the national registry or individual hospital is using a third-party generic or proprietary system such as Microsoft Access™, *e.g.,* the Belgian, German, Norwegian, Polish and Swedish National Databases, the data were first imported into the Dendrite EACTS central database using Dendrite's Import Manager software.

The data for five countries (England, Northern Ireland, the Republic of Ireland, Scotland and Wales) arrived in one file as they had been previously merged into a single Dendrite database for the purpose of producing the analyses for the Sixth National Adult Cardiac Surgical Database Report for the Society for Cardiothoracic Surgery in Great Britain & Ireland.

Once all the data had been mapped across into the EACTS central data repository as a number of parallel *Interim Registries* in a variety of languages, the data were translated and corresponded across to one common merged database, the *Final Target* EACTS Registry. The correspondence process entailed mapping the response-options of the questions in the *Interim Registries* across to identical or near-identical options in the *Final Target* EACTS Registry. Where there were incompatibilities in data definitions or only partial matches between source & target questions, only perfect / near perfect options were mapped. Hence not all the data analyses presented in this report involved data from all 29 of the countries that are represented.

At this point various data logic checks and validation scripts were applied by the Dendrite Data Analytical team to ensure that any major data errors (such as negative length-of-stay) were identified in the source data. In some cases, extensive dialogue was required between Dendrite and the contributors, which led to partial reformatting of data to correct obvious errors and, in a very few cases, data had to be re-submitted and then re-imported in their entirety to eliminate major data errors in the original source files.

Data merging, manipulation and analysis were carried out using a suite of integrated software systems including the Dendrite software, Microsoft Excel™, Microsoft Access™ and Crystal Decisions' Crystal Reports™ using an ODBC link to the data in the Dendrite Registry. Where possible, data from all entries and all countries were used for the basic aggregate data analysis and inter-country comparisons. In the production of this report, the methodology described above was applied to data from 366 hospitals located in 29 countries.

For further information about Dendrite's National Registry Software System, the Import Manager Module and / or Dendrite's data analysis and report production methodologies, please write to:

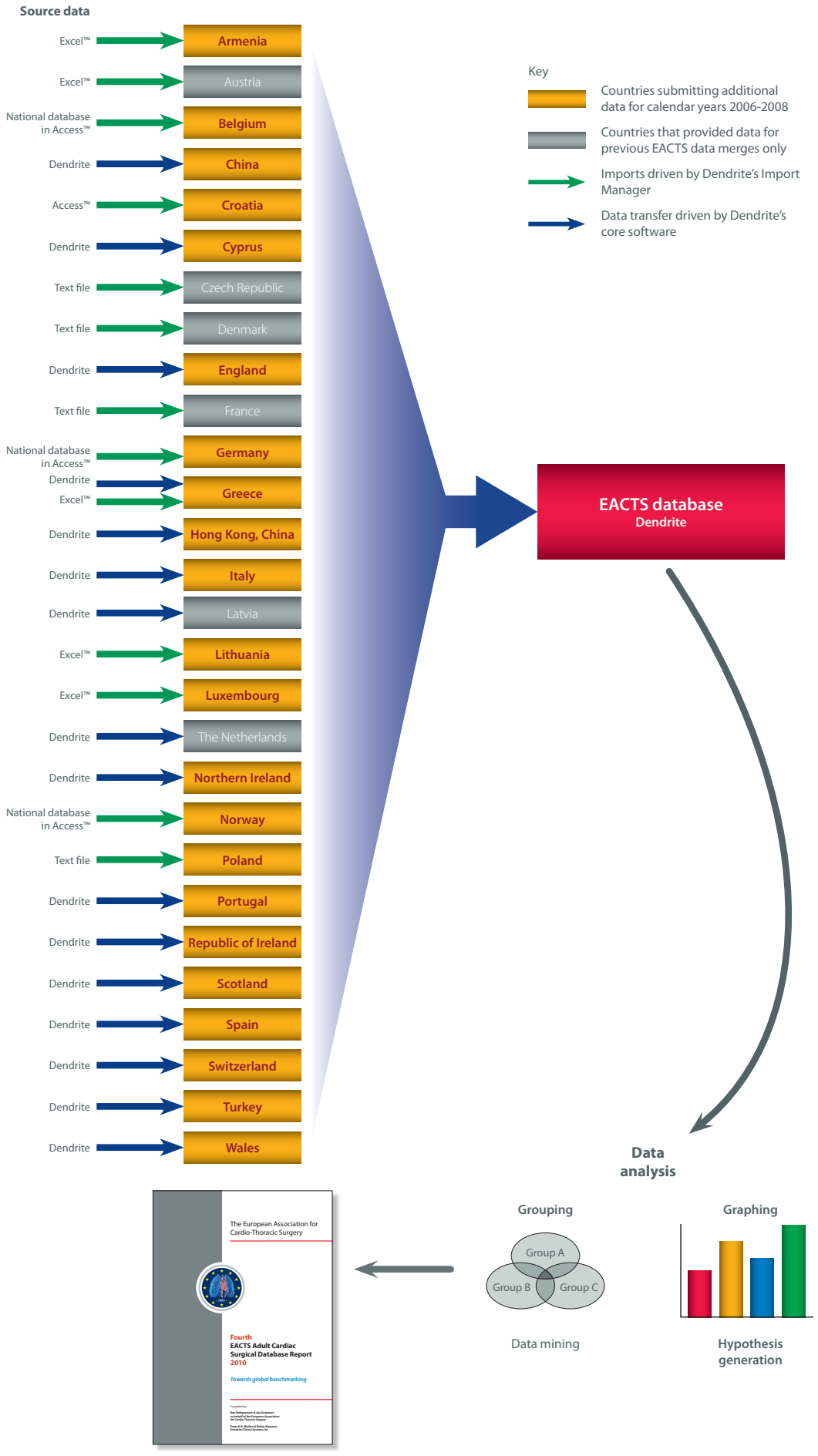
Dr Peter K.H. Walton, Managing Director

Dendrite Clinical Systems Ltd

The Hub, Station Road, Henley-on-Thames

Oxfordshire RG9 1AY, United Kingdom

phone +44 1491 411 288
e-mail peter.walton@e-dendrite.com



Import, merging and analysis

A note on the conventions used throughout this report

There are a number of conventions used in the report in an attempt to ensure that the data are presented in a simple and consistent way. These conventions relate largely to the tables and the graphs, and some of these conventions are outlined below.

The specifics of the data used in any particular analysis are made clear in the accompanying text, table or chart. For example, the analysis of mortality data tends to focus on the calendar years 2006 to 2008 in an attempt to minimise the effects of the well-documented and ongoing improvement in outcomes for patients over time.

Conventions used in tables

On the whole, unless otherwise stated, the tables in this report record numbers of operations (see the example below reproduced in part from page 80).

Mortality at the time of discharge after isolated CABG surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge			
		Alive	Died	Unspecified	**All**
Age at surgery / years	<56	34,121	308	203	**34,632**
	56-60	29,066	336	194	**29,596**
	61-65	33,085	447	240	**33,772**
	66-70	43,674	920	292	**44,886**
	71-75	40,406	1,193	281	**41,880**
	76-80	25,199	1,117	194	**26,510**
	>80	8,000	577	65	**8,642**
	Unspecified	594	10	2	**606**
	All	**214,145**	**4,908**	**1,471**	**220,524**

Each table has a short title that is intended to provide information on the subset from which the data have been drawn, such as the calendar years encompassed or particular procedure groupings under examination.

The numbers in each table are colour-coded so that patient-entries with complete data for all of the components under consideration (in this example both the patient's age and outcome at discharge) are shown in regular black text. If one or more of the database questions under analysis is blank, the data are reported as unspecified in purple text. The totals for both rows and columns are highlighted as bold text.

Some tables record percentage values; in such cases this is made clear by the use of an appropriate title within the table and a % symbol after the numeric value.

Rows and columns within tables have been ordered so that they are either in ascending order (age at operation: <56, 56-60, 61-65, 66-70, 71-75, >75; calendar year: 2006, 2007, 2008, *etc*.) or with negative response options first (No; None) followed by positive response options (Yes; Oral alone, Diet, Insulin).

Row and column titles are as detailed as possible within the confines of the space available on the page. Where a title in either a row or a column is not as detailed as the authors would have liked, then footnotes have been added to provide clarification.

There are some charts in the report that are not accompanied by data in a tabular format. In such cases the tables are omitted for one of a number of reasons:

- insufficient space on the page to accommodate both the table and graph.
- there would be more rows and / or columns of data than could reasonably be accommodated on the page.
- the tabular data had already been presented elsewhere in the report.

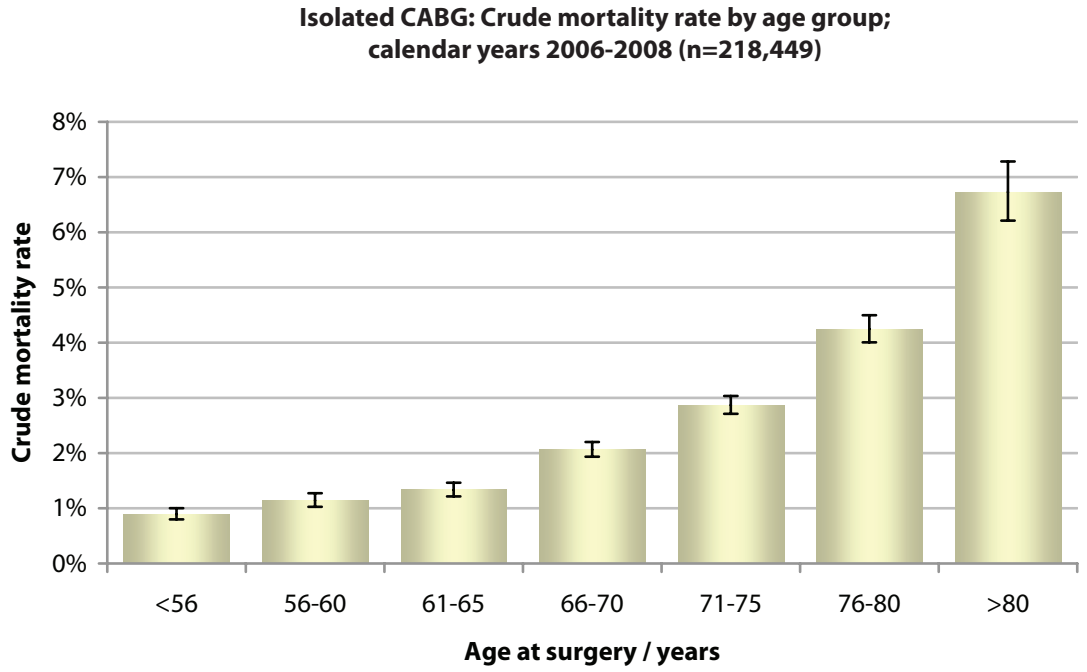
Conventions used in graphs

The basic principles applied when preparing graphs for the third EACTS report were based, as far as possible, upon William S. Cleveland's book *The elements of graphing data* [1]. This book details both best practice and the theoretical bases that underlie these practices, demonstrating that there are sound, scientific reasons for plotting charts in particular ways.

Counts: The counts (shown in parentheses at the end of each graph's title as n=) associated with each graph can be affected by a number of independent factors and will therefore vary from chapter to chapter and from page to page. Most obviously, many of the charts in this EACTS report are graphic representations of results for a particular group (or subset) extracted from the database, such as data recorded for isolated CABG procedures or data recorded for isolated valve procedures. This clearly restricts the total number of database-entries available for any such analysis.

In addition to this, some entries within the group under consideration have data missing in one or more of the database questions under examination (reported as unspecified in the tables); all entries with missing data are excluded from the analysis used to generate the graph because they do not add any useful information.

For example, in the graph on page 80 (reproduced below), only the entries where both the patient's age and outcome at discharge are known are included in the analysis; this comes to 218,449 patient-entries (34,121 + 29,066 + 33,085 + 43,674 + 40,406 + 25,199 + 8,000 + 308 + 336 + 447 + 920 + 1,193 + 1,117 + 577 from examining the table; the 2,075 entries with unspecified data are excluded from the chart).



Confidence interval: In the charts prepared for this report, most of the bars plotted around rates (percentage values) represent 95% confidence intervals. The width of the confidence interval provides some idea of how certain we can be about the calculated rate of an event or occurrence. If the intervals around two rates do not overlap, then we can say, with the specified level of confidence, that these rates are different; however, if the bars do overlap, we cannot make such an assertion

Bars around averaged values (such as patients' age, post-operative length-of-stay) are classical standard error bars; they give some idea of the spread of the data around the calculated average. In some analyses that employ these error bars there may be insufficient data to legitimately calculate the standard error around the average for each sub-group under analysis; rather than entirely exclude these low-volume sub-groups from the chart their arithmetic average would be plotted without error bars. Such averages without error bars are valid in the sense that while they truly represent the data submitted; however, they should not to be taken as definitive and therefore it is recommended that such values are viewed with extra caution.

1 Cleveland WS. The elements of graphing data. 1985, 1994. Hobart Press, Summit, New Jersey, USA.


~ 1986 ~

Database overview

An overview of cardiac surgery in Europe

Entries in the EACTS database

The previous EACTS report was published in 2006, encompassing data on patients undergoing surgery up to the end 2005. The majority of the countries that have submitted previously have continued to submit for the current data-merge. A number of countries including Austria, the Czech Republic, Denmark, France, the Netherlands and Latvia have submitted previously, but have not submitted for the current time period. We are delighted that we have a number of new contributors that include Armenia, China (including Hong Kong) and Sweden.

Number of operations submitted by contributor country

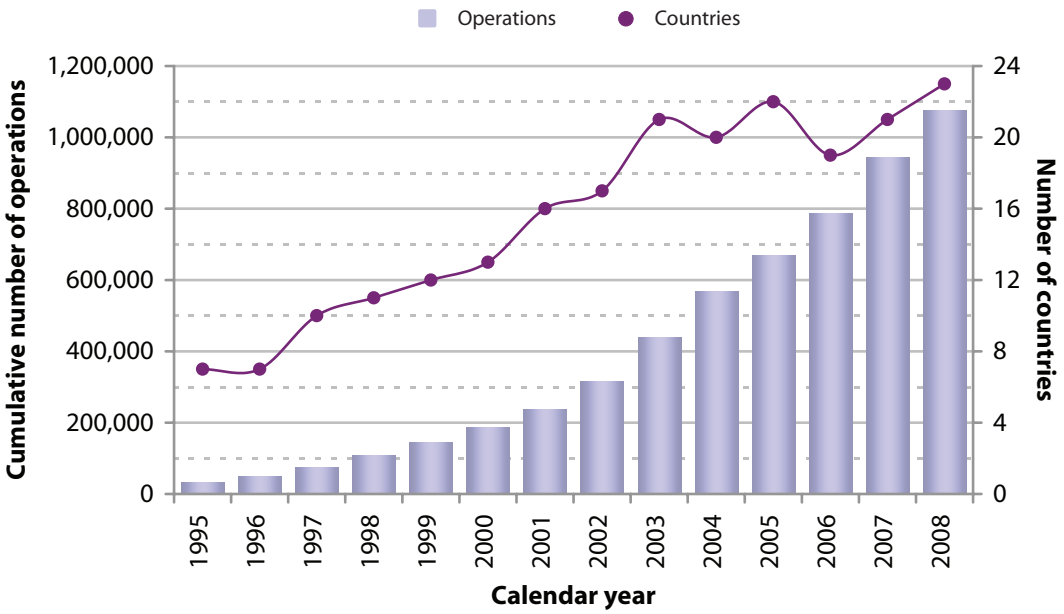
		Operation records			
		Calendar years 2006-2008		All entries in the database	
		Count	Percentage	Count	Percentage
Country	Armenia	85	0.02%	**85**	**0.01%**
	Austria	0	NA	**1,595**	**0.1%**
	Belgium	34,670	8.6%	**78,739**	**7.3%**
	China	24,168	6.0%	**24,168**	**2.2%**
	Croatia	1,225	0.3%	**3,543**	**0.3%**
	Cyprus	638	0.2%	**1,829**	**0.2%**
	Czech Republic	0	NA	**23,688**	**2.2%**
	Denmark	0	NA	**25,090**	**2.3%**
	England	71,887	17.8%	**344,342**	**32.0%**
	France	0	NA	**30,271**	**2.8%**
	Germany [1]	122,452	30.3%	**224,216**	**20.9%**
	Greece	5,593	1.4%	**12,470**	**1.2%**
	Hong Kong, China	891	0.2%	**940**	**0.1%**
	Italy	21,726	5.4%	**58,524**	**5.4%**
	Latvia	0	NA	**2,007**	**0.2%**
	Lithuania	400	0.1%	**2,858**	**0.3%**
	Luxembourg	1,246	0.3%	**3,110**	**0.3%**
	The Netherlands	0	NA	**3,094**	**0.3%**
	Northern Ireland	762	0.2%	**4,130**	**0.4%**
	Norway	14,495	3.6%	**62,123**	**5.8%**
	Poland	64,191	15.9%	**64,191**	**6.0%**
	Portugal	1,565	0.8%	**7,259**	**0.7%**
	Republic of Ireland	3,296	0.8%	**9,242**	**0.9%**
	Scotland	4,922	1.2%	**31,209**	**2.9%**
	Spain	12,591	3.1%	**16,629**	**1.5%**
	Sweden	6,817	1.7%	**6,817**	**0.6%**
	Switzerland	3,657	0.9%	**4,752**	**0.4%**
	Turkey	3,880	1.0%	**12,214**	**1.1%**
	Wales	3,564	0.9%	**15,483**	**1.4%**
	All	**404,721**		**1,074,618**	

1 The data received from Germany for the period 2006-2008 comprised only isolated CABG procedures, isolated aortic valve procedures and combined AV & CABG procedures.

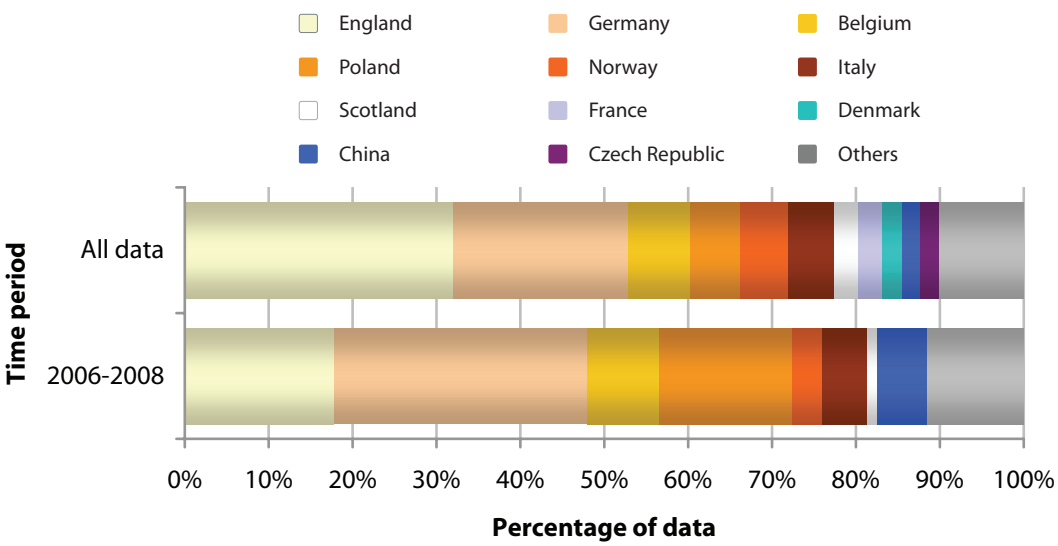
The number of patients-records submitted to the EACTS Adult Cardiac Surgical Database has now increased to over 1,000,000. The calendar year 2008 saw the largest number of countries submitting with 23 contributions.

There are a number of countries with relatively mature database systems that have contributed large volumes of data to the database, including the United Kingdom (England, Wales, Scotland and Northern Ireland), Germany, Belgium and Poland. Together these countries make up over 70% of all the records. These countries will have less uncertainty in the data presented and are likely to be more representative of the *true* national picture than some other countries where the data may be from either a small number of units or even a solitary hospital. The large-volume contributor countries should act as the most important benchmark in the following analyses, and variations in submission volume should be considered at all times when looking at the subsequent charts.

All operations: Number of contributor countries and submitted operation records (n=1,074,618)



The relative contributions of the top contributor countries



Data completeness

There is significant variation in the completeness of submitted data. Some countries have >90% completeness of all important variables, others have submitted only age & gender. We would not wish to be in any way critical of those countries that are embarking on collection initiatives but cannot yet submit complete data.

Data completeness for selected database questions and contributor country

Percentage of records complete

- >90% complete
- 76-90% complete
- 51-75% complete
- 26-50% complete
- 1-25% complete
- 0% complete
- Data only partially compatible with the EACTS database

Country	Count	Age	Gender	Height and weight	Angina	Dyspnoea	Diabetes	Smoking	Hypertension	Renal failure	Neurological dysfunction	Extra-cardiac arteriopathy
Armenia	85	●	●	●	○	●	●	○	●	○	○	●
Austria	1,595	●	●	●	○	◕	●	●	○	○	●	○
Belgium	78,739	●	●	◑	○	○	◑	○	○	○	◑	◑
China	24,168	●	●	●	●	●	●	●	●	●	○	○
Croatia	3,543	●	●	◕	◕	●	●	○	●	○	●	◕
Cyprus	1,829	●	●	●	●	●	●	●	●	●	●	●
Czech Republic	23,688	●	●	●	●	●	○	●	●	○	●	●
Denmark	25,090	●	●	○	○	○	◕	◕	○	○	○	○
England	344,342	●	●	●	◕	●	●	◕	●	◕	◕	●
France	30,271	●	●	◕	○	◔	◕	◑	◕	○	○	○
Germany	244,216	●	●	●	●	◕	●	◑	◑	○	●	◕
Greece	12,470	●	●	◑	◕	◕	●	◕	◕	◑	◑	◔
Hong Kong, China	940	●	●	●	●	●	●	●	●	●	●	●
Italy	58,524	●	●	◕	◑	◔	◕	◑	◕	○	◑	◕
Latvia	2,007	●	●	○	○	○	○	○	○	○	○	○
Lithuania	2,858	●	●	●	◑	◑	●	◑	●	◑	◑	◑
Luxembourg	3,110	●	●	●	◑	◑	●	◑	●	●	●	●
The Netherlands	3,094	●	●	●	●	◕	●	●	●	●	◔	●
Northern Ireland	4,130	●	●	●	●	●	●	●	●	●	●	●
Norway	62,123	●	●	◕	○	◕	◕	○	○	○	○	○
Poland	64,191	●	●	●	●	●	●	●	●	●	●	●
Portugal	7,259	●	●	●	●	●	●	◔	◔	◔	◔	◔
Republic of Ireland	9,242	●	●	●	●	●	●	●	●	◕	●	●
Scotland	31,209	●	●	●	●	●	●	●	●	◕	◕	◕
Spain	16,629	●	●	●	◕	◕	●	●	●	◕	◑	◕
Sweden	6,819	●	●	●	○	○	○	○	○	○	●	○
Switzerland	4,752	●	●	●	◕	◕	●	◕	●	●	●	●
Turkey	12,214	●	●	●	◕	◕	●	●	●	◔	◔	◕
Wales	15,483	●	●	◕	◕	●	●	●	●	◕	◕	◕

For data to be deemed *correct* and *complete* in this report, it must be collected completely in the local hospital, exactly according to the definitions in the EACTS database (see appendices) and there must be no errors in data submission, transfer or import between the hospital, the national society and the EACTS database. We would hope that the data in the following tables will be helpful in facilitating more complete data collection in future.

Data completeness for selected database questions and contributor country

Percentage of records complete

- >90% complete
- 76-90% complete
- 51-75% complete
- 26-50% complete
- 1-25% complete
- 0% complete
- Data only partially compatible with the EACTS database

Country	Count	Ejection fraction	Left main stem disease	Number of diseased vessels	Number of valves treated	Pre-operative ventilation	IV nitrates pre-operatively	Operative priority	Previous cardiac surgery	New post-operative stroke	New post-operative dialysis	In-hospital mortality
		Database question										
Armenia	85	●	●	●	◕	○	○	●	●	●	●	●
Austria	1,595	◕	●	◕	●	○	○	●	○	○	○	○
Belgium	78,739	◑	○	○	◑	○	◑	◑	○	○	○	○
China	24,168	●	●	●	●	○	●	●	●	●	●	●
Croatia	3,543	◕	●	●	◕	○	●	◕	◕	●	●	●
Cyprus	1,829	●	●	●	◕	●	●	●	●	◕	◕	●
Czech Republic	23,688	●	●	●	●	○	●	●	○	●	●	●
Denmark	25,090	◑	◕	◕	○	○	○	○	○	○	○	●
England	344,342	●	◕	◕	●	◕	◕	●	●	◕	◕	●
France	30,271	◑	○	◔	◔	○	○	◔	○	○	○	◕
Germany	244,216	●	●	◕	◕	●	●	●	●	●	●	●
Greece	12,470	●	◕	◕	◕	◔	◔	◕	◔	◑	◑	●
Hong Kong, China	940	●	●	●	●	●	●	●	●	●	●	●
Italy	58,524	◕	◑	◑	◑	○	◑	●	◕	○	◔	◑
Latvia	2,007	○	○	○	○	○	○	○	●	○	○	○
Lithuania	2,858	◕	●	●	◔	◑	◑	◑	◔	◑	◑	●
Luxembourg	3,110	◕	◔	◔	●	●	●	●	●	○	○	●
The Netherlands	3,094	◔	●	◕	●	○	●	●	●	●	●	○
Northern Ireland	4,130	●	●	◕	●	●	●	●	●	◕	◕	●
Norway	62,123	◕	◕	○	●	○	○	○	○	○	○	●
Poland	64,191	◕	●	●	●	◕	◕	●	●	○	●	●
Portugal	7,259	●	◔	◔	●	◔	◔	●	●	◔	◔	◔
Republic of Ireland	9,242	●	●	●	●	●	●	●	●	●	●	●
Scotland	31,209	●	●	◕	◕	◑	◕	●	●	◑	◕	●
Spain	16,629	●	◕	◕	●	●	◕	●	●	◕	◕	●
Sweden	6,819	●	○	○	○	○	○	○	○	○	○	●
Switzerland	4,752	●	◕	◕	●	●	●	●	◕	◕	◕	●
Turkey	12,214	◕	◑	◕	◕	◑	◑	●	●	●	●	●
Wales	15,483	●	◕	◕	●	◕	◕	●	●	◕	◕	●

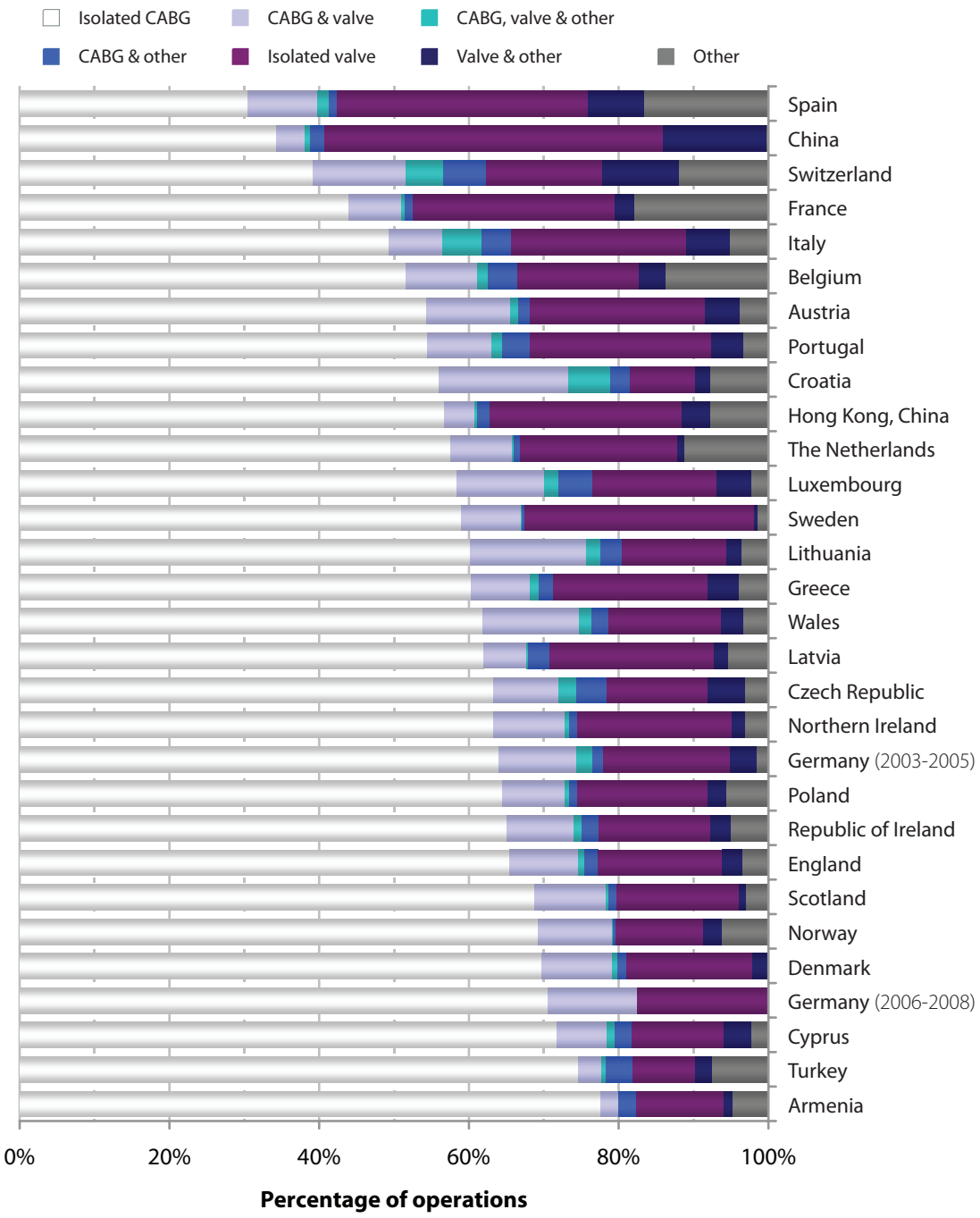
Type of operation

Type of operation and country

The following charts show some marked differences in casemix by operation type between countries submitting to the database. Historically, isolated coronary artery surgery has been the predominant operation performed by cardiac surgeons. The proportion of all cardiac surgery that was isolated coronary artery surgery varies from 30% in Spain up to nearly 80% in Armenia; of the high-volume contributors there remains a marked variation from around 50% in Belgium to 70% in Denmark.

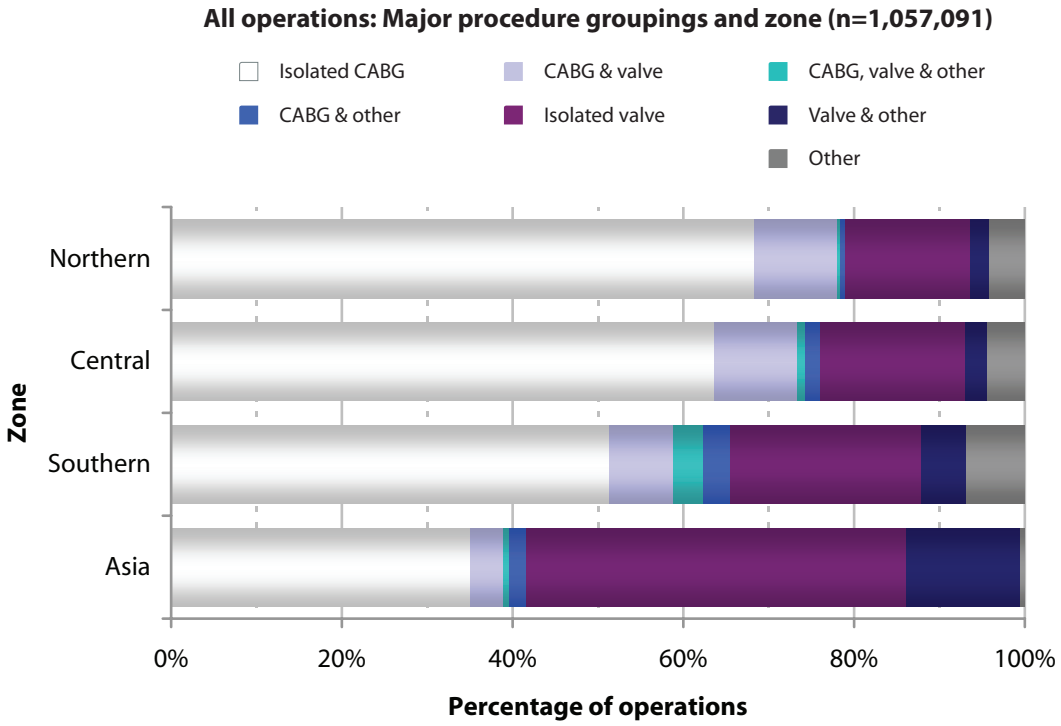
As described previously on page 11 of this report, probably the two most important factors underpinning the data in this graph are the relative burden of valvular and ischaemic heart disease and the proportion of ischemic heart disease that is treated by coronary artery surgery rather than percutaneous coronary intervention.

All operations: Major procedure groupings and contributor country (n=1,057,091)



There are, again, large variations in the proportion of surgery that is isolated coronary artery surgery across the geographical regions, from less than 40% in Asia up to 70% in Northern Europe. In Asia, nearly 50% of all cardiac surgery is isolated valve surgery.

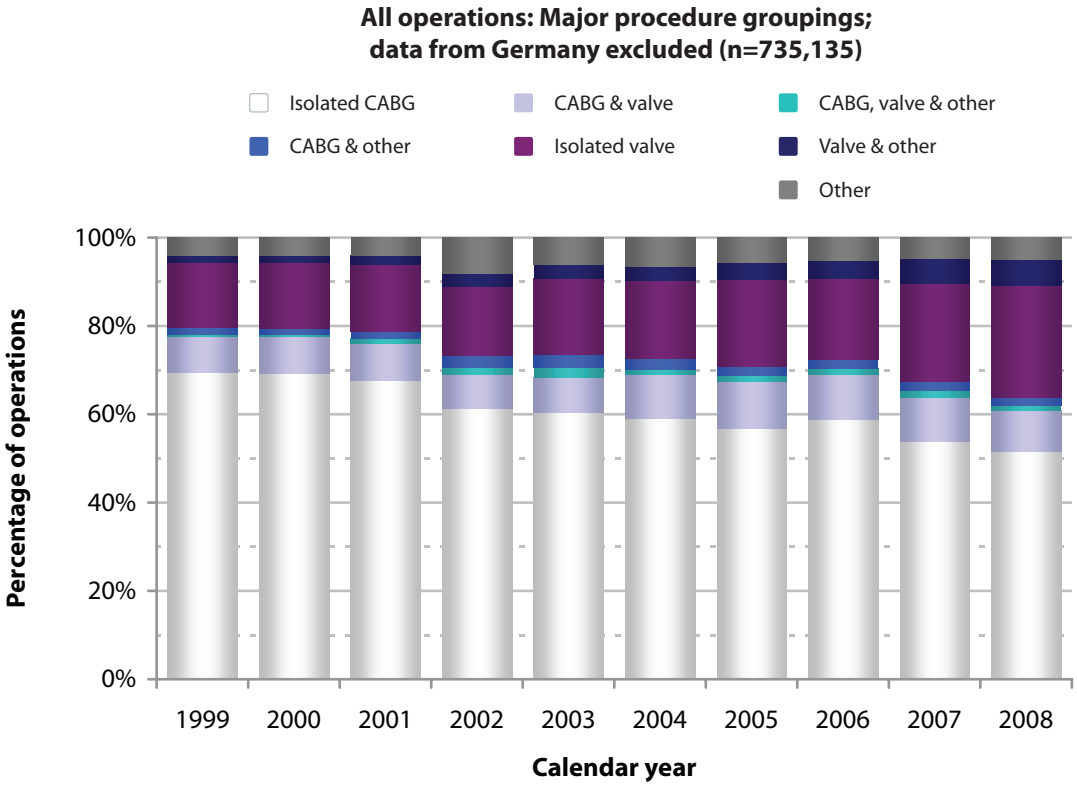
With these marked variations, it is important that comparisons of overall cardiac surgery mortality should not be made with about making efforts to adjust for casemix (see page 60).

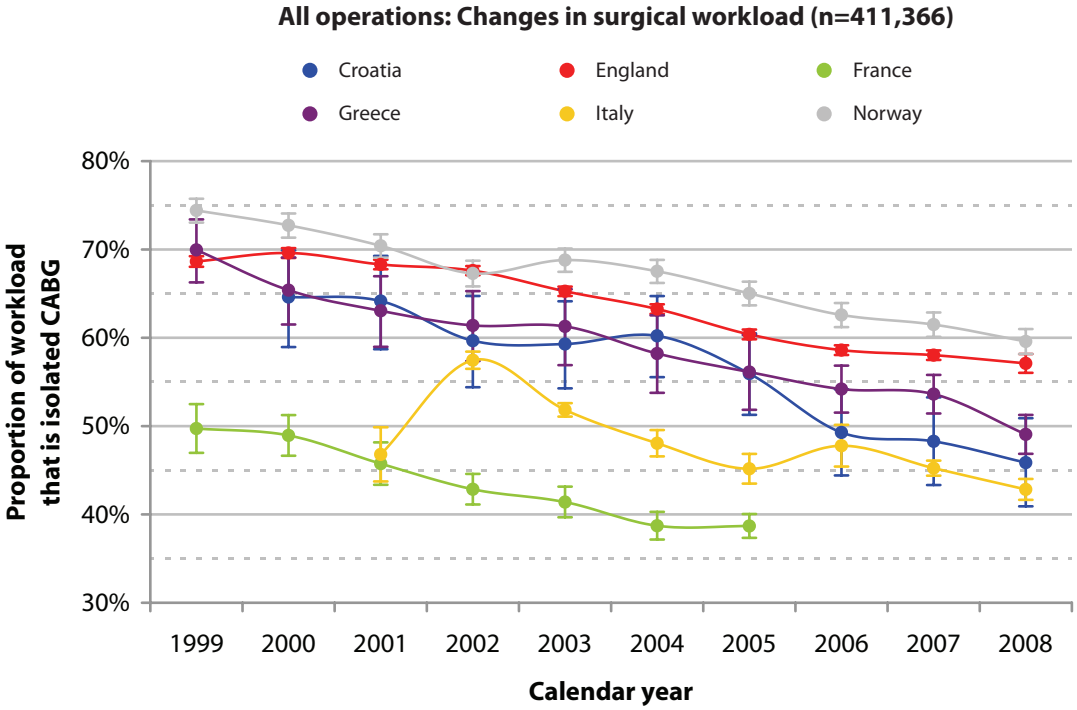


Changes in workload patterns over time

The proportion of the cardiac surgical workload that is recorded in the database as isolated CABG surgery has decreased systematically over time from 70% in 1999 to just over 50% in 2008. There have been marked increases in the proportions of isolated valve surgery and combined CABG & valve surgery in particular.

There have been gradual but persistent decreases in the proportion of isolated CABG surgery over time for all the major contributing countries.





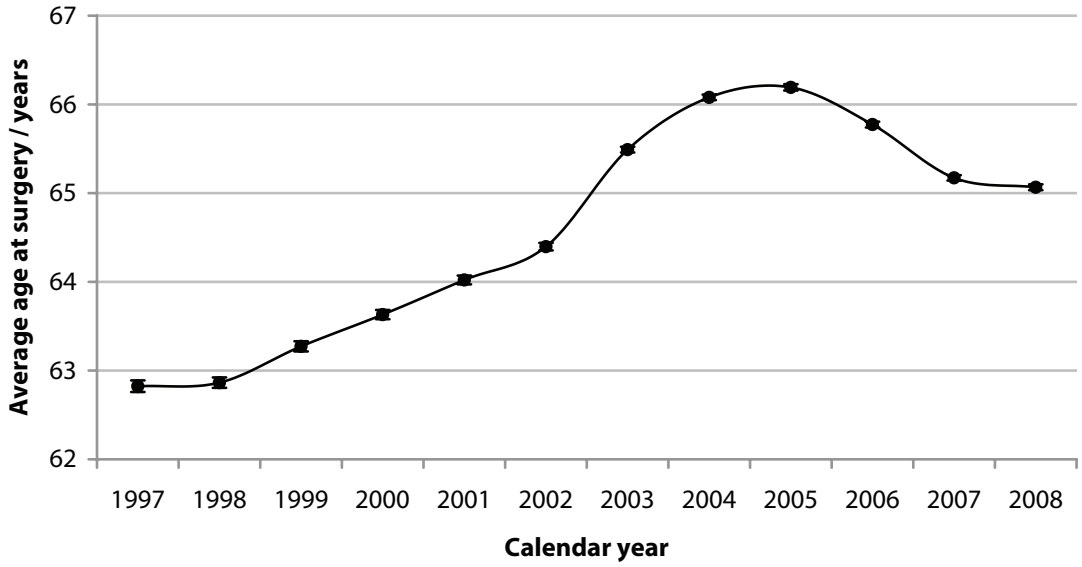
Age and gender

Trends in average age

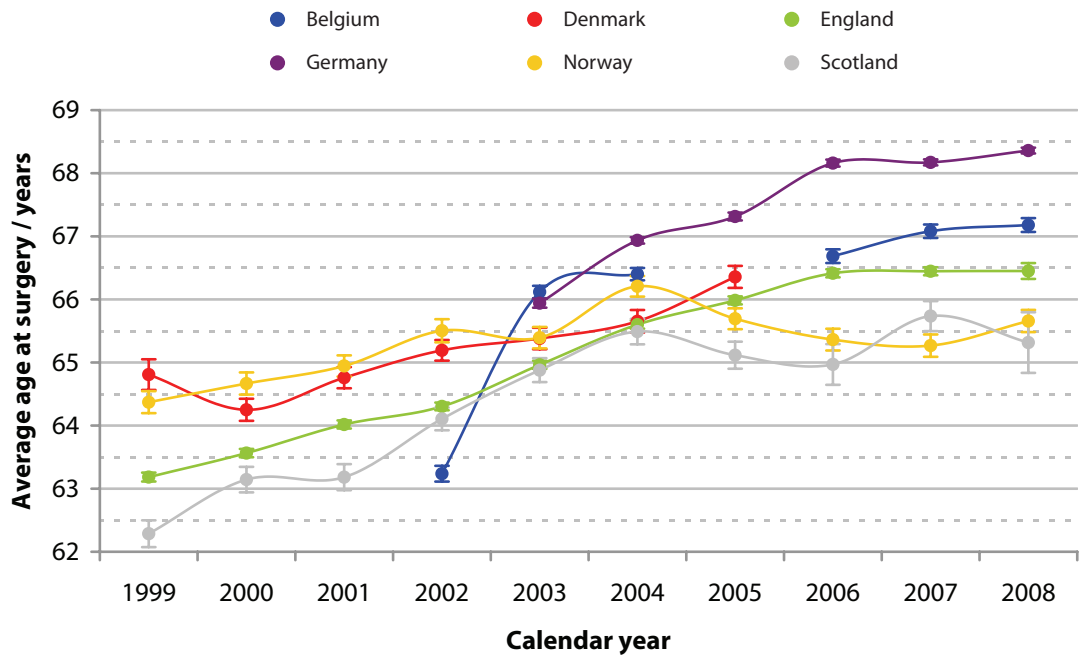
Overall there has been an increase in the average age of patients coming to cardiac surgery, from just under 63 years in 1997 to over 66 in 2005. These are important changes given the associations between increasing age and both mortality and length-of-stay, as shown later in this report. These increases in age apply to all of the major operative groups.

In recent years, the average age in the database has fallen slightly overall due to the effect of data from the new contributors. Changes in the average age of the major contributors shows a variable pattern.

All operations: Average age (n=1,021,991)



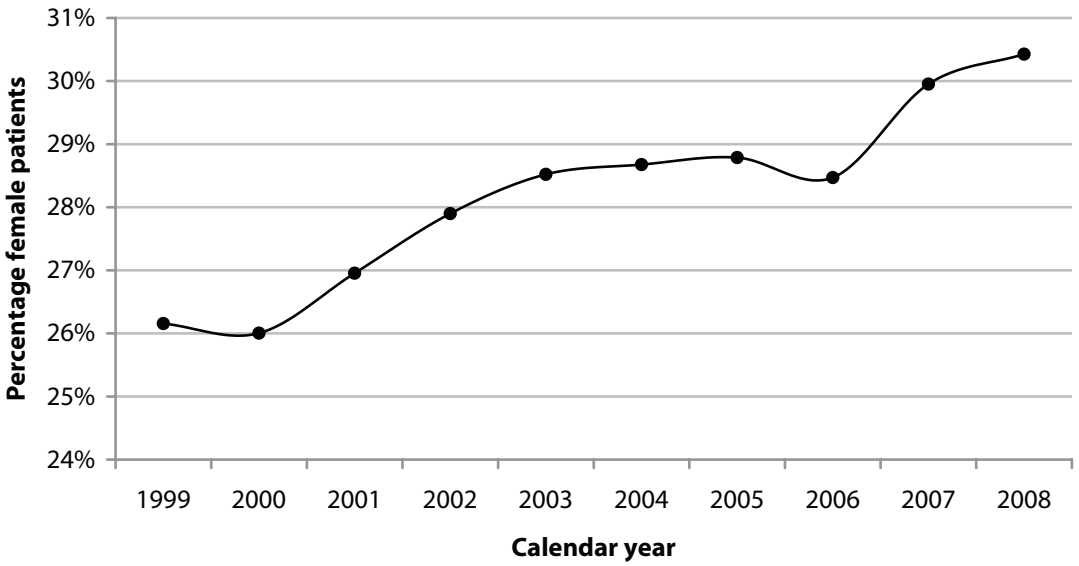
All operations: Average age and contributor country (n=670,973)



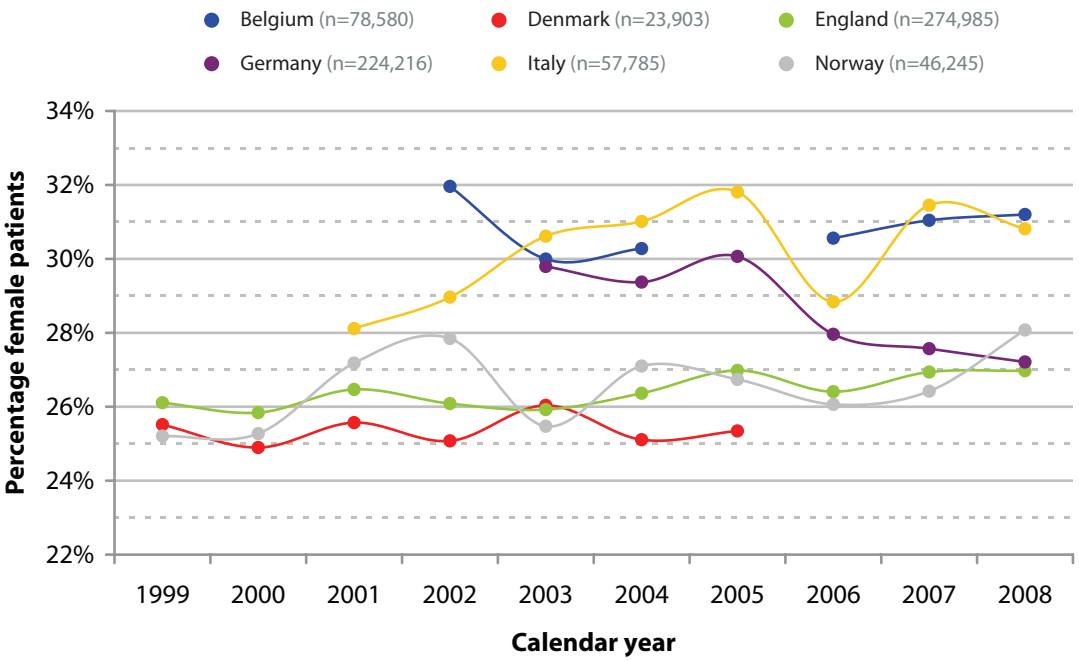
Trends in gender distributions

Patient-gender is an interesting topic in cardiac surgery, and there are number of important observations on this theme throughout this report. The overall trend has been for an increase in the proportion of patients who are female over time; however, the major contributing countries have more stable rates, which vary from about 25% in Denmark to over 30% in Italy and Belgium.

All operations: The trend in the proportion of female patients (n=964,918)



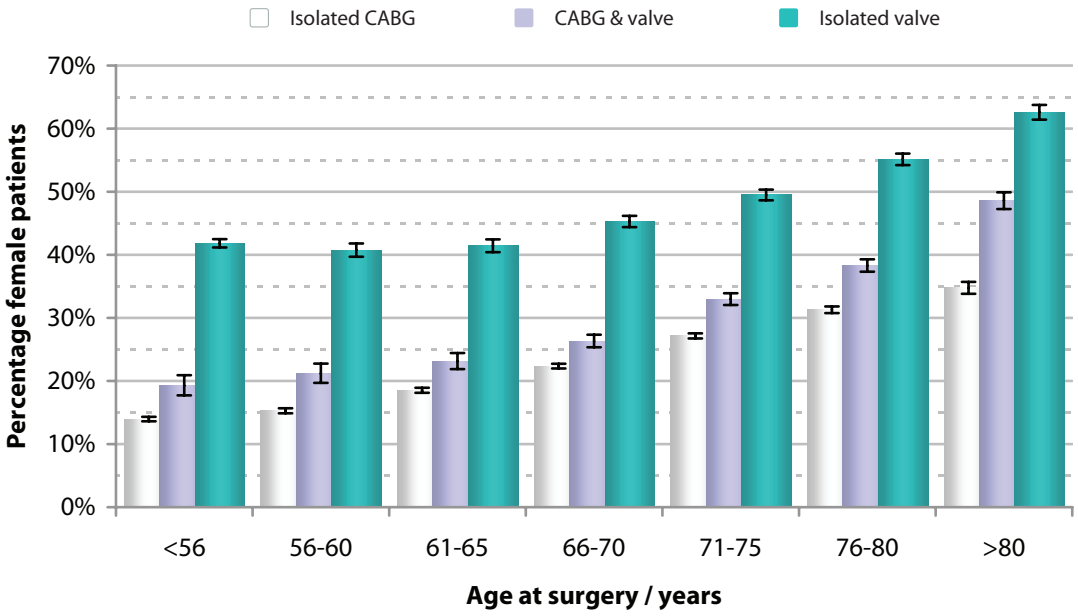
All operations: Trends in gender distributions for selected contributor countries (n=705,714)



Type of procedure, age & gender

The proportion of cardiac surgery that is performed on women increases with increasing age at surgery. The proportion of isolated CABG surgery on women under the age of 56 is only 15%, but this rises to 35% amongst the octogenarians. For isolated valve surgery the increase across the same age-range is from just over 30% to just over 60%. These findings are complex to unravel, but are probably due to a number of issues including gender- and age-related factors in the aetiology of coronary and valve disease, differences in life expectancy between men and women, as well as aspects about sex-related access to cardiac surgical services.

All operations: Percentage of female patients, age and operation type; calendar years 2006-2008 (n=362,976)



Mortality

Mortality following cardiac surgery is an important outcome measure. Quoting the likely risk of mortality is an important aspect of deciding whether or not patients will benefit from surgery and can guide the informed consent process. High overall mortality rates may be indicative of poor care.

The following pages document the mortality rates that have been returned to the database. These analyses show variation in data completion rates from the various countries for this important variable. For the purposes of documenting mortality by operative type (CABG, Valve, CABG & valve, *etc*), by subtype (CABG x1, CABG x2, AV surgery, MV surgery, *etc*) and by year of procedure, we have analysed those records where *status at discharge* (alive / dead) has been recorded and returned. Where this field is absent, those patient-entries are excluded from mortality analyses. For this reason, the total numbers of patient-entries in the presented analyses that focus on mortality are lower than those in later analyses on the frequency of the various risk factors.

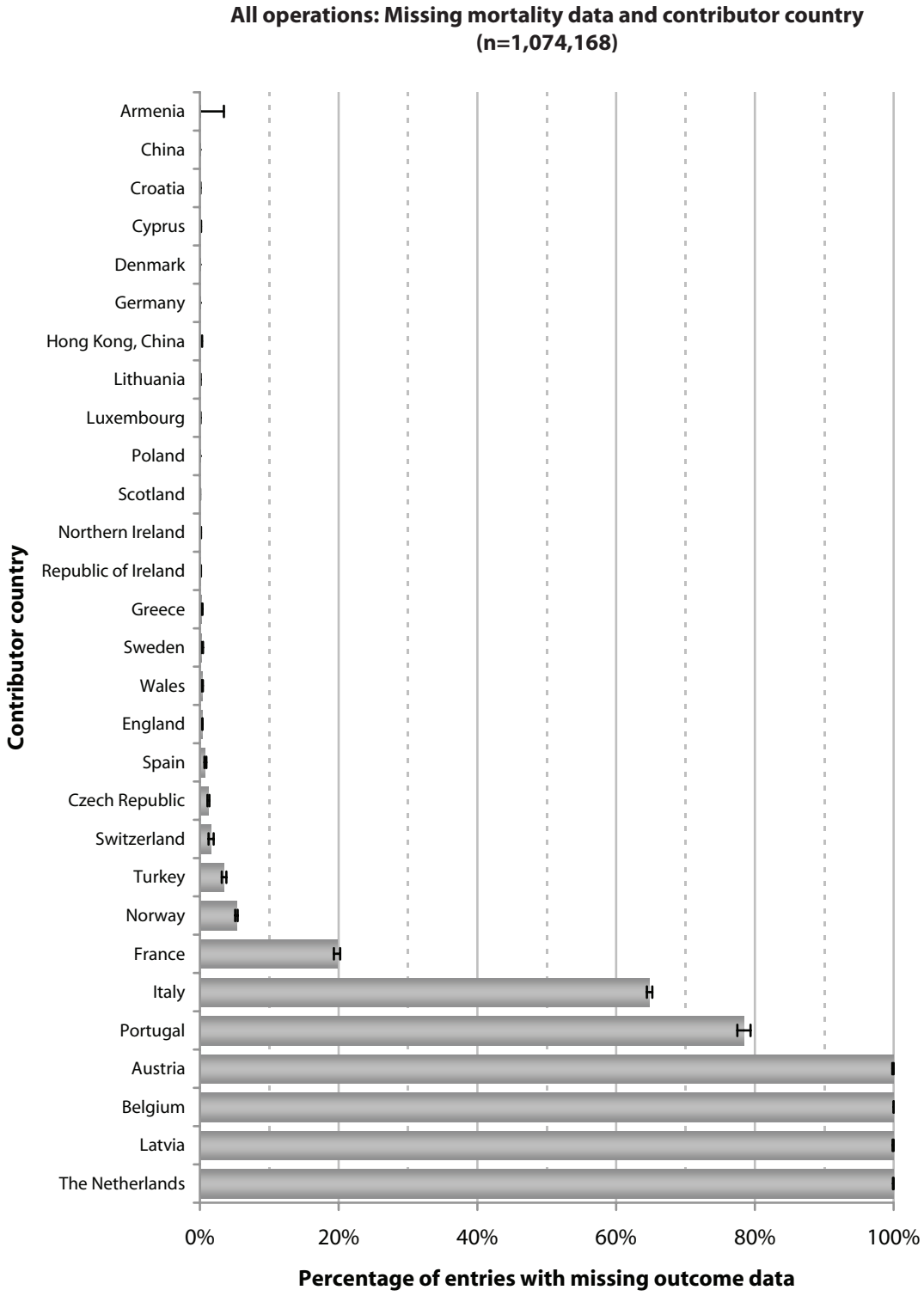
There are a number of important issues that are worthy of consideration when looking at analyses based on cardiac surgical mortality data:

- The mortality data are returned voluntarily by the submitting organisations. These data have not been subjected to routine, external validation. There are some data from the United Kingdom that suggest that this type of data submission is very accurate, but it is possible that there is some variation in data quality and validity across hospitals or countries.
- Mortality may be determined at different times after surgery; for example, in-hospital mortality (which may be in *base* hospital or in any hospital if patients are transferred post-surgery), 30-day mortality, 30-day in-hospital mortality, or 90-day mortality (which is probably the ideal for quality analyses as the hazard function for mortality after surgery persists for several months). There is a balance to be struck here. In-*base*-hospital mortality is the most straightforward to collect, but this has some shortcomings. It is possible that there is variation in the way *mortality* has been interpreted between hospitals and countries submitting to this database.
- Crude overall mortality data are critically dependent on casemix with, for example, mortality being higher for isolated valve surgery than for isolated CABG surgery (see page 62). Since there is significant variation in the proportion of patients with the different procedure types between countries (see page 54), crude mortality rates should not be compared without adjusting for casemix.
- Within single procedure groups (*e.g.*, isolated CABG) mortality is again dependent on the presence of various risk factors, which vary significantly in incidence between countries (see pages 76 to 143). Again, comparisons should not be made without making appropriate adjustments.
- The most commonly used risk adjustment model, the ***EuroSCORE***, significantly over-predicts the mortality reported to this database. In addition the level of completeness of risk factor data for CABG surgery is not sufficient to be sure that all patients can be scored accurately using this model. These issues are considered further on pages 150 to 158.
- Accurate collection and local scrutiny of cardiac surgical mortality rates, ideally against a contemporary risk-adjusted benchmark, is an important aspect of local clinical governance activities. Furthermore, detailed consideration of aspects of care related to specific mortalities is an important contributor to ongoing quality improvement. There remains controversy about whether there is further benefit from publishing mortality data (see page 20).

Given the above issues we have not reported mortality rates by named countries in this report. We have, however, offered confidential, bespoke feedback of data quality and risk-adjusted mortality to submitting countries, to help the process of improvement at a national and local level (see also pages 150-151).

Missing mortality data

The incidence of missing in-hospital mortality data is shown in the graph below. The majority of countries have complete mortality data; for some no mortality data have been returned. It should be noted that the analysis of mortality following cardiac surgery is a potentially sensitive issue.



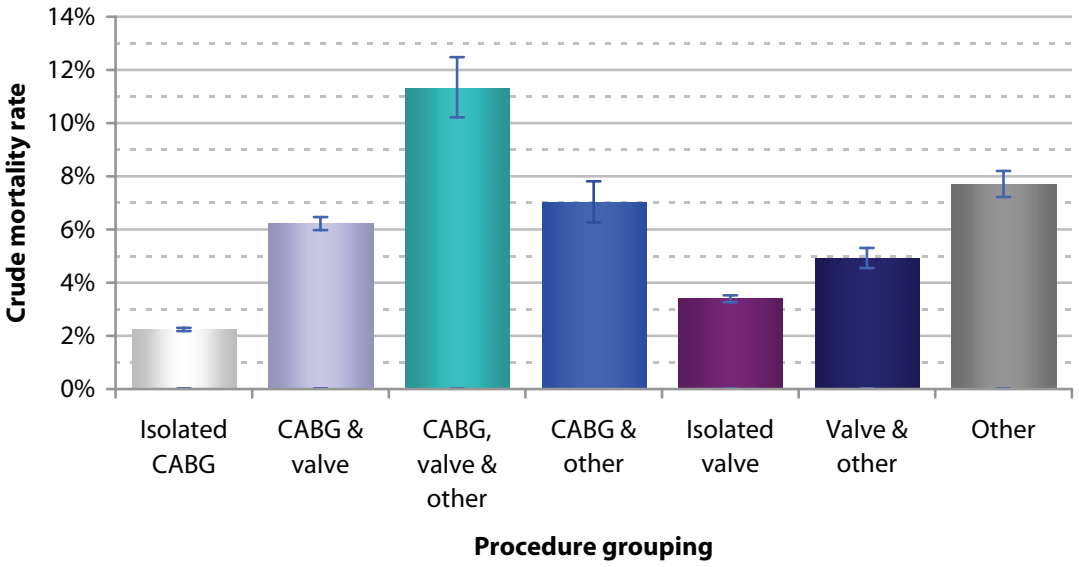
Mortality and major procedure grouping

The mortality rates for the different operative groups vary, from 2.2% for isolated coronary artery surgery, through a rate of 3.4% for isolated valve surgery, up to 11.3% for combined CABG, valve & other surgery (which could, for example, be major aortic surgery). In view of these issues, no comparison of post-operative surgical mortality rates should be made without adjusting appropriately for casemix.

Mortality and major procedure grouping ; information from only those countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Procedure group	Isolated CABG	214,145	4,908	1,471	2.2%	2.2-2.3%
	CABG & valve	35,376	2,345	379	6.2%	6.0-6.5%
	CABG, valve & other	2,747	350	83	11.3%	10.2-12.5%
	CABG & other	4,024	303	102	7.0%	6.3-7.8%
	Isolated valve	72,694	2,553	754	3.4%	3.3-3.5%
	Valve & other	12,250	633	214	4.9%	4.5-5.3%
	Other	10,672	890	237	7.7%	7.2-8.2%
	Unspecified	2,457	186	278		
	All	**354,365**	**12,186**	**3,518**		

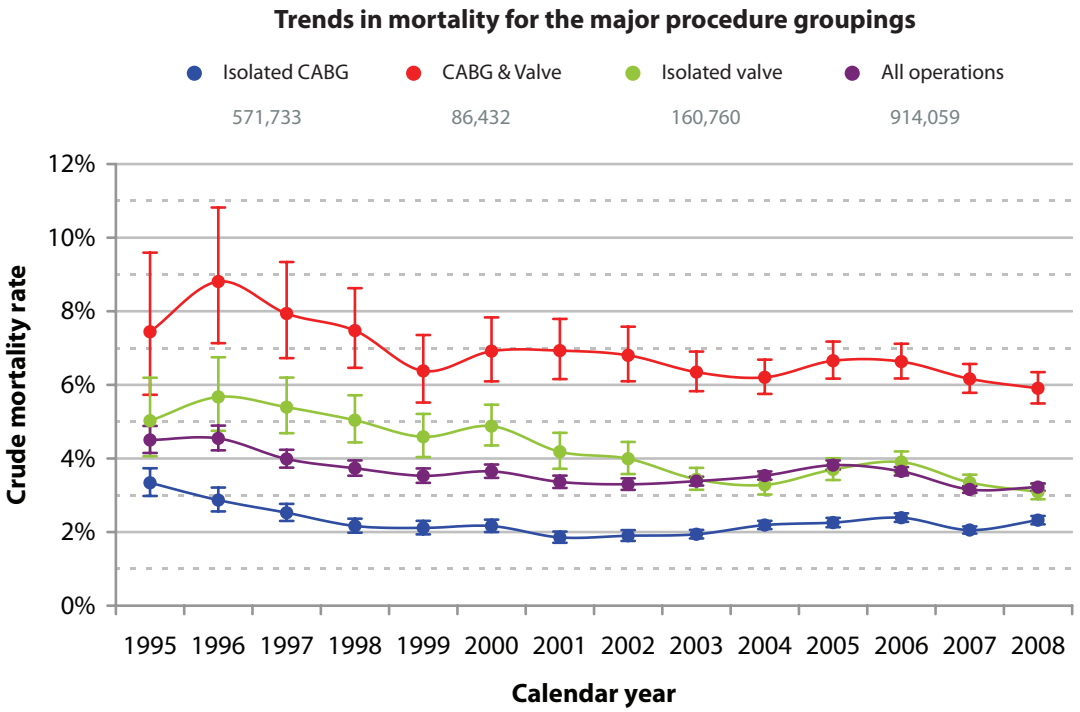
All operations: Crude mortality rate by procedure grouping; calendar years 2006-2008 (n=363,890)



Trends in mortality and major procedure grouping

The trend has been for a decrease in mortality over time. These decreases are evident and consistent despite increases in the relative proportions of various risk factors that we know are associated with increased mortality (increasing average age, increase in the number of diabetic patients, *etc*).

This is a good news story for both surgeons and, of course, patients.



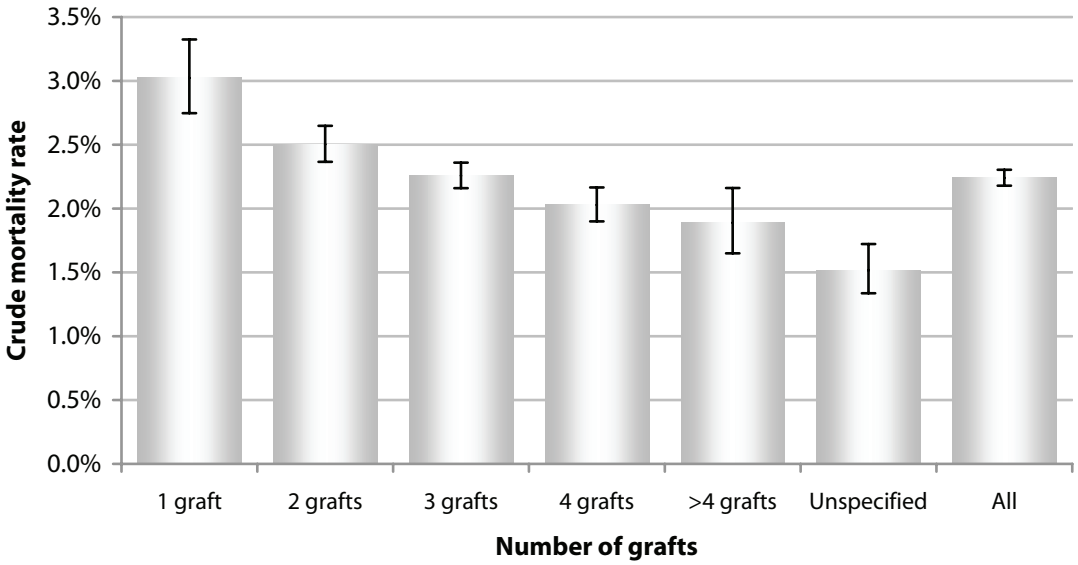
Mortality and major procedure sub-grouping

The following table and charts provide mortality data in more detail for the specific sub-groups of surgery.

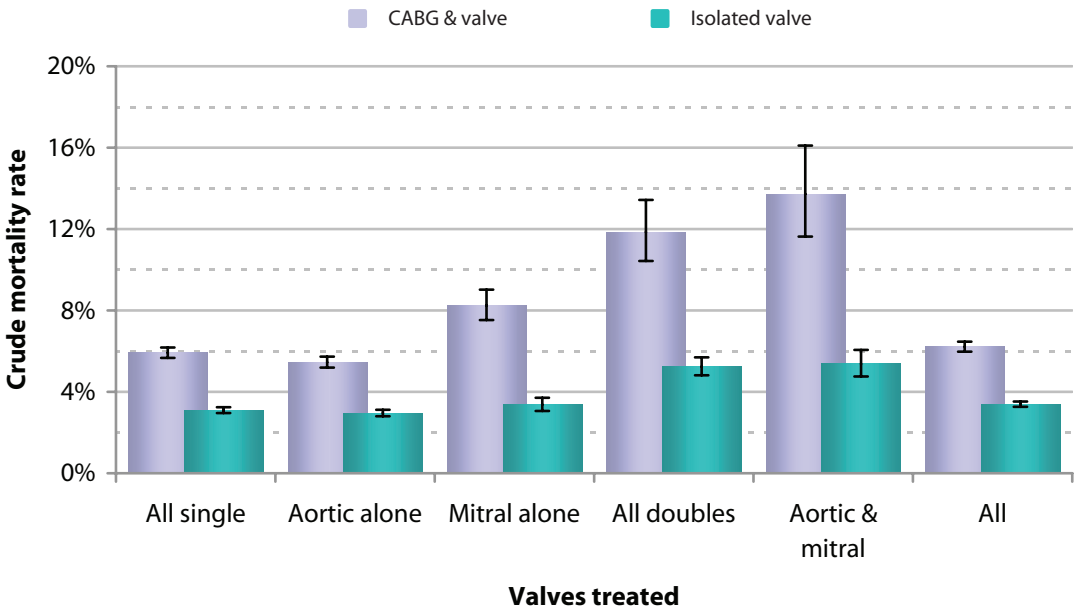
Mortality and major procedure grouping ; information from only those countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge			
			Alive	Died	Unspecified	Mortality rate (95% CI)
Procedure group	Isolated CABG	1 graft	13,443	419	173	3.0% (2.7-3.3%)
		2 grafts	46,699	1,199	341	2.5% (2.4-2.6%)
		3 grafts	84,074	1,942	460	2.3% (2.2-2.4%)
		4 grafts	43,040	891	221	2.0% (1.9-2.2%)
		>4 grafts	11,117	214	55	1.9% (1.6-2.2%)
		Unspecified	15,772	243	221	1.5% (1.3-1.7%)
		All isolated CABG	**214,145**	**4,908**	**1,471**	2.2% (2.2-2.3%)
	CABG & valve	All single valves	31,271	1,967	296	5.9% (5.7-6.2%)
		Aortic valve (AV)	26,270	1,516	184	5.5% (5.2-5.7%)
		Mitral valve (MV)	4,897	440	111	8.2% (7.5-9.0%)
		All double valve	1,629	219	30	11.9% (10.4-13.4%)
		Aortic and mitral	824	131	22	13.7% (11.6-16.1%)
		All CABG & valve	**35,376**	**2,345**	**379**	6.2% (6.0-6.5%)
	Isolated valve	All single valves	55,507	1,775	549	3.1% (3.0-3.2%)
		Aortic valve (AV)	43,168	1,315	310	3.0% (2.8-3.1%)
		Mitral valve (MV)	11,783	411	226	3.4% (3.1-3.7%)
		All double valve	9,553	528	85	5.2% (4.8-5.7%)
		Aortic and mitral	4,475	254	49	5.4% (4.8-6.1%)
		All isolated valve	**72,694**	**2,553**	**754**	3.4% (3.3-3.5)

Isolated CABG: Crude mortality rate and number of grafts; calendar years 2006-2008 (n=219,053)

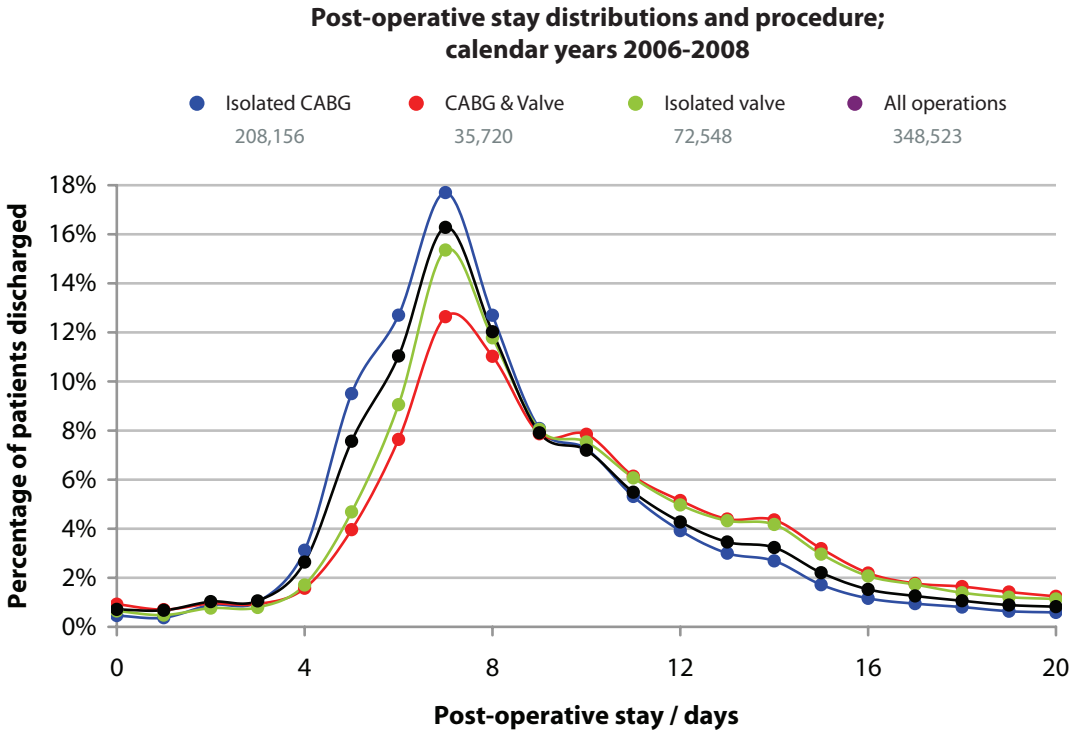


Valve surgery: Crude mortality rate and valves treated; calendar years 2006-2008 (n=37,721 and n=75,247 respectively)



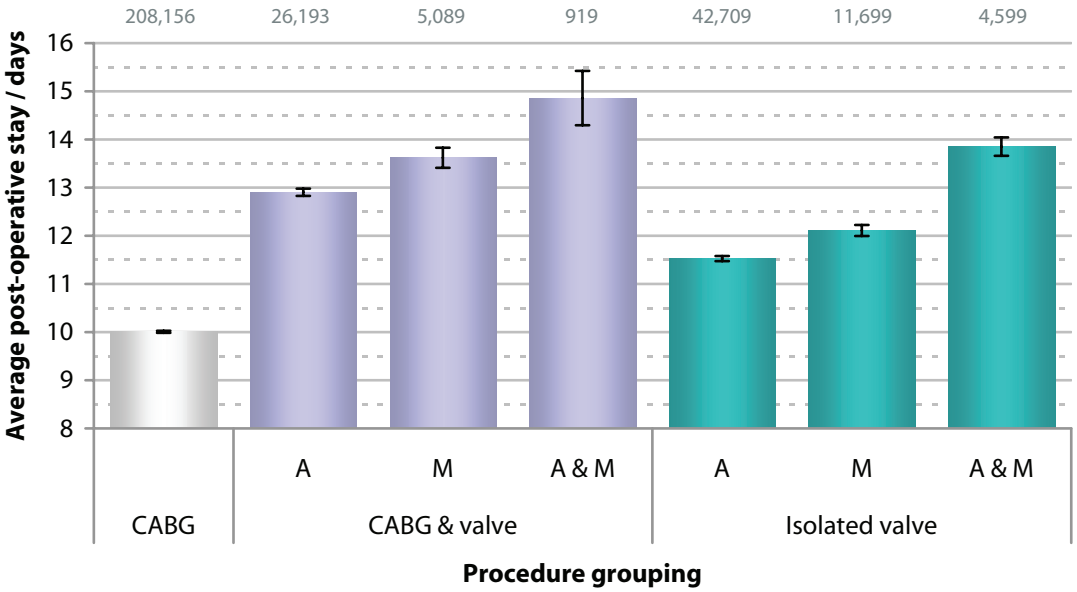
Post-operative stay

The length of post-operative in-hospital stay after the various types of cardiac operations is given in the following section. The first graph shows the distribution of length-of-stay; this is not a *normal* distribution and as such it is useful to describe the patient's post-operative stay using summary statistics in several ways. We have given the average length-of-stay, which is can be useful for assessing the duration of stay for economic reasons and in reference to discussions around cost constraint. We have also given a non-parametric analysis (median, inter-quartile ranges and adjacents), which are probably more useful for clinical benchmarking.



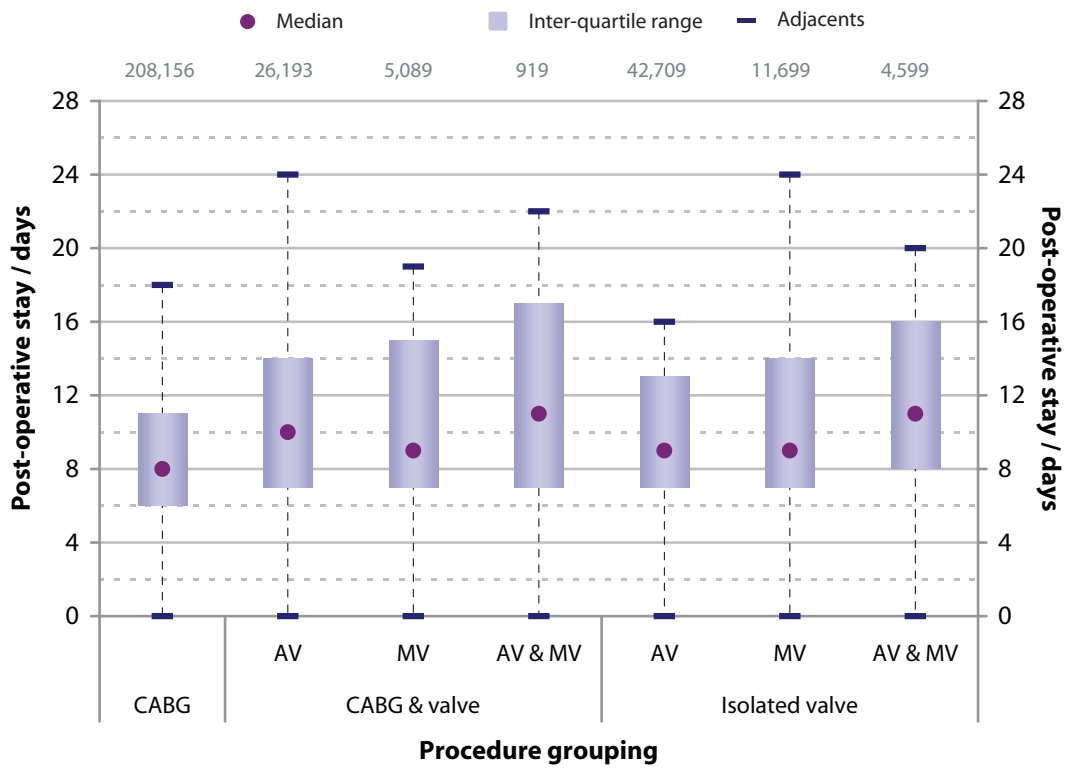
The average post-operative length-of-stay varies across the operative groups, from an average of 10.0 days for isolated coronary artery bypass surgery, up to 13.9 days for combined AV & MV surgery. The length-of-stay for combined CABG & valve surgery is over a day longer than that reported for isolated valve surgery.

All operations: Average post-operative stay for major procedure groups; calendar years 2006-2008



The median length-of-stay following the various operative groups is shown below. The median stay following CABG surgery is 8 days. Overall, isolated valve surgery has a greater length-of-stay by about 1 day, and combined CABG & valve surgery a further increase of 1 day. The variation in length-of-stay is quite large; for example, more than 25% of patients undergoing isolated CABG surgery stay in hospital for more than 11 days.

All operations: Median post-operative stay for major procedure groups; calendar years 2006-2008




~ 1986 ~

Isolated CABG

Isolated CABG

Foreword

The Fourth EACTS Adult Cardiac Surgical Database Report is a remarkable document. It is based on data from over one million patients undergoing adult cardiac surgery in 366 hospitals, across 29 countries. Consequently some of the analyses are grouped into geographical regions: Northern, Central and Southern Europe, and an Asian zone to accommodate the valuable contributions from China (including Hong Kong). In terms of the mass of data acquired, the major contributors are England with over 344,000 procedures, followed by Germany with over 224,000 procedures and then Belgium, Italy, Norway, Poland all with over 50,000.

The database provides background information on the burden of cardiovascular disease across Europe, and gives an overview of population numbers, life-expectancy, mortality rates and risk factors for cardiovascular disease. It also explores these factors in relationship to healthcare services in terms of numbers of doctors, hospital beds and expenditure on health in different countries. Crucial aims of the database are, therefore: to help understand which patients come to cardiac surgery; (although this is also very influenced by the frequency of percutaneous interventions) to discover how the patient-population, and the nature of their surgery, have changed over time; to measure the contemporary outcomes of cardiac surgery and to determine whether or not these outcomes have improved over time; and, finally, to try and understand differences in risk-adjusted clinical outcomes in the contributor countries. In addition to providing reassurance for individual patients and those who commission healthcare services, the analyses from the EACTS database should help drive up standards and improve outcomes.

Despite the size of this database there are two important caveats when examining and comparing outcomes between countries. Whilst some countries have >90% completeness of all the variables used in risk stratification, others have only submitted age and gender. There is a marked variation in the completeness of risk factors data, with complete ***EuroSCORE*** data available for only 3% of patients; almost 50% of database entries are missing at least 4 of the 14 required ***EuroSCORE*** variables. Clearly, this considerably hampers attempts to make meaningful risk-adjusted comparisons. Even more importantly, whilst most countries provide complete mortality data, seven countries have more than 18% of entries with missing mortality data, and four provide no mortality data at all.

Looking specifically at coronary artery bypass grafting, the database shows that the proportion of CABG surgery as proportion of all adult cardiac surgery has fallen from 70% in 1999 to around 50% a decade later, in 2008. This is almost certainly due, at least in part, to the exponential growth of percutaneous coronary intervention (PCI) and raises the key issue that some patients may not be given the option of having CABG surgery even when there is clear evidence that it provides superior survival and freedom from reintervention in certain anatomic patterns of disease [1, 2, 3]. This specific issue will be addressed in the new combined ESC / EACTS guidelines for coronary revascularization, due to be published in August 2010. In the absence of data on the relative rates of PCI & CABG surgery in different countries, the explanation for the significant variation in the proportion of CABG surgery as part of all adult cardiac surgery remains speculative. Generally, CABG surgery is a lower proportion of total workload in Asian countries at around 35% of all adult operations *versus* 45% in Southern Europe, and around 60% in Central & Northern Europe.

There are a number of summary observations from the analyses presented in this section on CABG surgery:

- The average age at presentation for CABG surgery is 65 years in Europe, but 62 years for Asian patients. Approximately 5% of European patients are over 80 when presenting for CABG as opposed to only 0.6% of Asian patients. In contrast, only 15% of European patients are under 56 years at time of CABG; the corresponding rate for Asia is 25%.
- The database confirms the well-established relationship between post-operative mortality and age; being approximately 1% in patients aged <56, rising to 3% in those aged 71-75 years, and almost 7% in those over the age of 80. There is a marked difference in post-operative stay between different countries, varying from a median of 5 up to 11 days; there is an increase in hospital stay associated with advancing age, from 9 days in those aged 60 to over 12 days in those aged over 80.
- There is also a marked variation in the proportion of patients who are female, varying from 13% in Greece to 30% in Lithuania. Female gender is clearly associated with an increase in post-operative mortality in all age ranges, of the order of 1% over the rate reported for men. Women stay, on average, one more day in hospital after surgery than do their male counterparts.

- There is marked variation in the Body Mass Index (BMI) between countries. Almost half of patients in the Asian zone have a BMI that indicates they are over-weight, but three-quarters of European patients fall into this category; the proportion of patients who are obese or morbidly obese varies from around 10% to a little over 40% between countries. The greatest mortality is associated with under-weight patients (BMI <20), whereas obese and morbidly obese patients do not have elevated rates of adverse outcomes.
- The proportion of patients with diabetes varies from country to country, in the range 14-50%; across the zones, the rates go from 18% (Northern) to over 30% (Asian & Southern). The proportion of patients with diabetes undergoing CABG surgery has increased from 17% to 32% over the last decade. As this condition is associated with increased mortality (2.0% for the non-diabetics & 2.9% for the patients with diabetes), and is accompanied by an additional stay of 1.6 days in hospital, the increase in its incidence is important.
- The presence of simultaneous extra-cardiac arteriopathy (ECA) varies from under 5% of patients in Hong Kong, China to over 40% for those from Luxemburg; ECA rates vary from under 4% in Asia to 20% in Southern Europe. ECA is associated with a doubling in the baseline mortality rate to 4%, and with an additional 1.6 days of hospital stay.
- The proportion of patients with a good ejection fraction varies from 42% in Armenia to around 85% in China. Post-operative mortality was strongly correlated with left ventricular function: 1.4% for those with good function; 3.2% for those with fair function; and 7.8% for those with poor function. There is also an associated increase in hospital stay of an extra 1 day for fair and 3 days for poor ventricles.
- The proportion of elective operations ranges from 30% to 90% between countries, and over the last decade has increased from 28% to 33% of all CABG surgery. The mortality for elective patients is 1.4% *versus* 4.2% for those undergoing more urgent operations; non-elective surgery adds at least an extra day to post-operative stay.
- The proportion of CABG surgery performed *off-pump* varies from 2% to over 90% between countries, with an associated mortality of 1.4% *versus* 2.9% for those performed *on-pump*. Whether this reflects the effects of patient selection or a genuine reduction in mortality related to the use of the off-pump technique is uncertain.
- The median number of bypass grafts used is 3 and the proportion of patients receiving total arterial grafts varies from almost none to over 30%. Whilst mortality was lower for patients receiving more than one arterial graft, this almost certainly reflects patient selection, with lower-risk patients receiving more arterial grafts, while those requiring urgent or emergency surgery are more likely to receive a higher proportion of vein grafts. The ART trial (a randomized trial of over 3,000 patients) is designed to see whether two internal mammary arteries provides superior 10-year survival to a single internal mammary artery [4].

This EACTS database report provides a useful, widespread, contemporary picture of current practices of CABG surgery, & should be useful for benchmarking and quality improvement in its own right. There must be ongoing efforts to improve the quality & completeness of data so that future reports can accurately describe actual practice against evidence-based best care to further drive the quality of surgical treatment of ischaemic heart disease.

David Taggart, Professor of Cardiovascular Surgery, University of Oxford

1 Taggart DP. PCI or CABG in coronary artery disease? *Lancet.* 2009; **373:**1150-2.

2 Taggart DP. Coronary artery bypass grafting is still the best treatment for multivessel and left main disease, but patients need to know. *Annals of Thoracic Surgery.* 2006;**82:** 1966-75.

3 Serruys PW, Morice MC, Kappetein AP, et al; SYNTAX Investigators. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease. *New England Journal of Medicine.* 2009; **360:** 961-72.

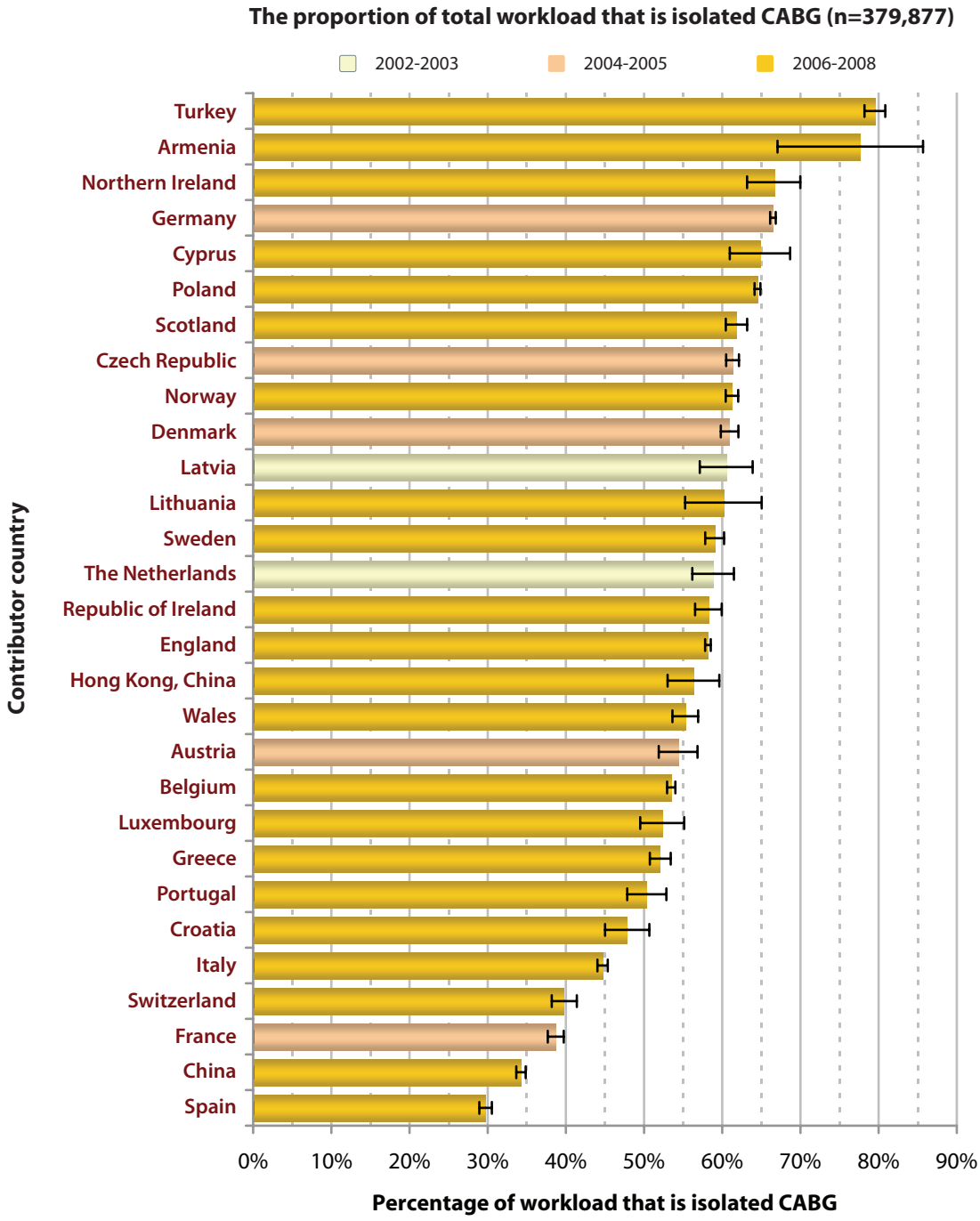
4 Taggart DP, Lees B, Gray A, Altman DG, Flather M, Channon K; ART Investigators. Protocol for the Arterial Revascularisation Trial (ART). A randomised trial to compare survival following bilateral versus single internal mammary grafting in coronary revascularisation [ISRCTN46552265]. *Trials.* 2006; **7:** 7.

Overview

Isolated CABG in relationship to overall workload

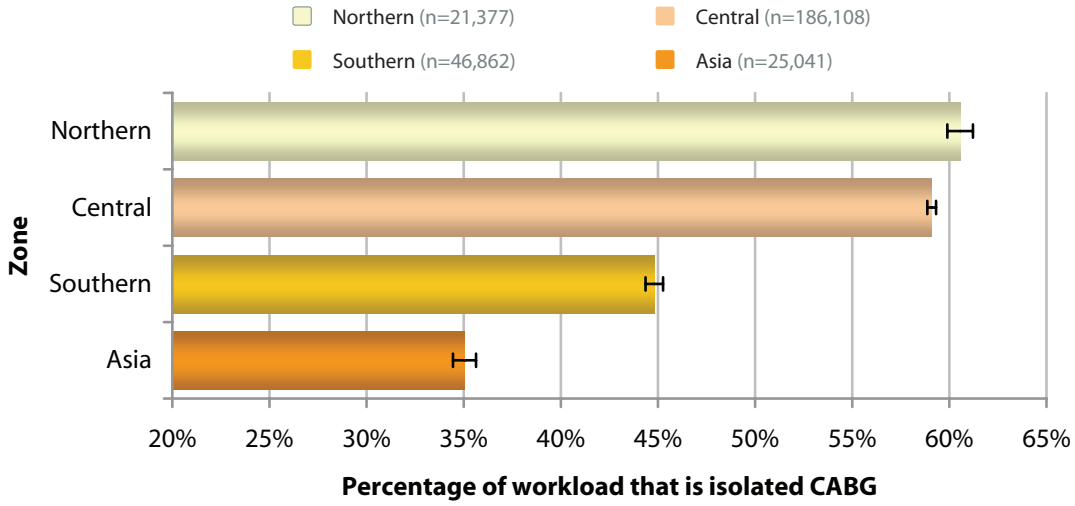
As described on page 56, the proportion of overall surgery that is isolated CABG has decreased systematically over time from 70% in 1999 to just over 50% in 2008. However, coronary surgery still comprises more than half of all cardiac surgery. There is a marked variation between countries in the proportion of surgery that is isolated CABG. These issues are also considered on pages 11 and 54.

We have used a convention in this report to print country names on the chart's axes in bold, **brick red** ink where there is greater than 90% completion of the variable under analysis; where the completion rate is less than 90% the country's name is printed in grey text, as will be seen in later graphs (for example, page 90).



There is a striking variation across the geographical zones in the proportion of overall workload that is isolated CABG surgery, with similar rates in Northern and Central Europe, lower rates in Southern Europe and only one-third of cardiac surgery operations being isolated CABG in Asia.

The proportion of total workload that is isolated CABG; calendar years 2006-2008 (n=279,348)

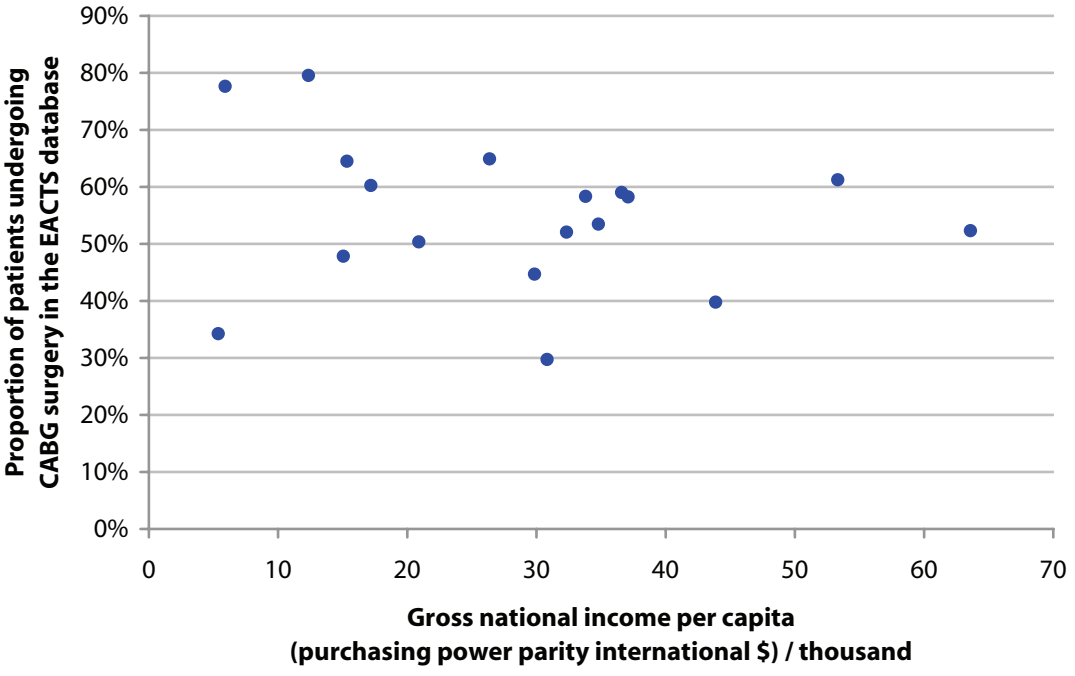


The relationship between WHO data and EACTS data

Gross national income and the rate of CABG surgery

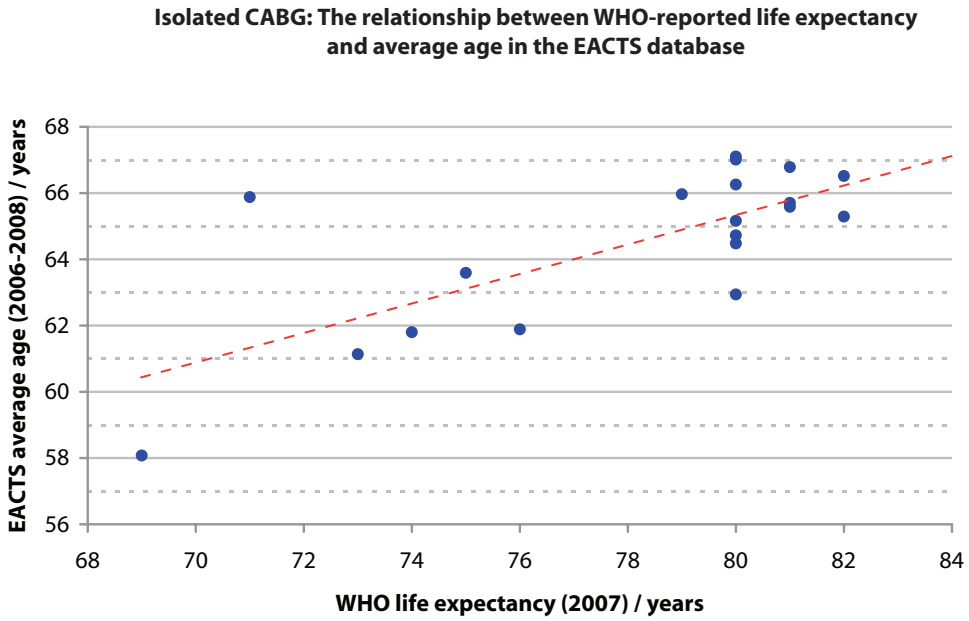
There is no significant correlation between the proportion of overall cardiac surgery that is isolated CABG and the gross national income *per capita* (r=0.198; r^2=0.039; p=0.430). There are significant correlations between life-expectancy and the average age of isolated CABG patients in the EACTS database by country (r=0.731; r^2=0.535; p<0.01), and between adult mortality rates (r=0.409; r^2=0.167; p=0.082) and average age.

The relationship between WHO-reported gross national income *per* capita and the proportion of patients undergoing isolated CABG in the EACTS database

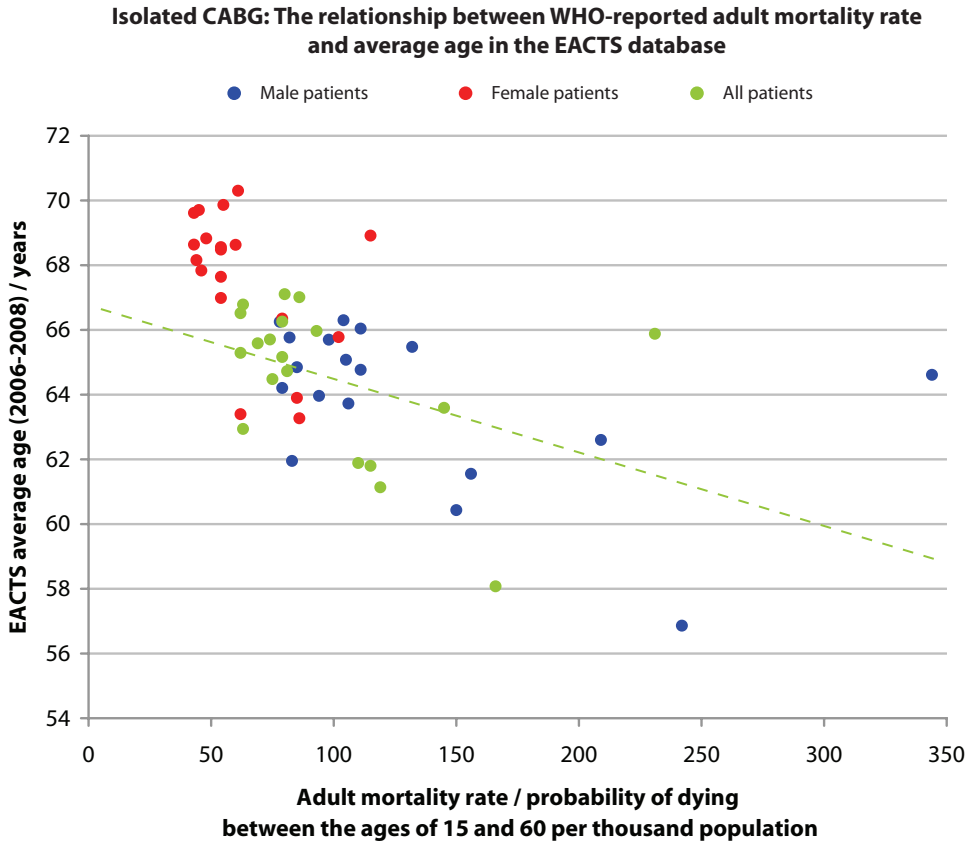


WHO data taken from http://apps.who.int/ghodata/

Life expectancy and average age at CABG surgery



Adult mortality rates and average age at CABG surgery

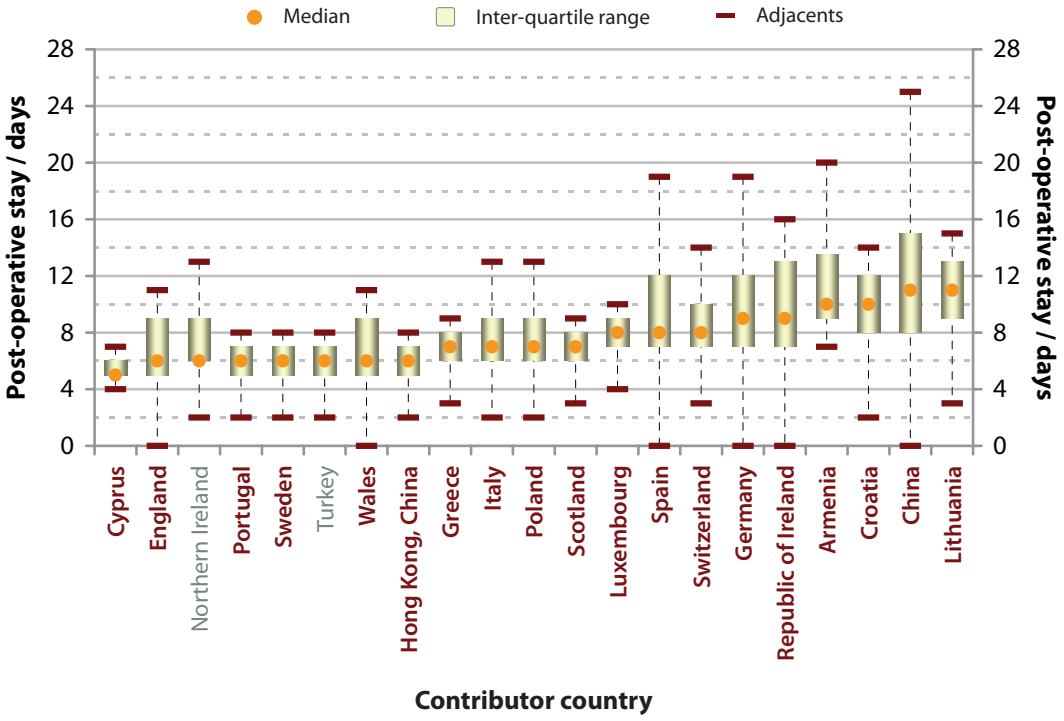


WHO data taken from http://apps.who.int/ghodata/

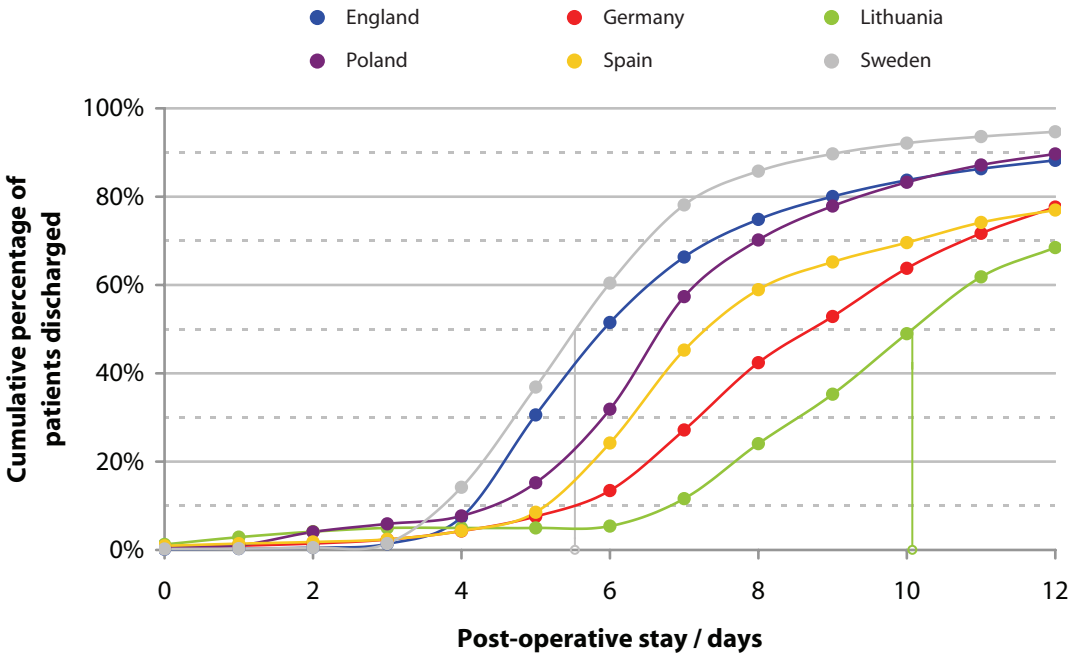
Post-operative stay

There is variation in the length-of-stay following isolated coronary artery surgery across countries from 5 days up to 11 days. These data cannot be interpreted fully without understanding each healthcare service in some detail, but length of post-operative stay has important resource implications, and the following data may be useful in an era of increasing financial pressure.

Isolated CABG: Post-operative stay distributions and contributor country; calendar years 2006-2008 (n=208,156)



All operations: Patterns of post-operative stay and contributor country (n=174,298)

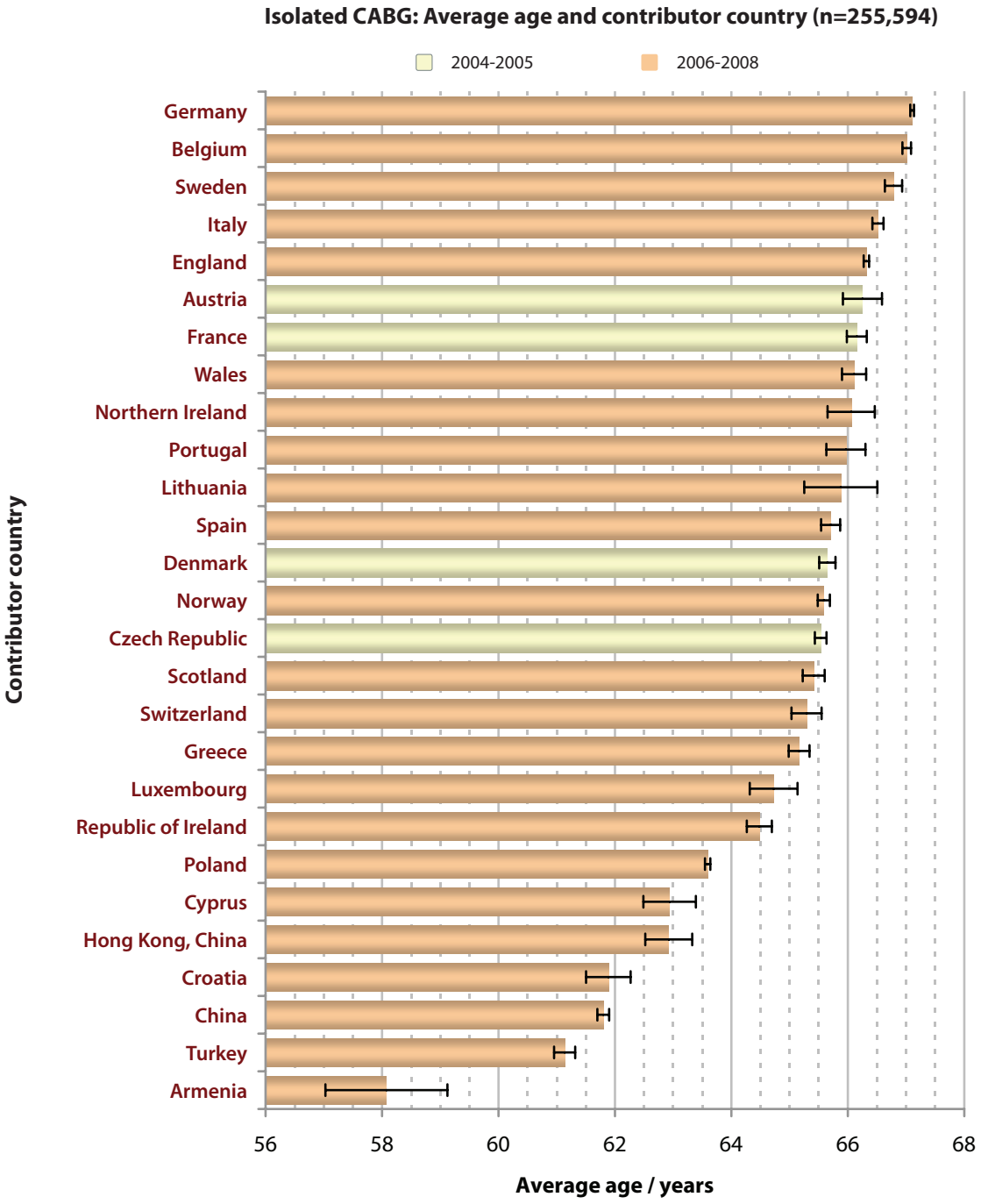


Age at surgery

Average age

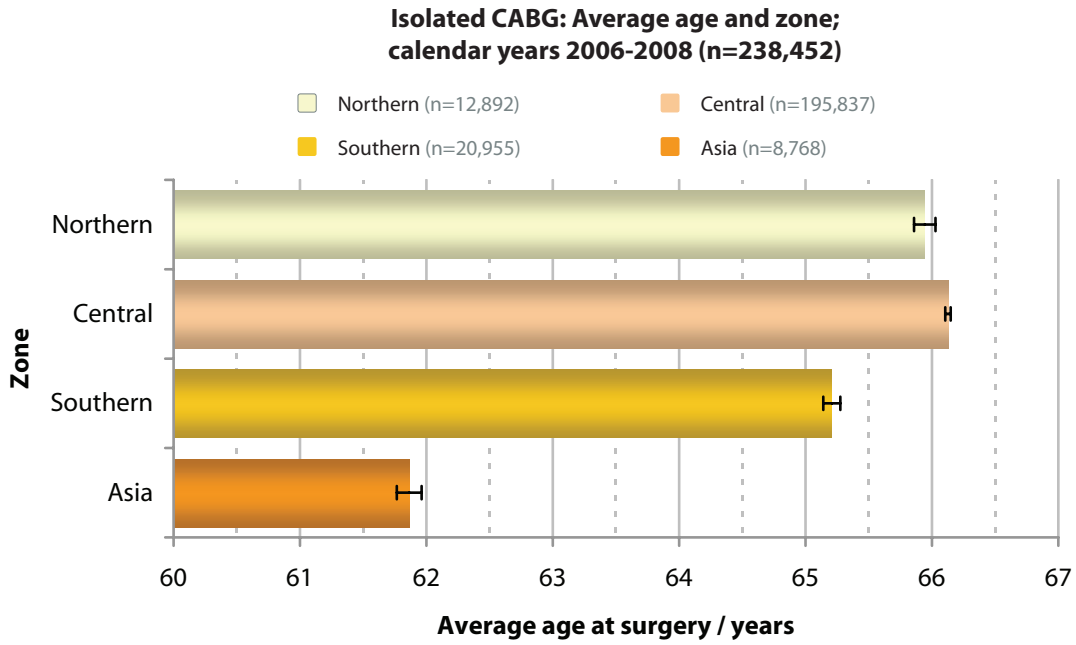
Average age and contributor country

Age is a well-recorded variable. The average age for patients undergoing isolated coronary artery bypass surgery ranges from 58 years in Armenia up to 67 in Germany. Given the variation in average age across the countries submitting to the database, it is also important that comparison of mortality rates are not made without adjusting for age and other important risk factors (see page 60).



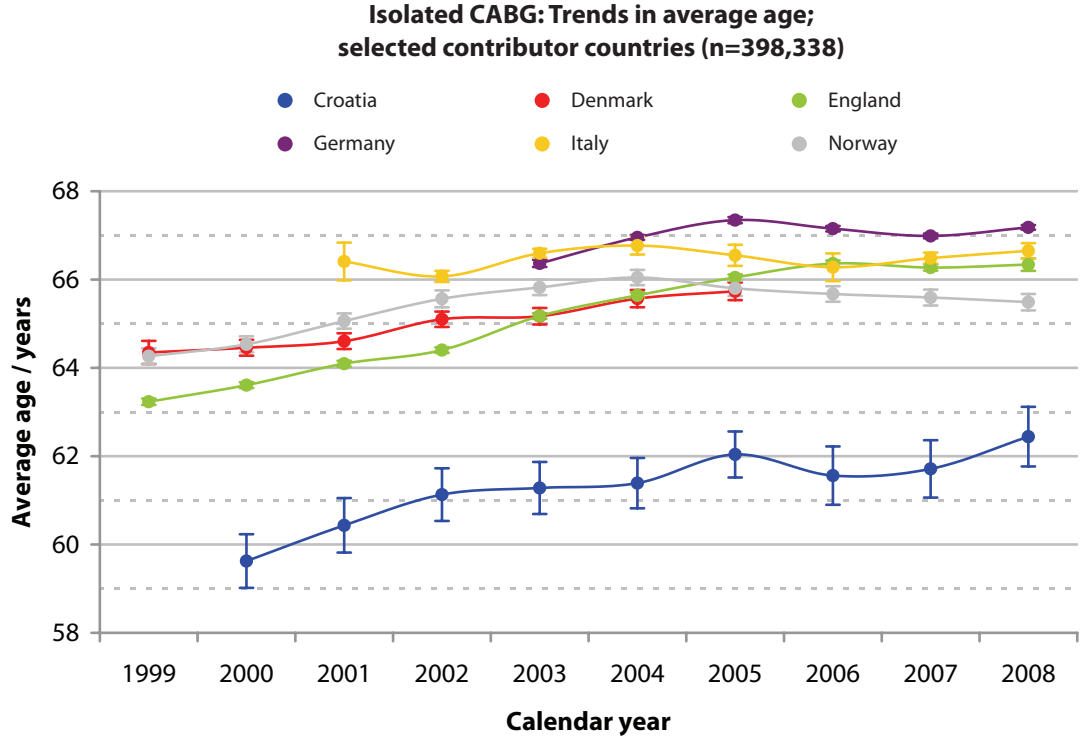
Average age and zone

There are numerically small, but statistically significant, differences in the average age of patients coming to isolated CABG surgery across geographical zones, from just under 62 years in Asia to over 66 in Central Europe.



Trends in average for selected contributor countries

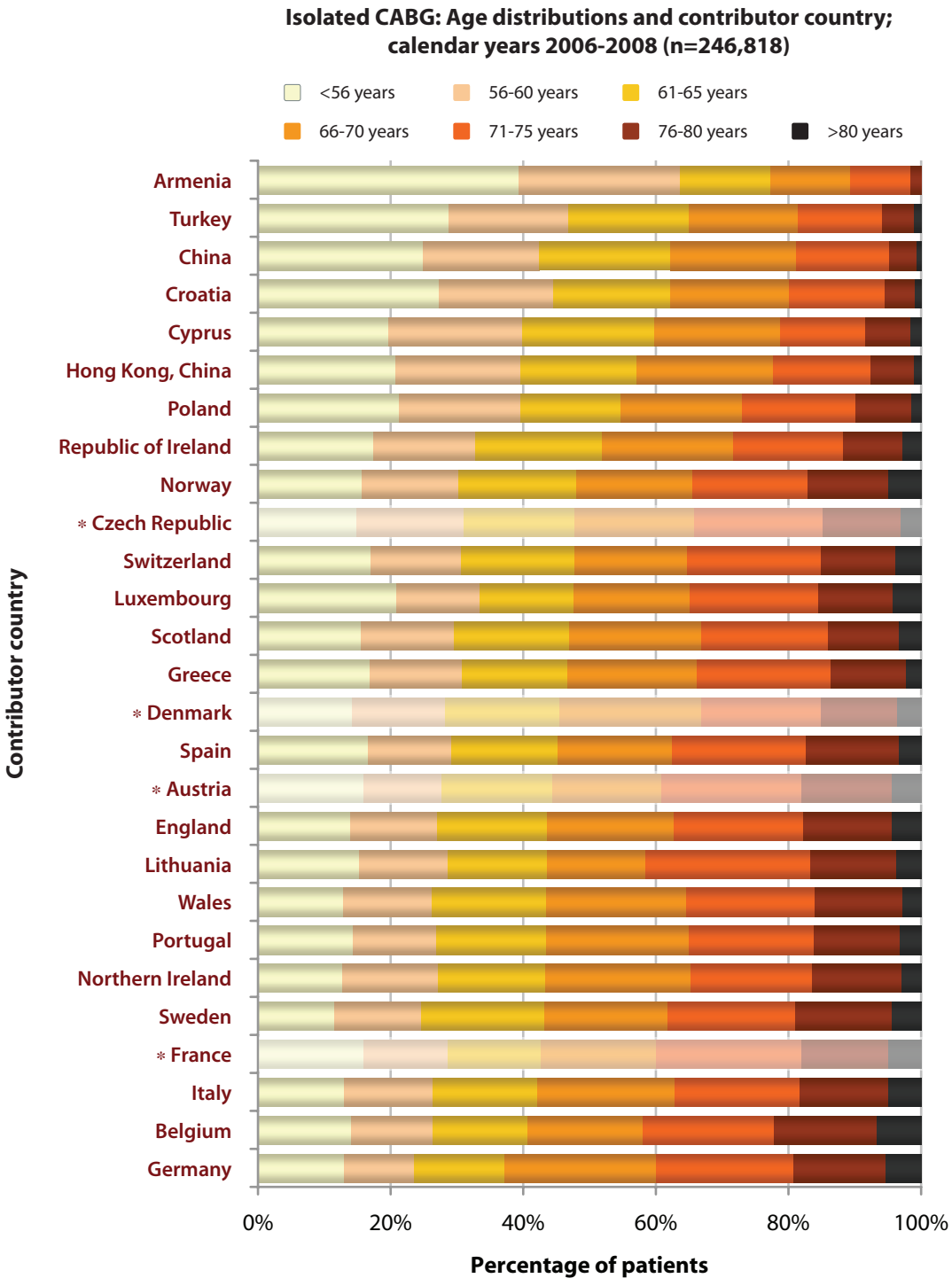
The obvious trend over time is that the average age of patients undergoing CABG is on the increase. Of interest, this trend seems to have plateaued in the recent years of submission for England, Germany, Norway and Italy.



Age categories

Age category and contributor country

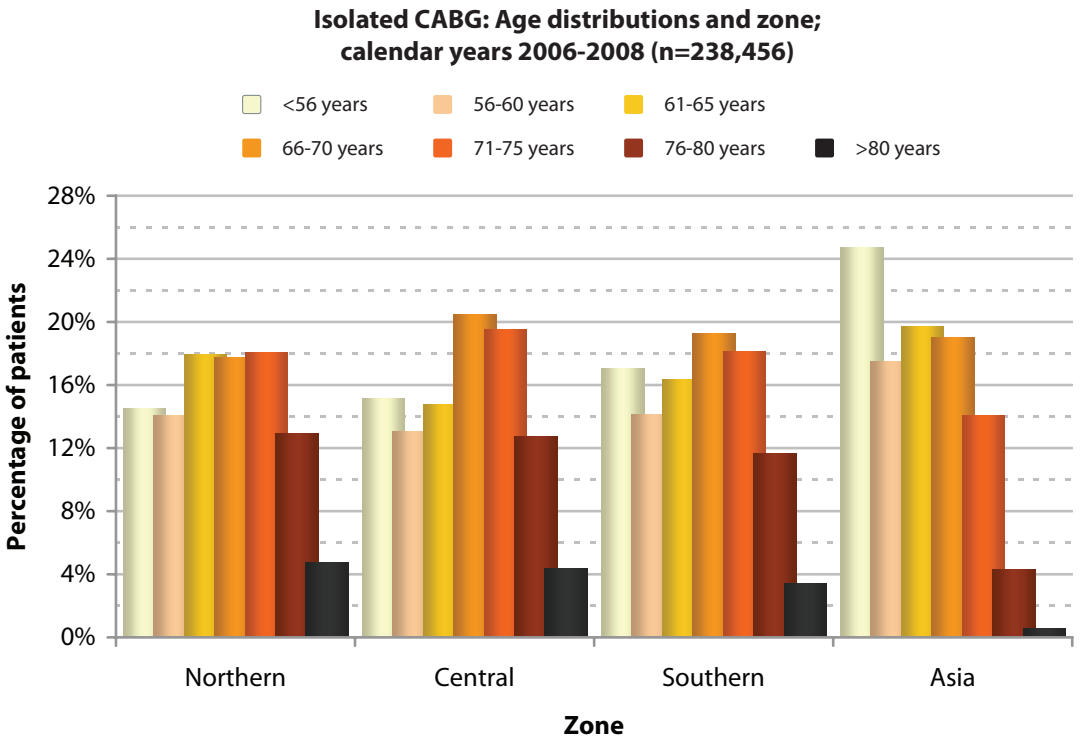
Increasing age is strongly correlated with increasing mortality and length-of-stay. A combination of an increase in the average age of patients coming to surgery over time and a difficult financial climate makes these observations important to both providers and commissioners / purchasers of healthcare from a perspective of resource utilisation and hospital throughput considerations.



n.b. The countries marked with an asterisk and whose bars are faded did not submit data for 2006-2008, and are therefore represented by their 2004-2005 data.

Age category and zone

The most striking finding of the following analysis is the varying proportion of octogenarians undergoing isolated coronary artery surgery, which varies from 4.7% in the Northern zone to 0.6% in Asia. Similarly, nearly twice as many patients (24.7%) in Asia are under 56 years of age, compared to Northern Europe (14.5%).



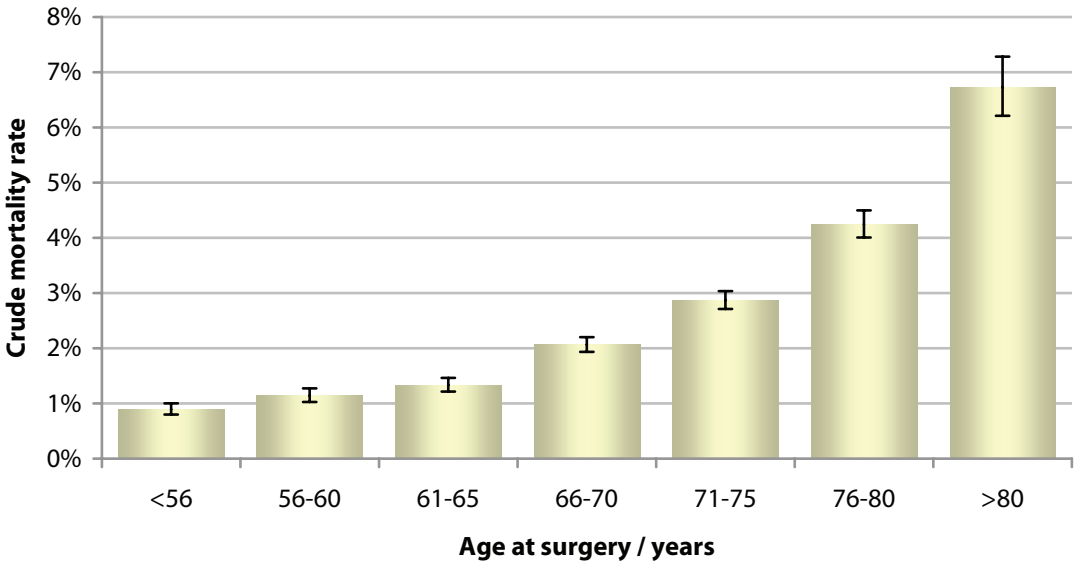
Age and mortality

As in most previous studies there is a strong and non-linear correlation between age and mortality. The overall mortality for octogenarians is about 7 times higher than that of those under 56 years of age.

Mortality at the time of discharge after isolated CABG surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Age at surgery / years	<56	34,121	308	203	0.9%	(0.8-1.0%)
	56-60	29,066	336	194	1.1%	(1.0-1.3%)
	61-65	33,085	447	240	1.3%	(1.2-1.5%)
	66-70	43,674	920	292	2.1%	(1.9-2.2%)
	71-75	40,406	1,193	281	2.9%	(2.7-3.0%)
	76-80	25,199	1,117	194	4.2%	(4.0-4.5%)
	>80	8,000	577	65	6.7%	(6.2-7.3%)
	Unspecified	594	10	2		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate and age group; calendar years 2006-2008 (n=218,449)

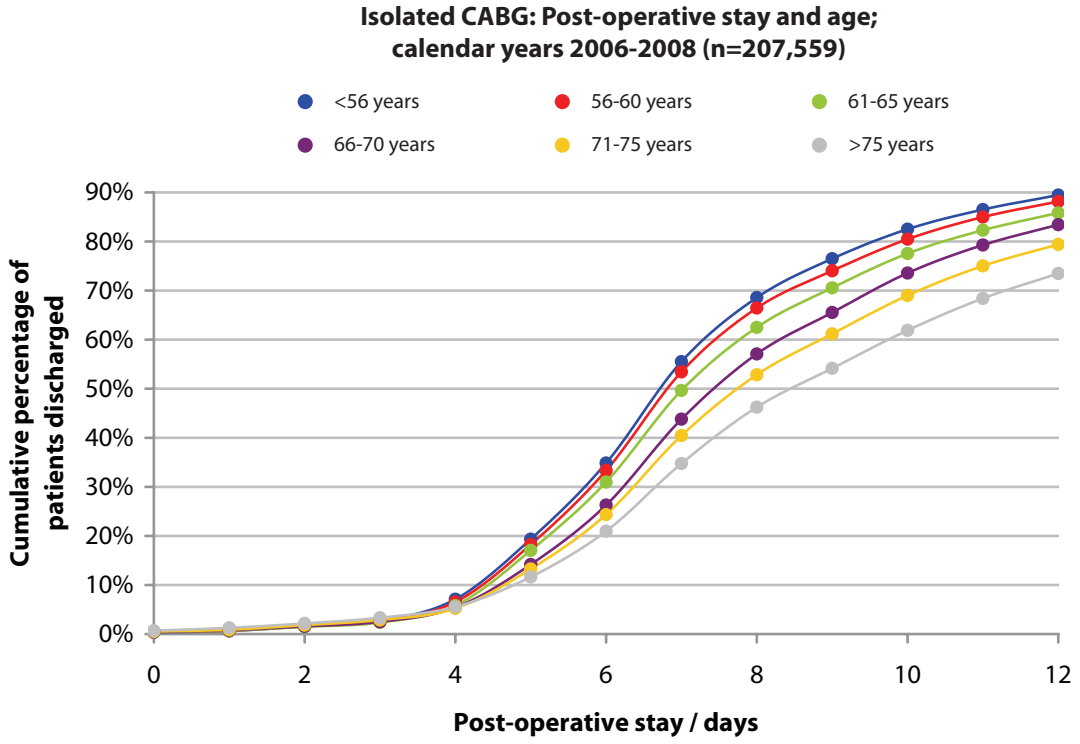


Age and post-operative stay

Increasing age is strongly associated with an increased length-of-stay. These observations are important for decision making on patient selection for surgery (length-of-stay is a surrogate measure of post-operative morbidity) and for informed consent.

Post-operative stay after isolated CABG surgery broken down by age group; calendar years 2006-2008

		Post-operative stay		
		Average / days	Count	Standard error
Age at surgery / years	<56	8.8	32,694	0.05
	56-60	8.9	27,826	0.05
	61-65	9.4	31,665	0.05
	66-70	10.0	42,657	0.05
	71-75	10.8	39,692	0.06
	>75	11.8	33,025	0.06
	Unspecified	9.5	597	0.33
	All	**10.0**	**208,156**	**0.02**



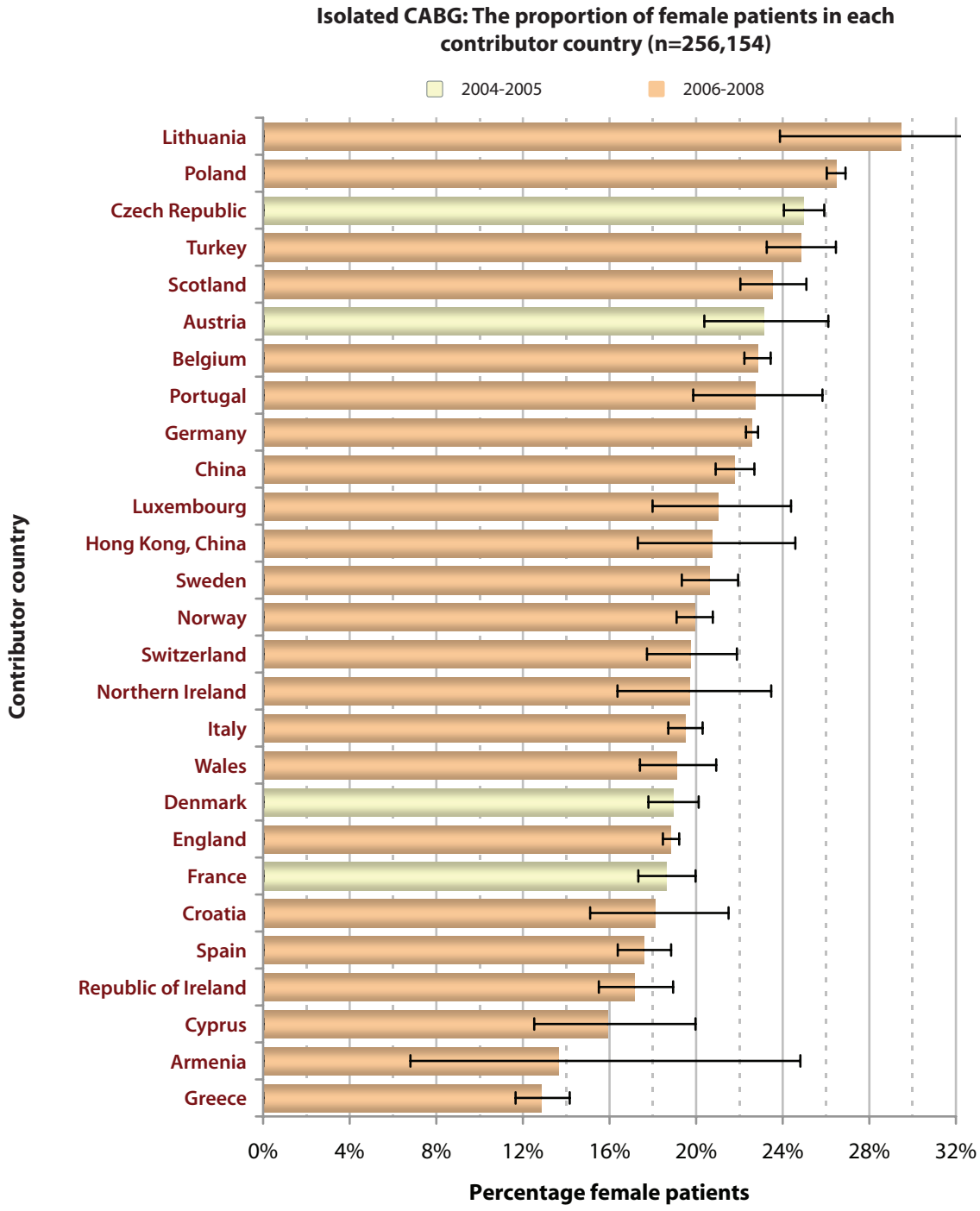
Gender

Gender distributions

Gender and country

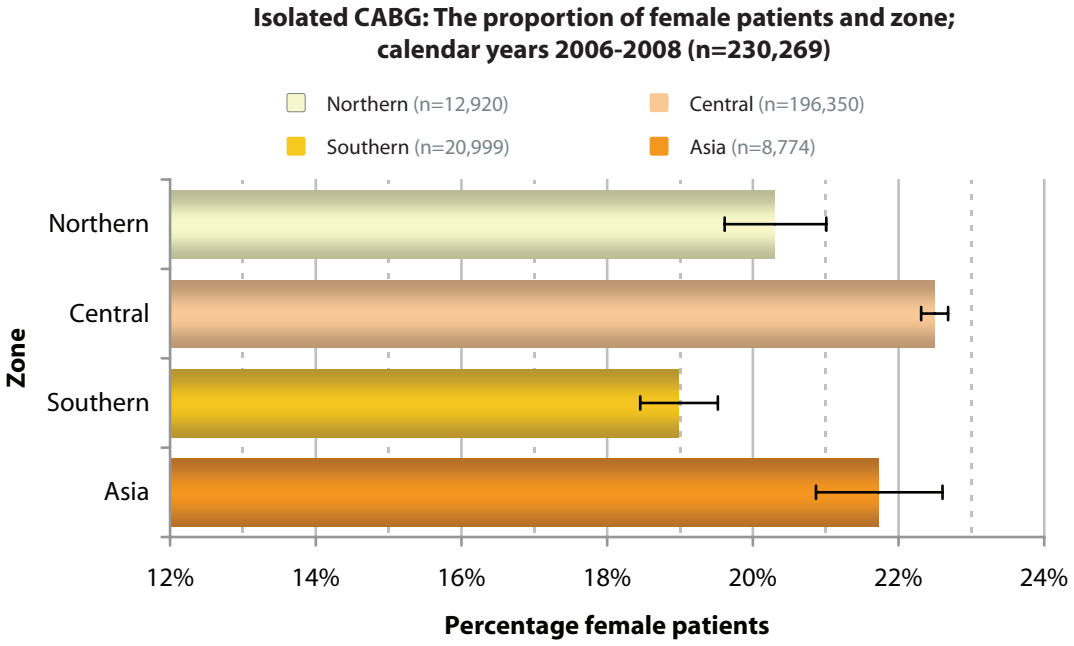
Gender is also a well-recorded variable, and all countries achieve a greater than 90% rate of completeness and therefore have their names presented in bold, **brick red** ink.

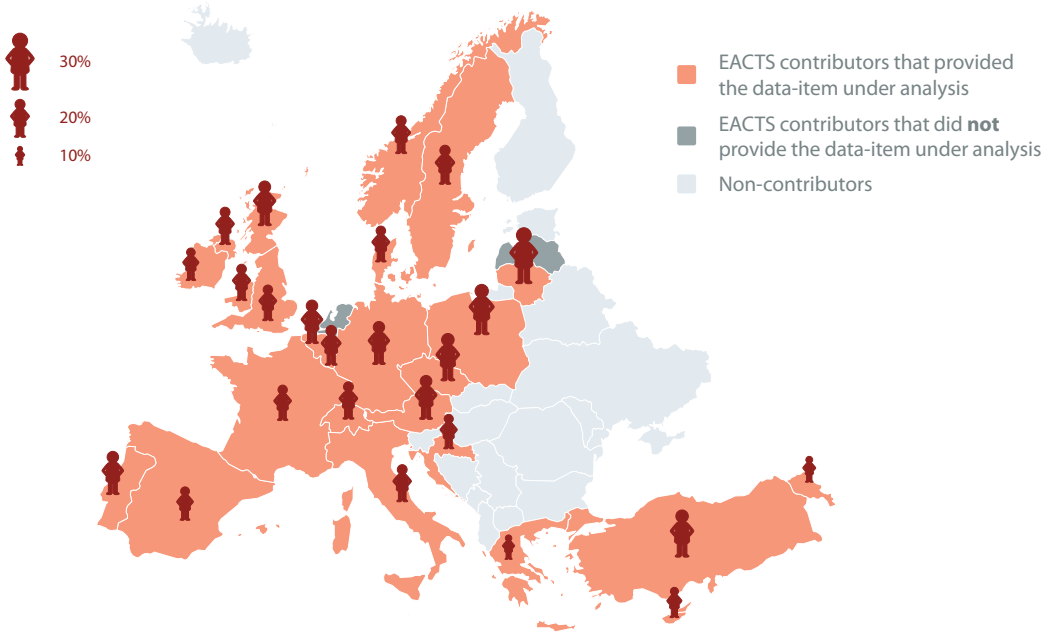
There are marked differences in the gender distribution for isolated CABG surgery across countries, ranging from 13% up to 30%. These findings are striking.



Gender and zone

Again, there are small but significant variations in gender distributions across the different zones, from 19.0% in the Southern zone up to 22.5% in the Central zone.

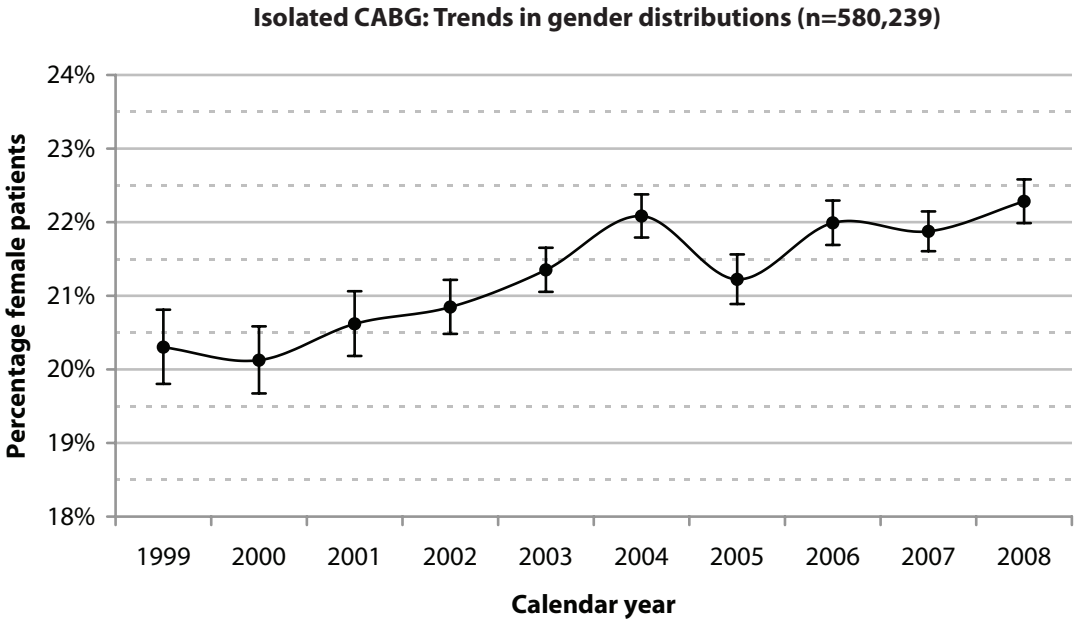


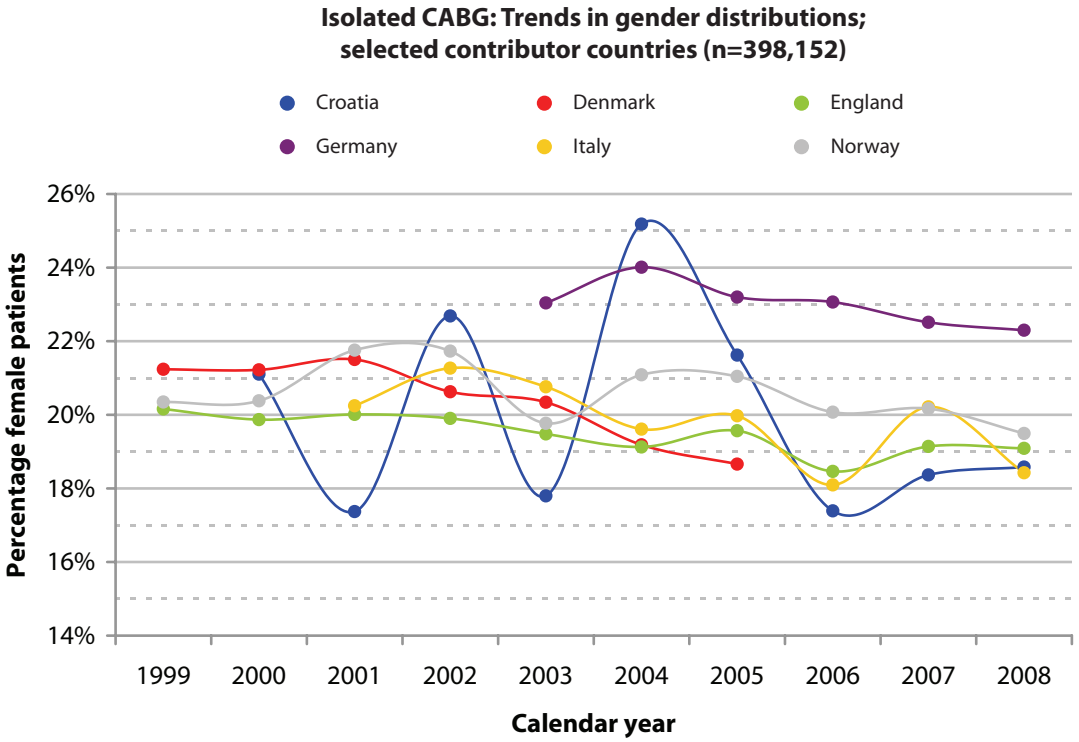


The sizes of the patient icons represent the relative proportions of female patients in the contributor countries that supplied these data.

Trends in gender distributions

The overall data in the database show a small but strongly significant increase over time in the proportion of patients undergoing CABG surgery who are women (χ^2 test for trend, $p<0.001$). This effect is due to new countries submitting data to the database, as the large contributors who have submitted consistently show an opposite trend.





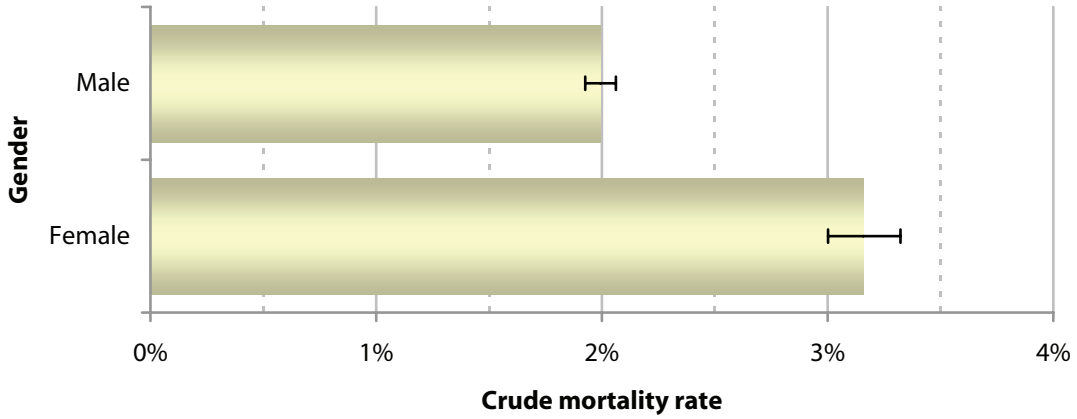
Gender and mortality

As noted in numerous previous analyses, gender is strongly associated with differential mortality (p<0.001).

Mortality at the time of discharge after isolated CABG surgery broken down by gender; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Gender	Male	167,475	3,406	1,181	2.0%	(1.9-2.1%)
	Female	46,663	1,501	290	3.1%	(3.0-3.3%)
	Unspecified	7	1	0		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate and gender; calendar years 2006-2008 (n=219,045)



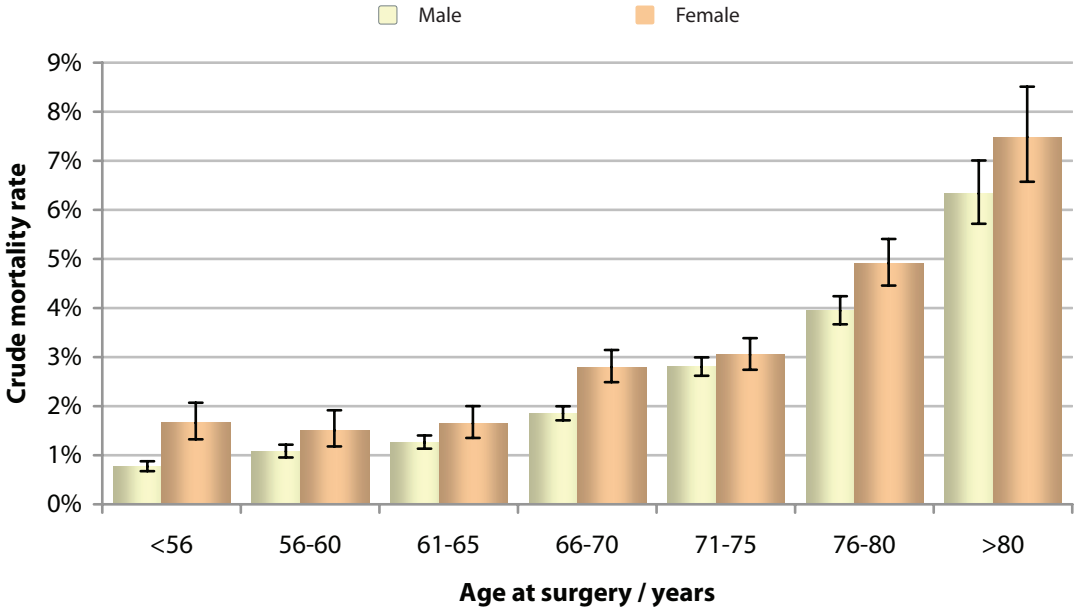
Gender, age and mortality

Women have a higher mortality than men for all age groups.

Mortality at the time of discharge after isolated CABG surgery broken down by age at the time of surgery and gender; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Gender	Male	<56	29,374	228	183	0.8%	(0.7-0.9%)
		56-60	24,616	268	160	1.1%	(1.0-1.2%)
		61-65	26,929	344	202	1.3%	(1.1-1.4%)
		66-70	33,909	639	243	1.8%	(1.7-2.0%)
		71-75	29,462	849	207	2.8%	(2.6-3.0%)
		76-80	17,434	716	139	3.9%	(3.7-4.2%)
		>80	5,281	357	45	6.3%	(5.7-7.0%)
		Unspecified	470	5	2		
	Female	<56	4,746	80	20	1.7%	(1.3-2.1%)
		56-60	4,449	68	34	1.5%	(1.2-1.9%)
		61-65	6,154	103	38	1.6%	(1.4-2.0%)
		66-70	9,762	281	49	2.8%	(2.5-3.1%)
		71-75	10,944	344	74	3.0%	(2.7-3.4%)
		76-80	7,765	401	55	4.9%	(4.5-5.4%)
		>80	2,719	220	20	7.5%	(6.6-8.5%)
		Unspecified	124	4	0		
	Unspecified	<56	1	0	0		
		56-60	1	0	0		
		61-65	2	0	0		
		66-70	3	0	0		
		71-75	0	0	0		
		76-80	0	0	0		
		>80	0	0	0		
		Unspecified	7	1	0		

Isolated CABG: Crude mortality rate, age and gender; calendar years 2006-2008 (n=218,442)

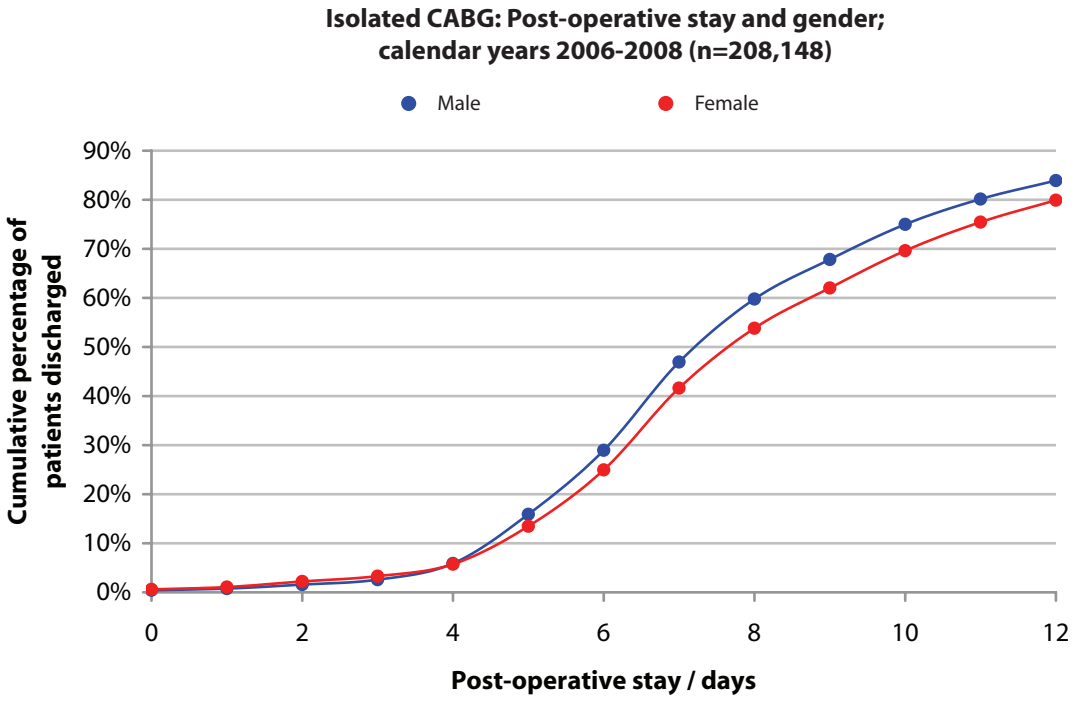


Gender and post-operative stay

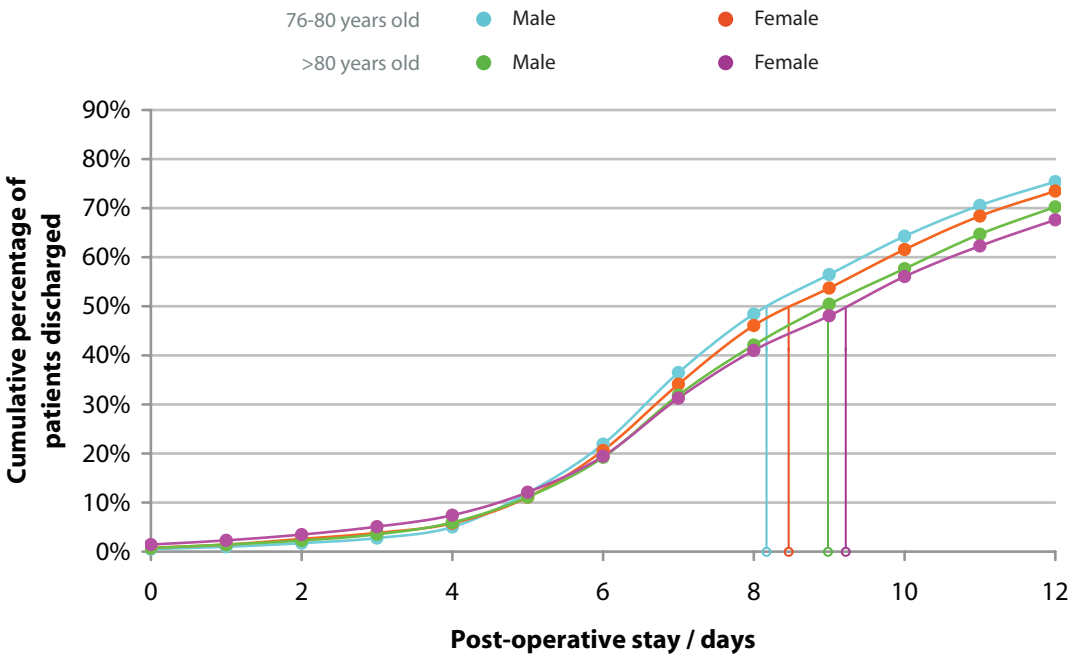
Women stay longer in hospital than men after isolated CABG, by an average of 1 day (χ^2 test, $p<0.001$).

Post-operative stay after isolated CABG surgery broken down by gender; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Gender	Male	162,205	8.0	9.8	0.02
	Female	45,943	8.0	10.6	0.05
	Unspecified	8	6.0	12.0	5.59
	All	**208,156**	**8.0**	**10.0**	**0.02**



Isolated CABG: Post-operative stay, gender and age; calendar years 2006-2008 (n=207,552)



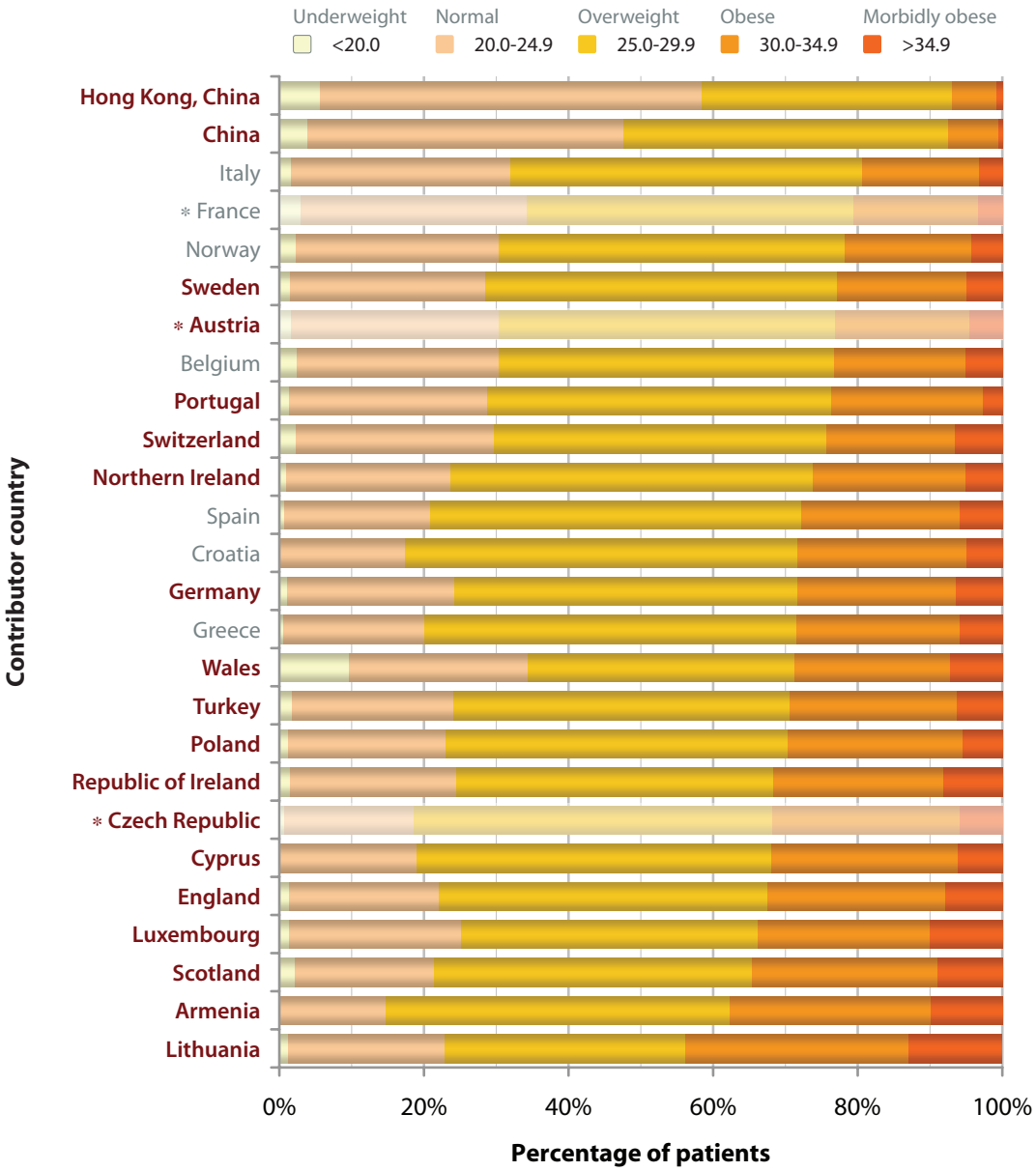
Body Mass Index

BMI distributions

BMI and country

The variables height and weight are not as complete as the previous variables age and sex. We have listed the countries with greater than 90% return for this variable in **brick red** ink and those with less than 90% in grey. There is obviously less certainty about the presented data for these latter countries. This style of presentation is applied to all of the following sections. There are significant variations in the proportion of patients who are obese and morbidly obese, from around a little under 10% up to over 40%.

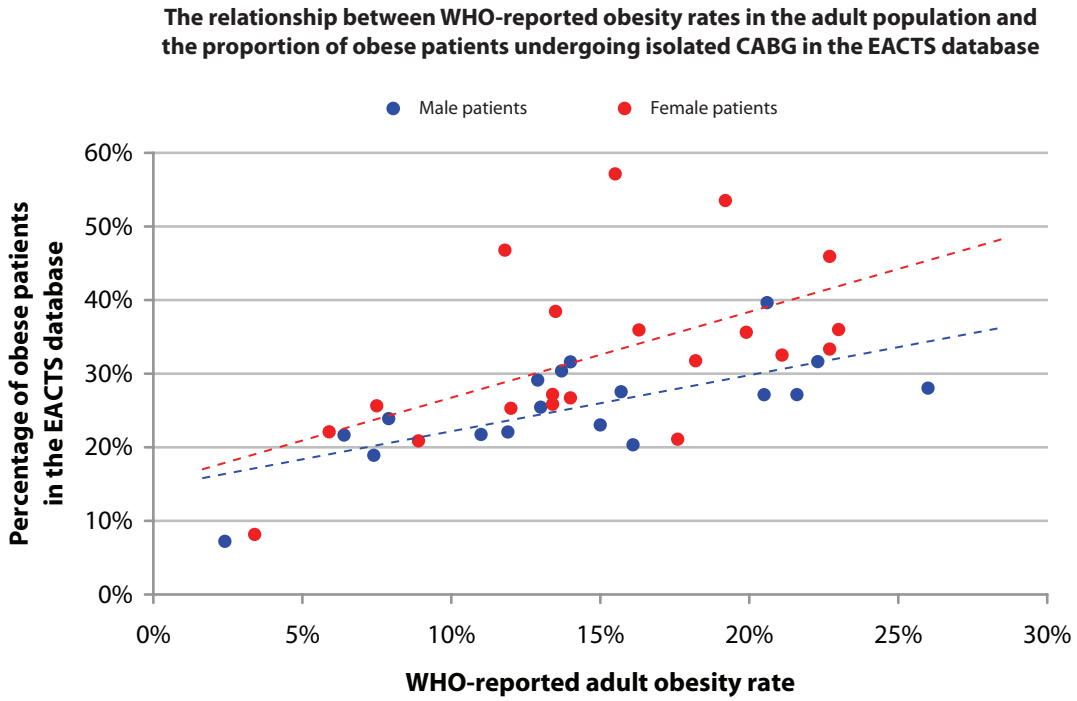
Isolated CABG: BMI distributions and contributor country; calendar years 2006-2008 (n=237,188)



n.b. The countries marked with an asterisk and whose bars are faded did not submit data for 2006-2008, and are therefore represented by their 2004-2005 data.

BMI: WHO and EACTS comparisons

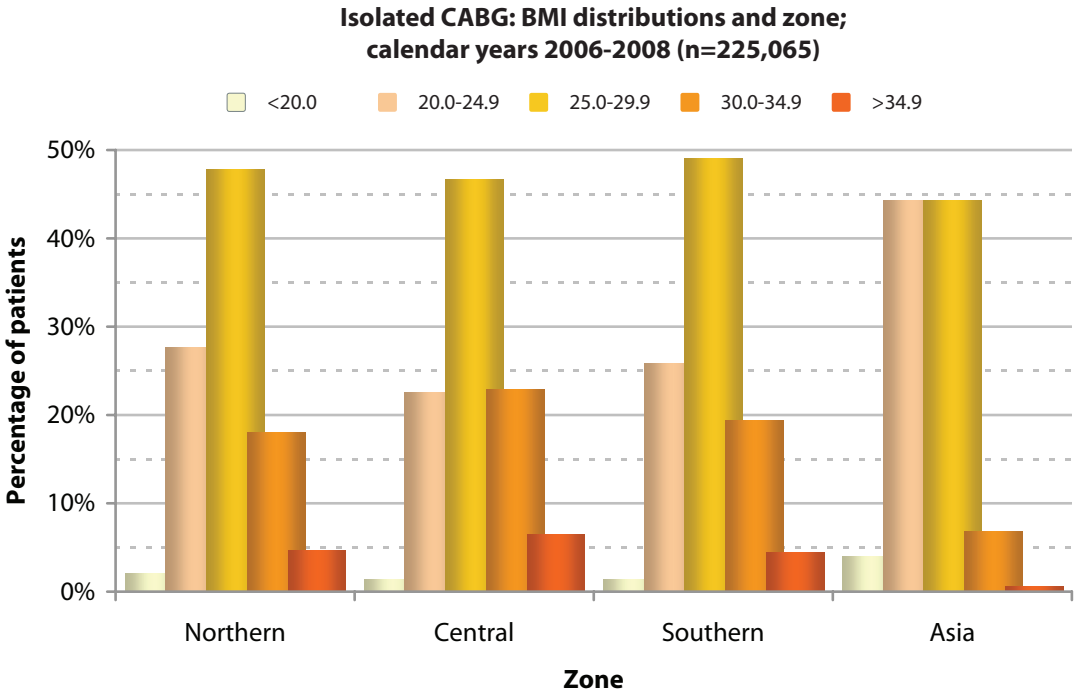
There is a strong correlation between the proportion of patients undergoing CABG who are obese in the EACTS database, & the reported WHO rates of adult obesity given on page 36 (male patients: p=0.001; female patients p=0.011).

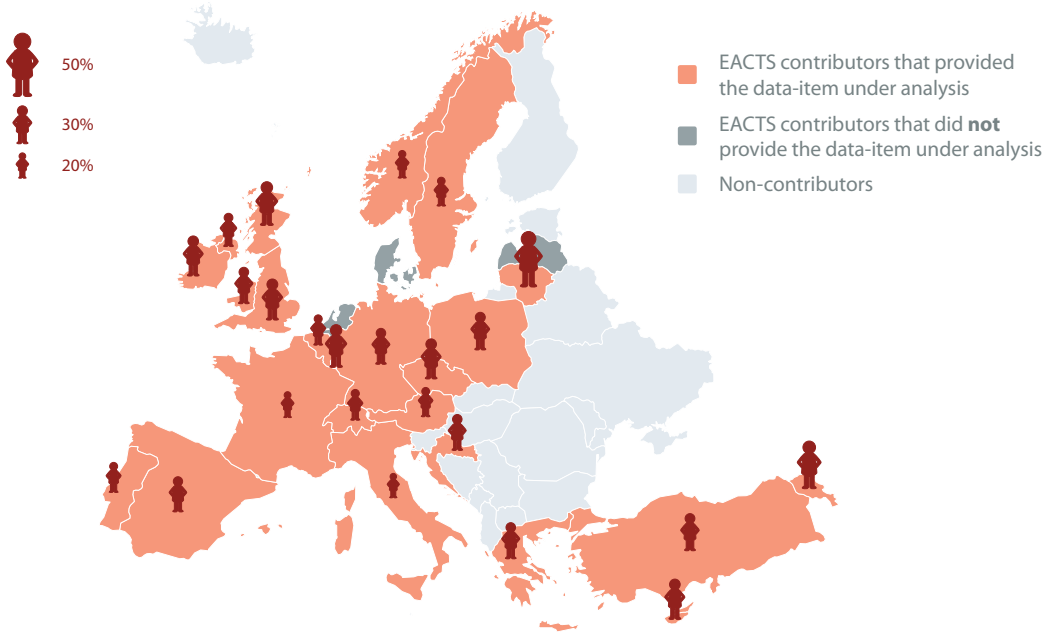


WHO data taken from http://apps.who.int/ghodata/

BMI and zone

The are, again, differences across the geographical zones, with the greatest incidence of high BMI rates in the Central zone, and the lowest in Asia, where surgery on the morbidly obese patient is very unusual. Just under half of patients undergoing surgery in Asia have a BMI less than 25, compared to only 24.0% in the Central zone.



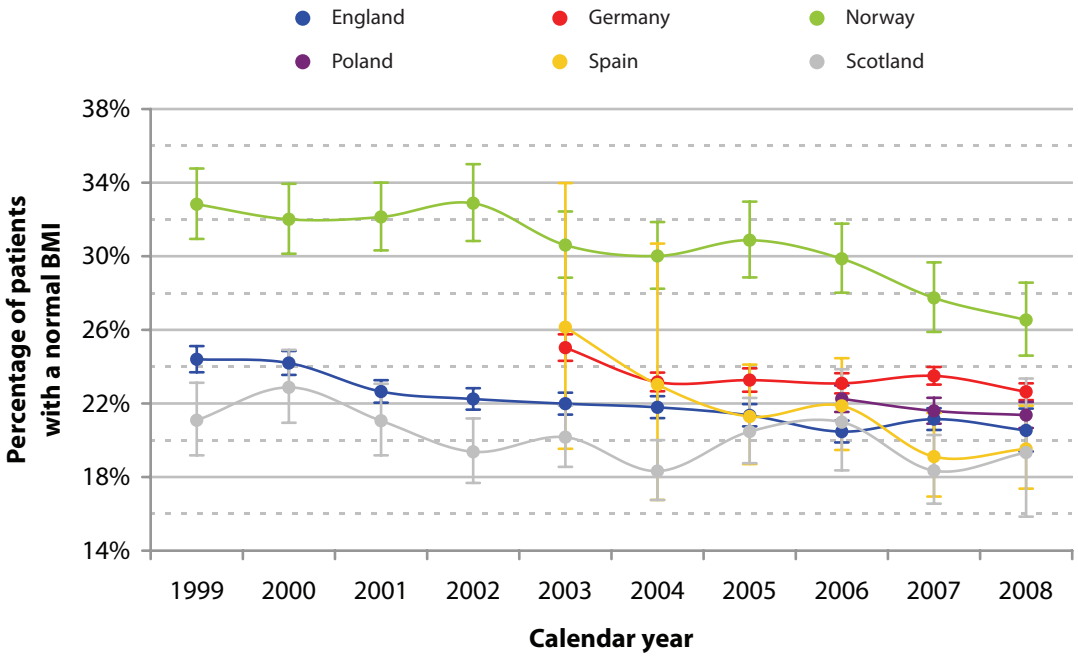


The sizes of the patient icons represent the relative proportions of patients who are obese / morbidly obese in the contributor countries that supplied these data.

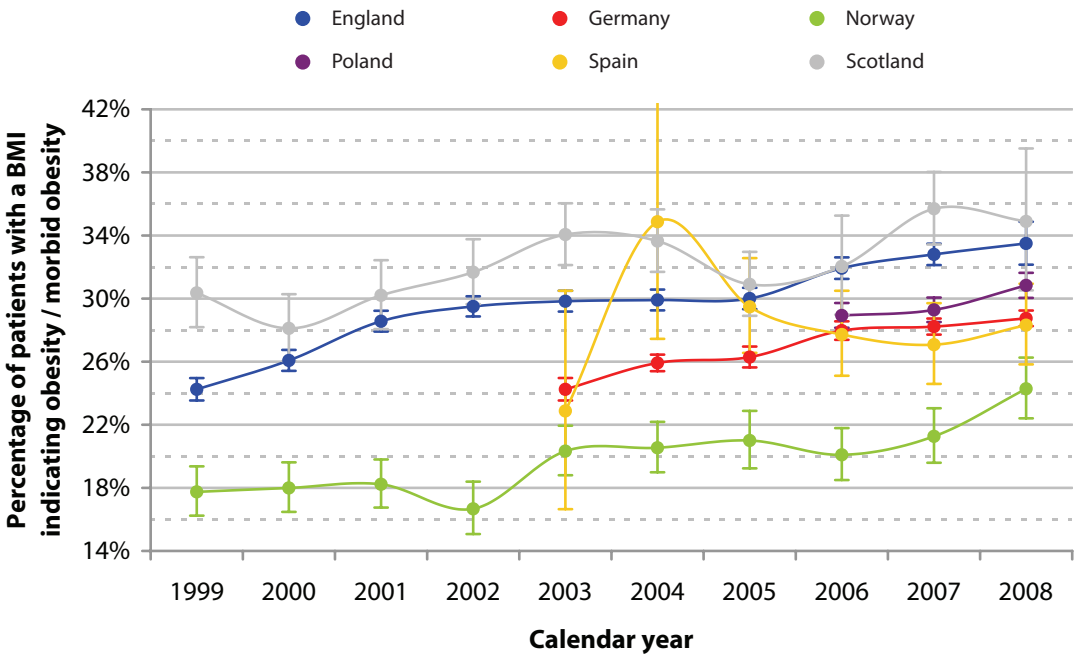
Trends in BMI distributions

There has been a gradual trend of decreasing proportions of patients having normal body mass index over time, with an increasing proportion of patients being obese.

Isolated CABG: Trends in the proportion of patients with a normal BMI; selected contributor countries (n=391,820)



Isolated CABG: Trends in the proportion of obese patients; selected contributor countries (n=391,820)



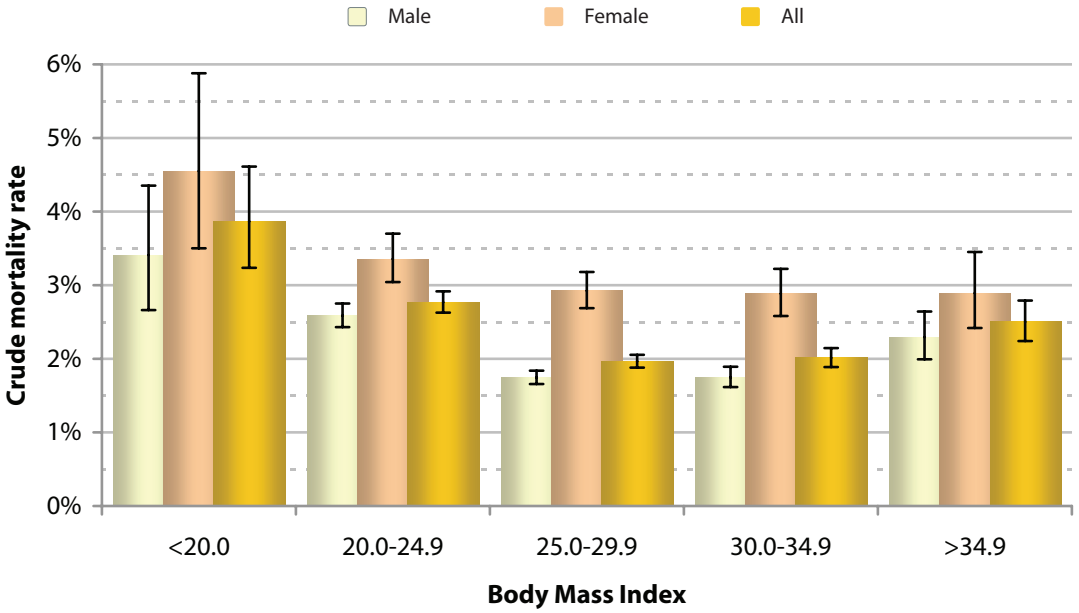
BMI and mortality

The most significant association between body mass index and mortality is that those with a BMI less than 20 have a mortality of 3.9%, twice that of those who are overweight. Surprisingly, from a lay person's perspective, morbid obesity is not associated with a major increase in mortality.

Mortality at the time of discharge after isolated CABG surgery broken down by BMI grouping; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Body Mass Index	<20.0	3,058	123	25	3.9%	(3.2-4.6%)
	20.0-24.9	48,724	1,387	383	2.8%	(2.6-29%)
	25.0-29.9	97,159	1,948	679	2.0%	(1.9-2.1%)
	30.0-34.9	45,513	935	254	2.0%	(1.9-2.1%)
	>34.9	12,472	320	87	2.5%	(2.2-2.8%)
	Unspecified	7,219	195	63		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and Body Mass Index; calendar years 2006-2008 (n=211,639)



BMI and post-operative stay

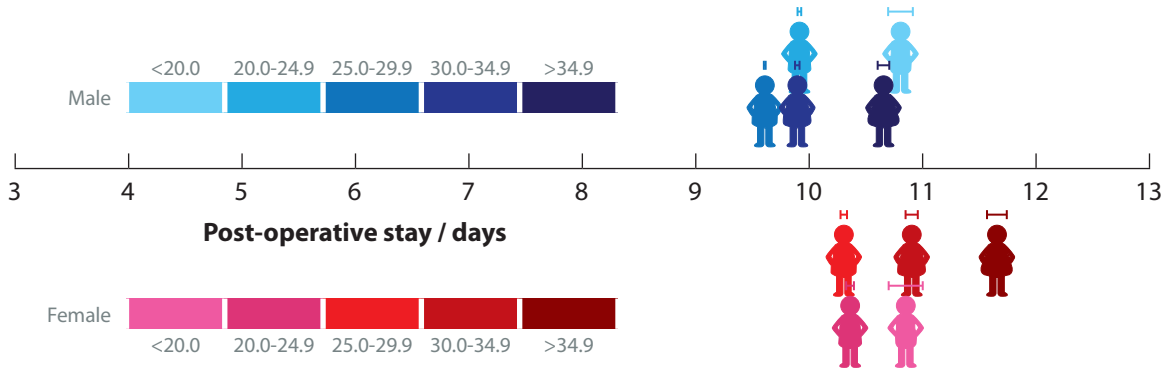
The graphic below is intended to provide a visual representation of the interactions between gender, Body Mass Index and post-operative stay. The horizontal position of the small patient-icon with respect to the post-operative stay linear scale represents the patient-group's average post-operative stay; the display shows data for both male and female patients in each of the five, standard BMI categories. The uncertainty around the average stay value is shown as a standard error bar above the icon, in the same colour as the icon.

From the graphic, it is clear that BMI category influences post operative length-of-stay. For men, those with a low BMI (<20) and the morbidly obese (>=35) have a prolonged post-operative stay. For women it is just the morbidly obese patients who stay significantly longer in hospital after surgery.

Post-operative stay after isolated CABG surgery broken down by BMI group; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Body Mass Index	<20.0	3,003	8.0	10.8	0.19
	20.0-24.9	47,827	8.0	10.0	0.04
	25.0-29.9	95,130	8.0	9.7	0.03
	30.0-34.9	44,933	8.0	10.1	0.05
	>34.9	12,392	8.0	11.0	0.10
	Unspecified	4,871	8.0	10.7	0.20
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: The relationship between gender, Body Mass Index and post-operative stay (n=203,277)

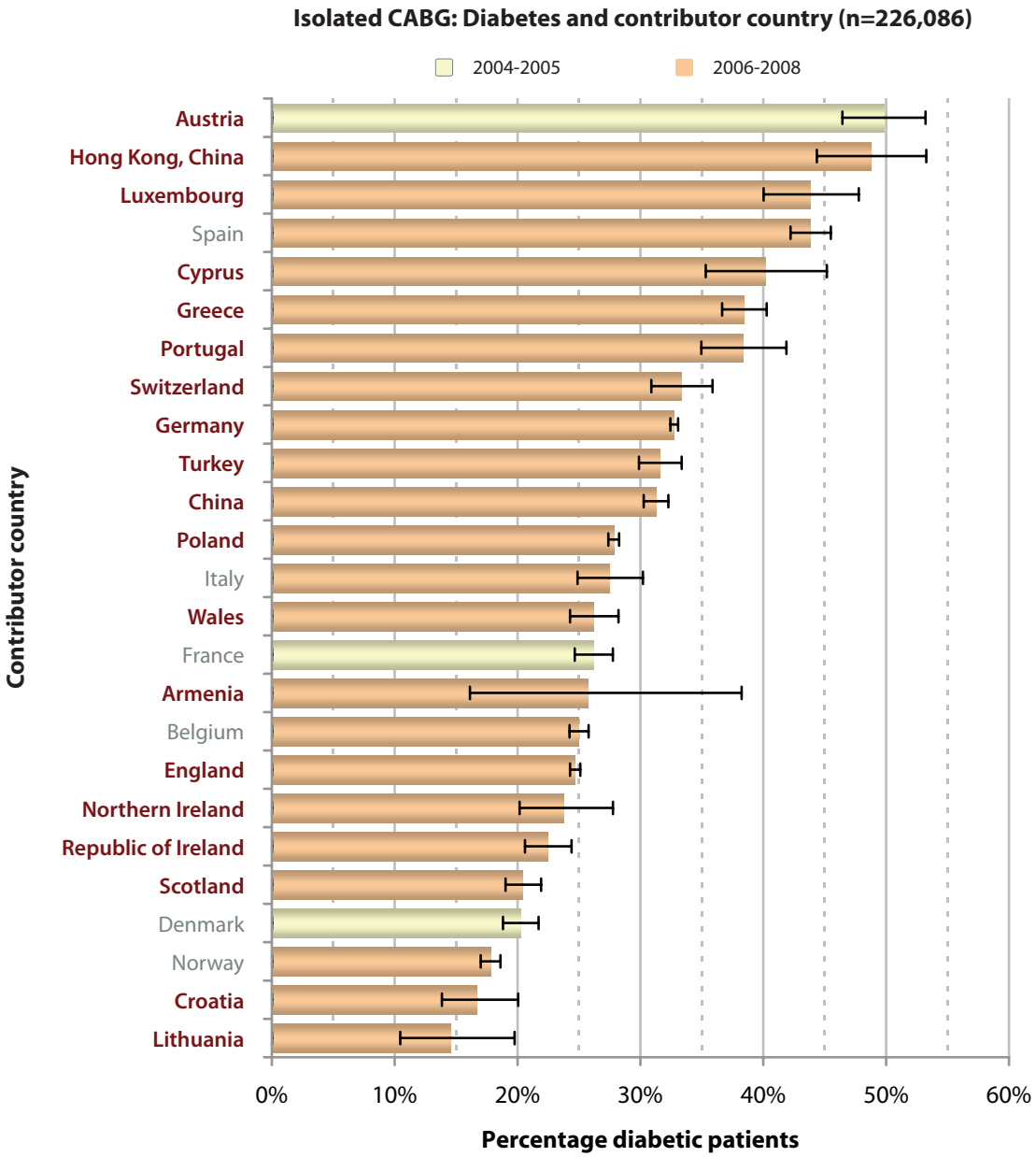


Diabetes

Diabetes distributions

Diabetes and contributor country

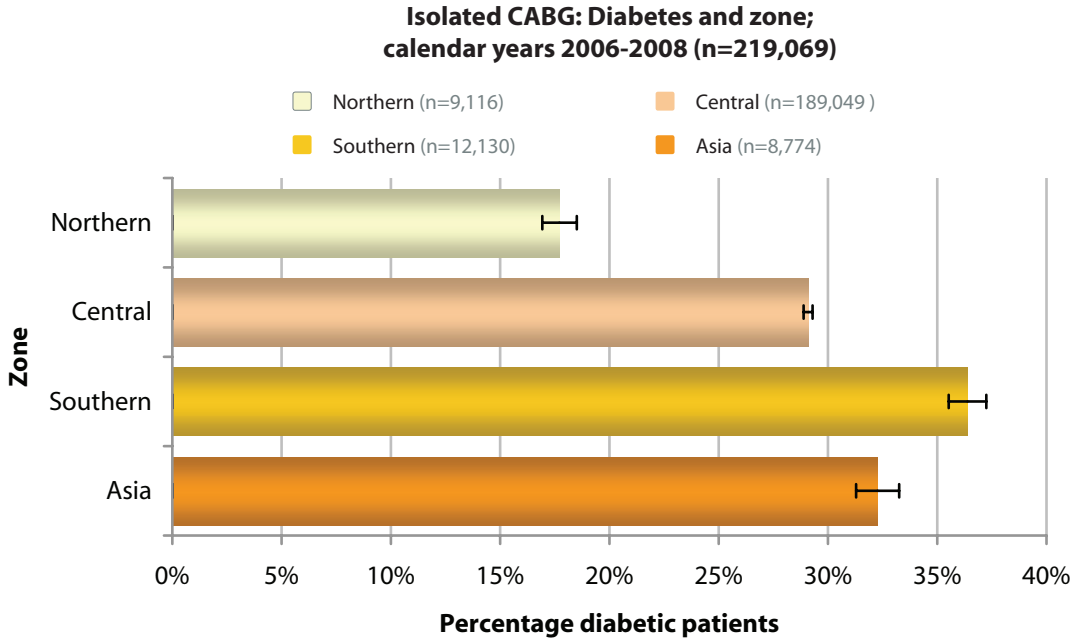
There are marked differences in the reported rates of diabetes, from 14% up to 50%.

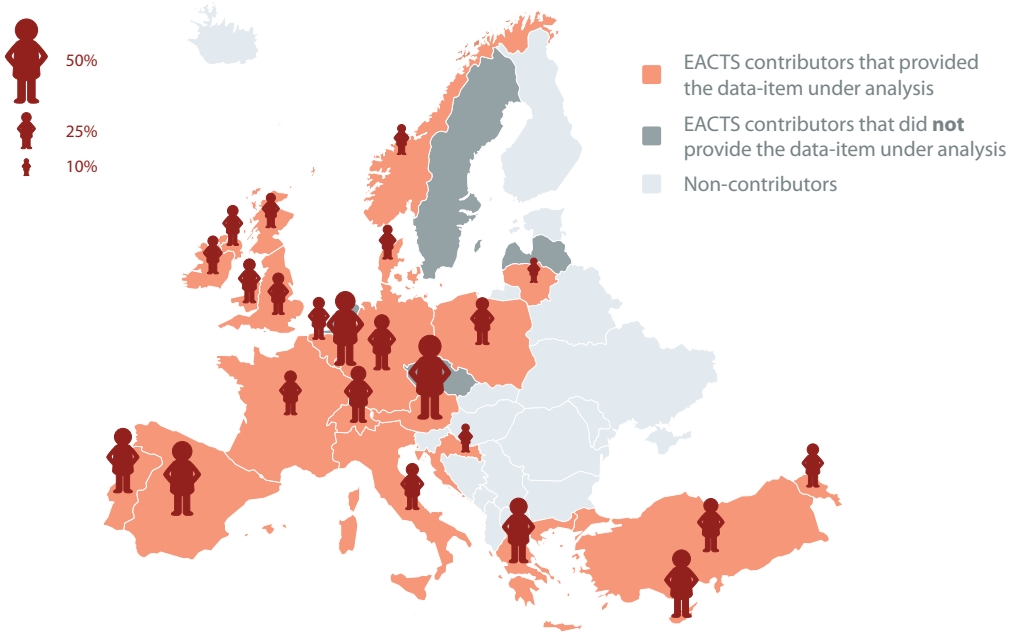


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Diabetes age and zone

There is a variation in the reported rates of diabetes from 17.7% in the Northern zone to 36.4% in the Southern zone. The rate of diabetes in Asia is also high at 32.3%.



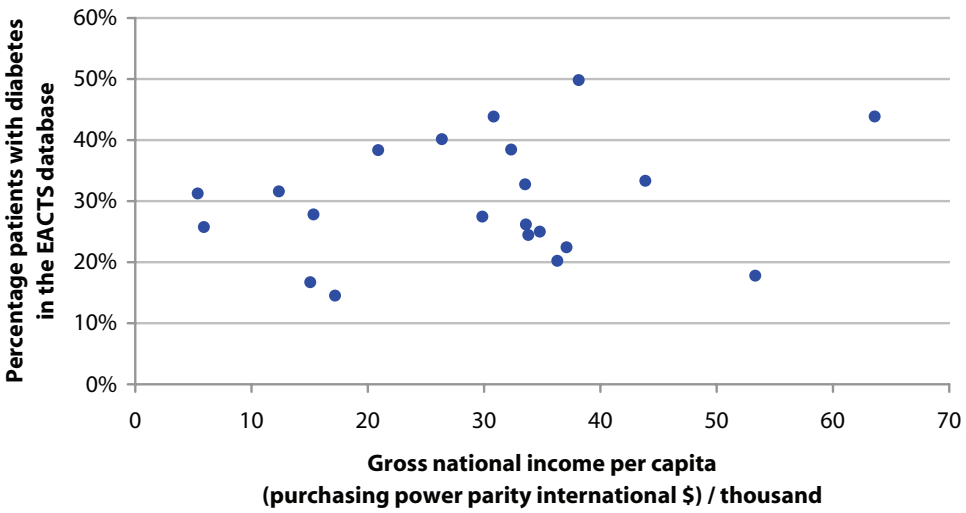


The sizes of the patient icons represent the relative proportions of patients with diabetes in the contributor countries that supplied these data.

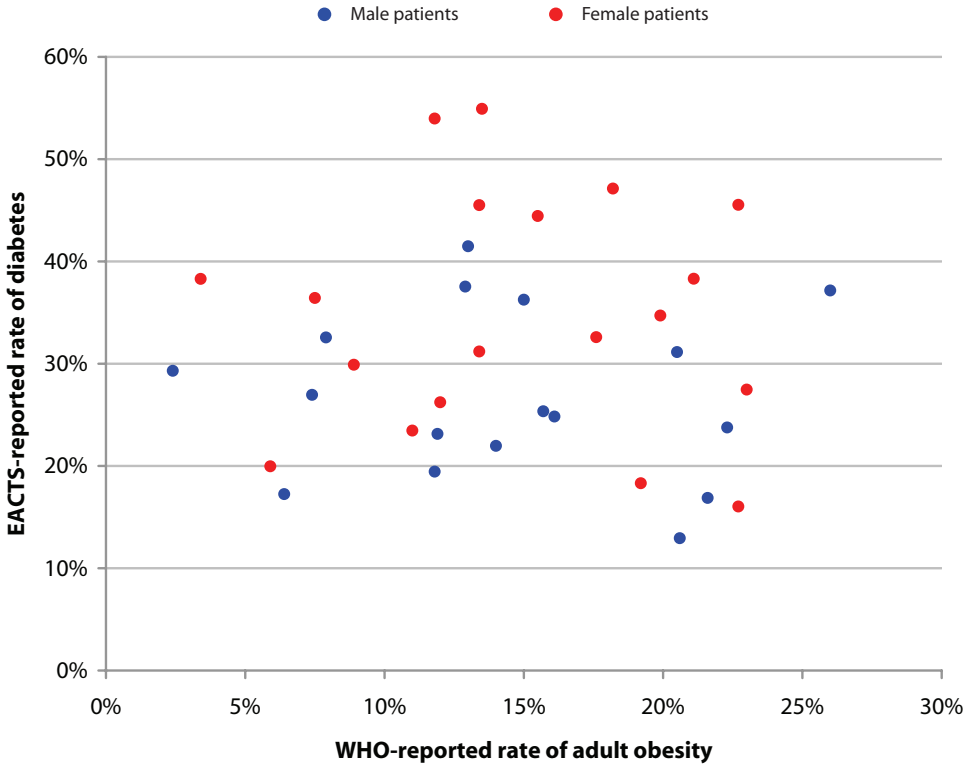
There is no significant association between the reported rate of diabetes in the EACTS database and the WHO-reported *per* capita Gross National Income (r=0.218, r^2=0.047 and p=0.342).

Neither are there any significant relationships between WHO-reported rates of adult obesity and the rates of diabetic patients recorded in the EACTS database (male patients: r=0.038, r^2=0.002 and p=0.880; female patients: r=0.040, r^2=0.002 and p=0.871).

Isolated CABG: The relationship between WHO-reported *per* capita gross national income and rates of diabetes recorded in the EACTS database



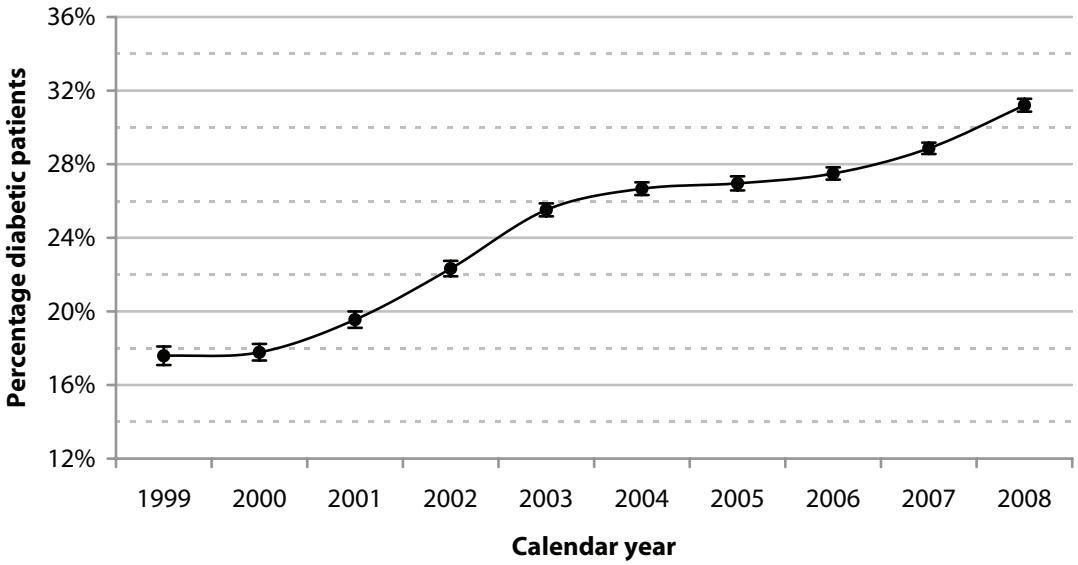
Isolated CABG: The relationship between WHO-reported adult obesity rate and rates of diabetes in the EACTS database



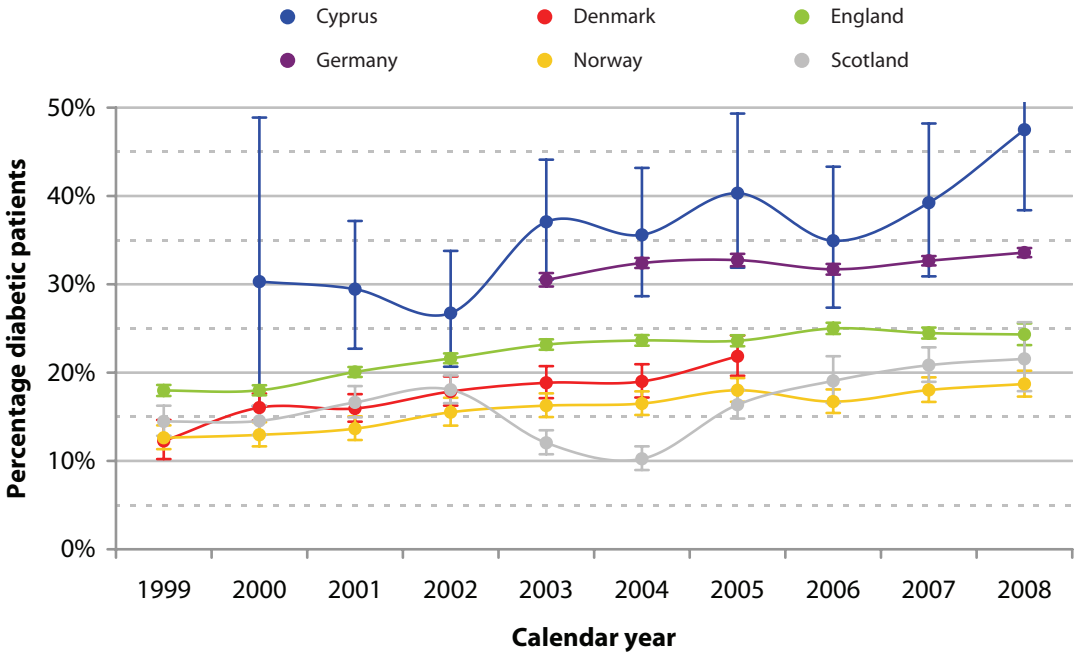
Trends in diabetes distributions

There has been a consistent increase in the proportion of patients with diabetes over time, up to the current rate of 31.2%. The rates for the some of major contributor countries (see below) show quite marked variation; the trend for increasing rates of diabetes amongst individual countries is less marked than for the overall database, suggesting than some of the increasing incidence is due to contributions from newly-submitting countries with high rates of diabetes.

Isolated CABG: Trends in diabetes distributions (n=511,731)



Isolated CABG: Trends in diabetes distributions; selected contributor countries (n=374,846)



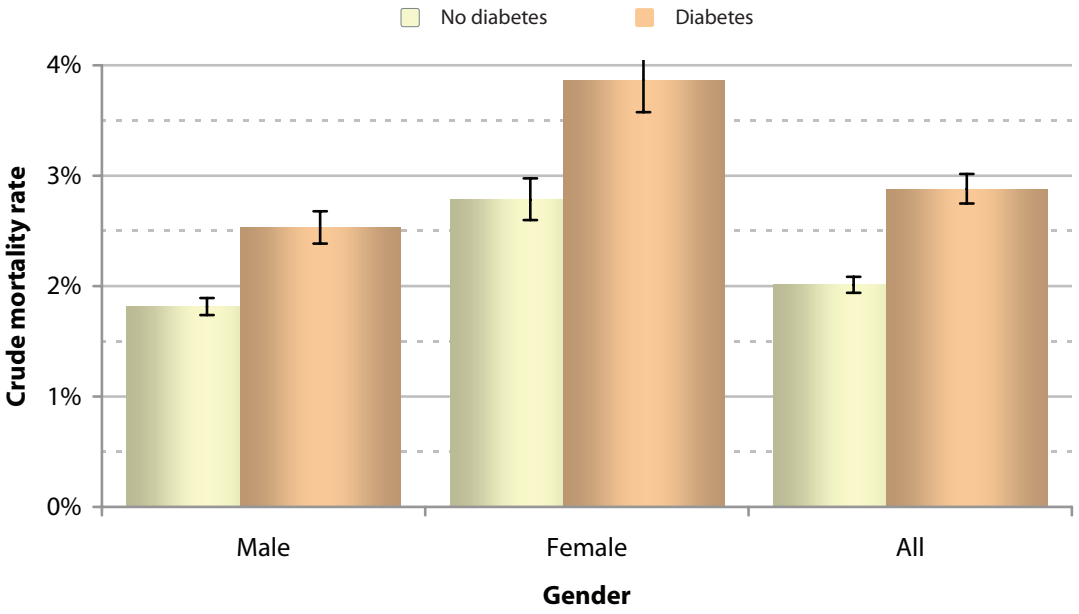
Diabetes and mortality

Diabetes is associated with an increase in operative mortality ($p<0.001$) . This applies similarly to both men and women.

Mortality at the time of discharge after isolated CABG surgery broken down by the presence / absence of diabetes; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Diabetes	No	143,022	2,934	211	2.0%	(1.9-2.1%)
	Yes	59,000	1,749	88	2.9%	(2.7-3.0%)
	Unspecified	12,123	225	1,172		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and diabetes; calendar years 2006-2008 (n=206,705)



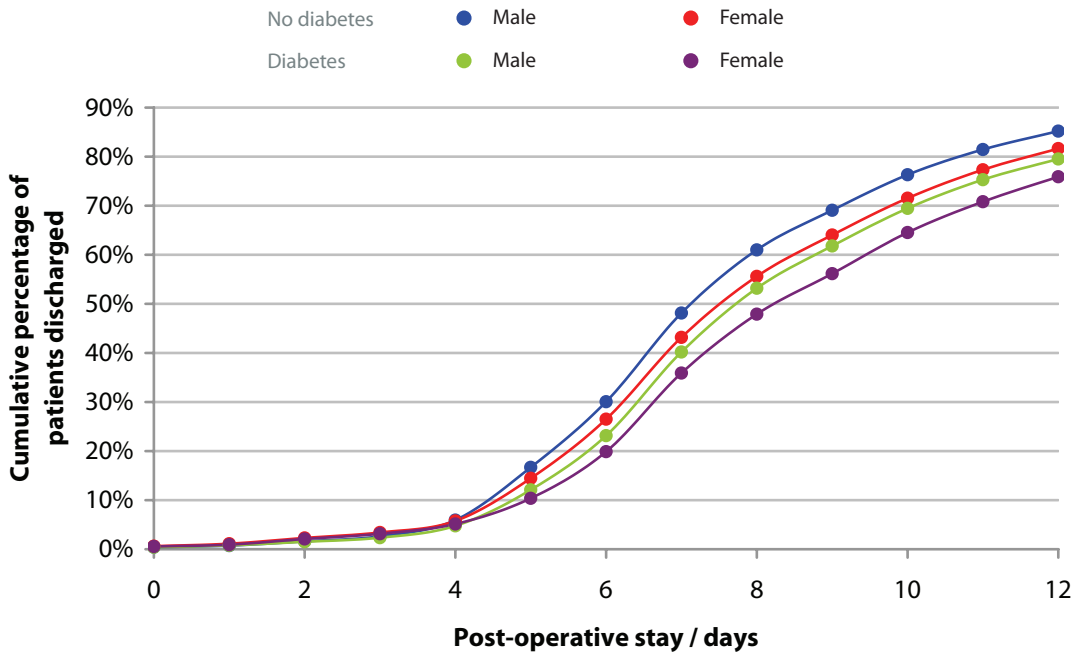
Diabetes and post-operative stay

The presence of diabetes is associated with a longer average length-of-stay of nearly 2 days (p<0.001).

Post-operative stay after isolated CABG surgery broken down by the presence / absence of diabetes; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Diabetes	No	137,151	8.0	9.6	0.02
	Yes	58,629	8.0	11.2	0.05
	Unspecified	12,376	7.0	8.8	0.09
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: Post-operative stay, gender and diabetes; calendar years 2006-2008 (n=195,773)



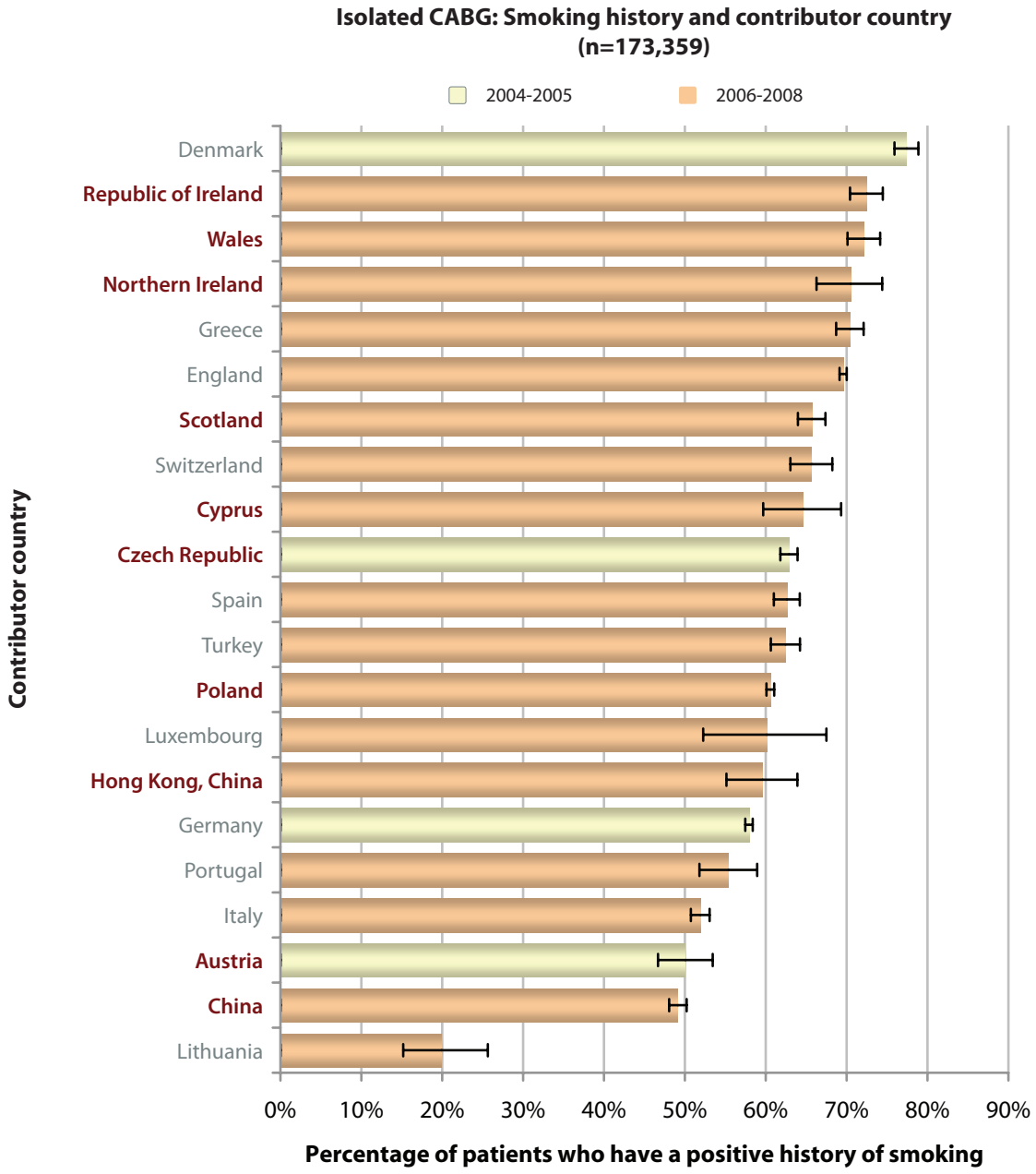
Smoking history

Smoking history distributions

Smoking history and contributor country

There are a number of countries in this figure with a significant incidence of missing data (see page 52), and these results need to be viewed with that in mind.

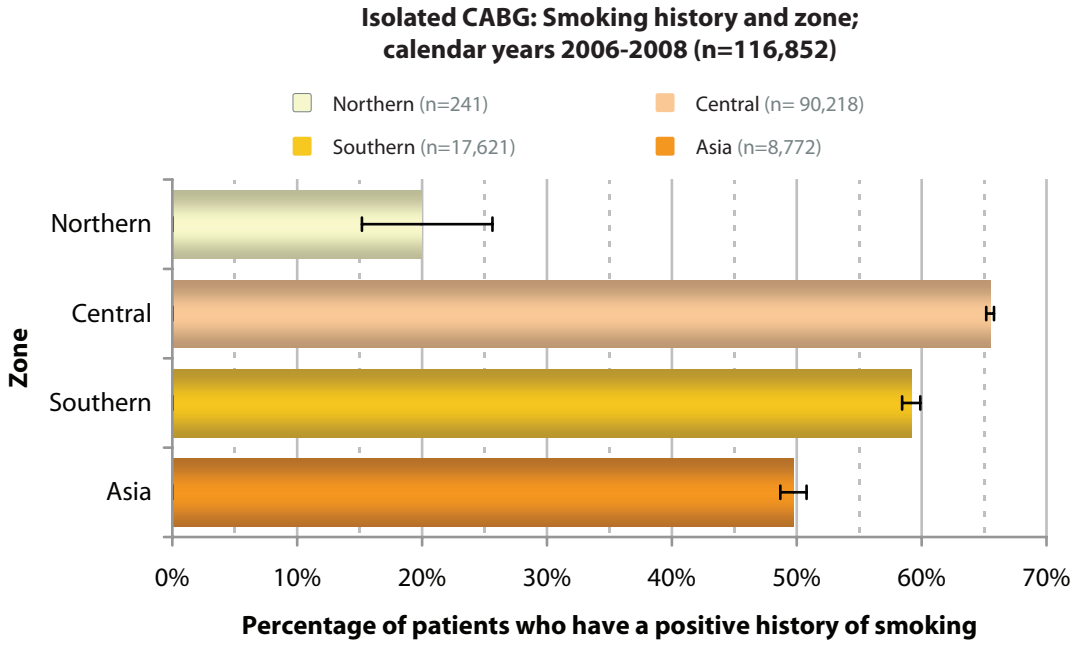
The reported proportion of patients with a smoking history varies from 20% up to 80%. We suspect there may be some issues with data quality in this analysis (see page 52).

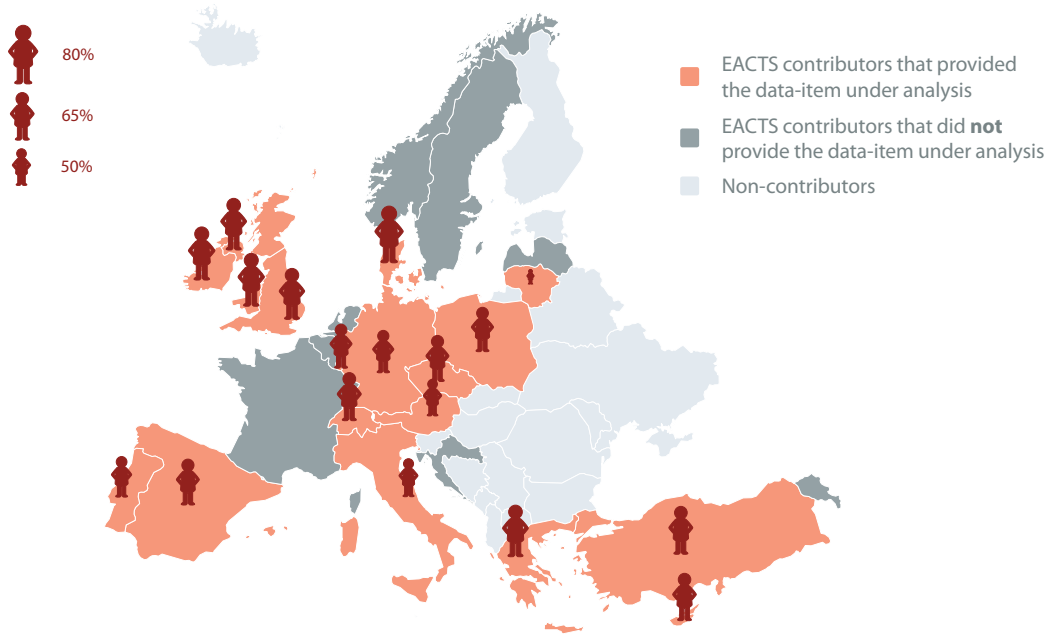


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Smoking history and zone

There are big variations in the reported incidence of smoking by geographical zone.

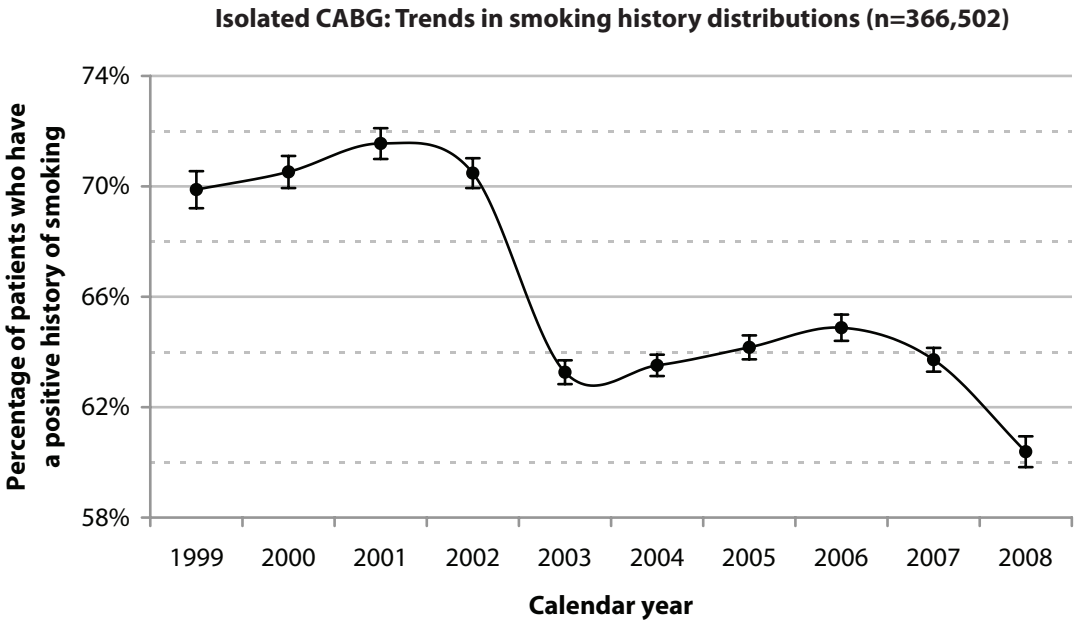




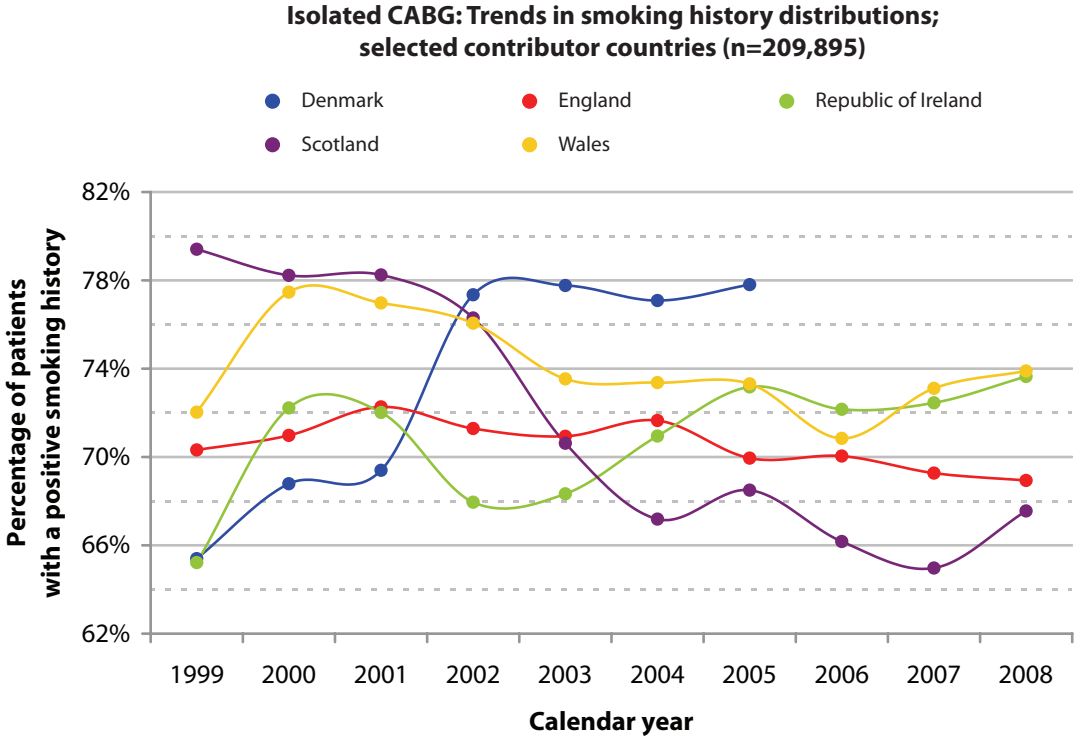
The sizes of the patient icons represent the relative proportions of patients with a positive smoking history in the contributor countries that supplied these data.

Trends in smoking history distributions

The proportion of patients in the database with a smoking history has decreased over time from 70.0% in 1999 to 60.4% in 2008.



There are variations in the overall proportion of patients with a smoking history between the major submitting countries. There is no clear trend apparent across these countries.



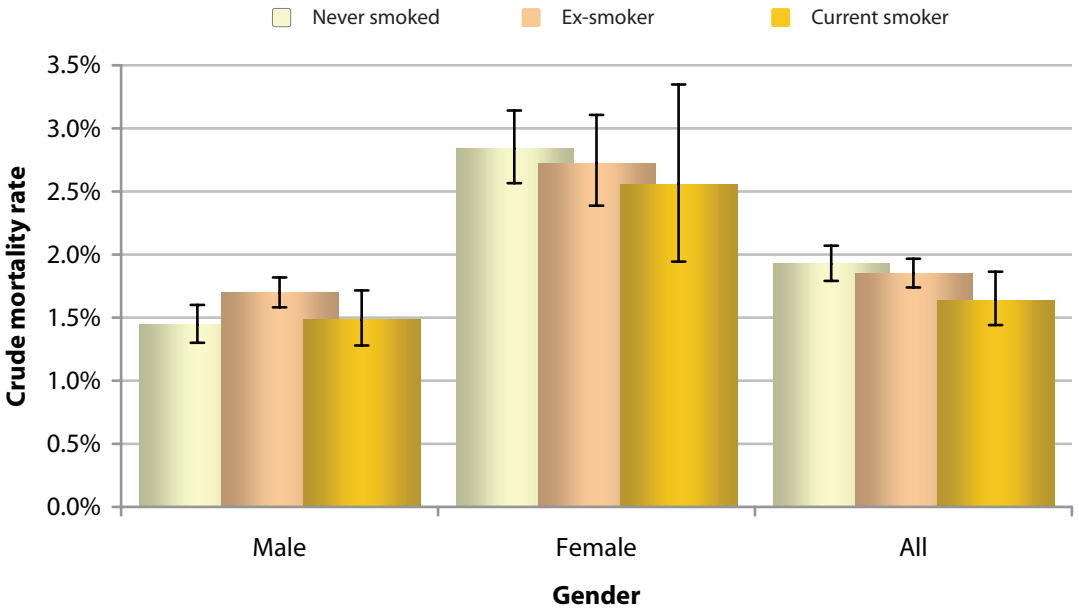
Smoking history and mortality

Of interest, current smoking history is not associated with an increase in mortality. This mirrors analyses from a number of national database reports [1].

Mortality at the time of discharge after isolated CABG surgery broken down by smoking history excluding data from China; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Smoking history	Never smoked	37,377	734	616	1.9%	(1.8-2.1%)
	Ex- smoker	53,749	1,013	493	1.8%	(1.7-2.0%)
	Current smoker	14,159	236	203	1.6%	(1.4-1.9%)
	Unspecified	100,760	2,753	159		
	All	**206,045**	**4,736**	**1,471**		

Isolated CABG: Crude mortality rate, gender and smoking history; calendar years 2006-2008 (n=214,529)



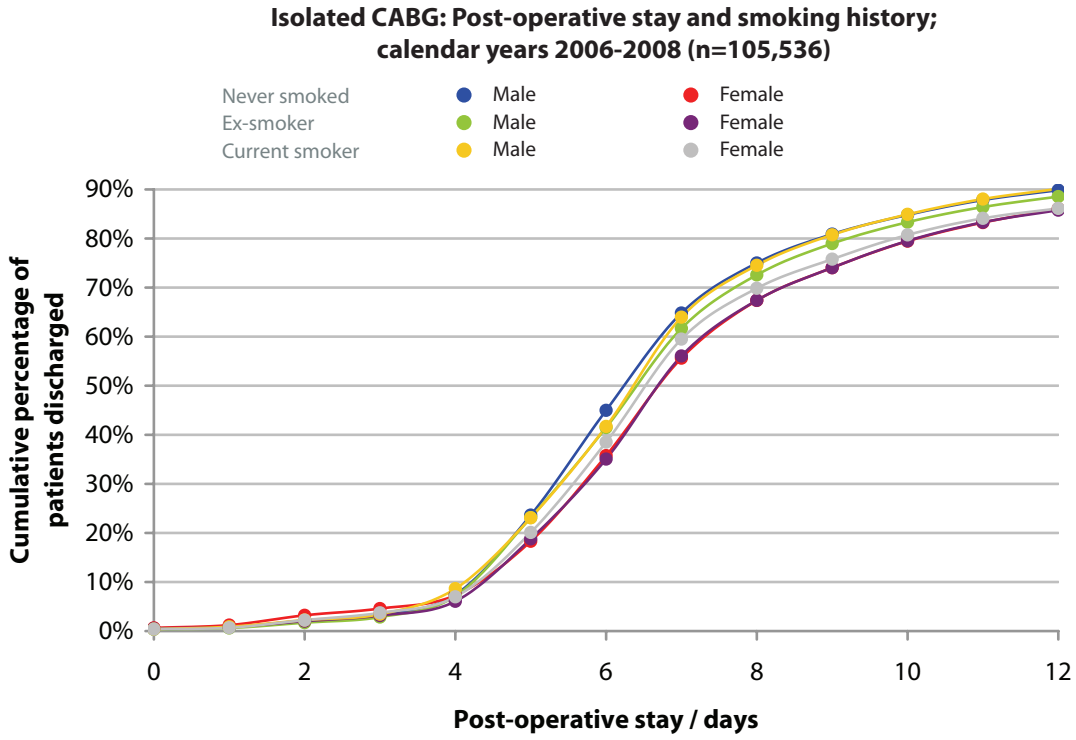
1 Demonstrating quality: The Sixth National Adult Cardiac Surgery database report: Bridgewater B, Kinsman R, Walton P and Keogh B. Published by Dendrite Clinical Systems Ltd. Henley-on-Thames. ISBN 1-903968-23-2.

Smoking history and post-operative stay

Smoking history is not associated with increased length of post-operative hospital stay.

Post-operative stay after isolated CABG surgery broken down by smoking history excluding data from China; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Smoking history	Never smoked	37,735	7.0	8.9	0.06
	Ex-smoker	53,821	7.0	8.9	0.04
	Current smoker	13,987	7.0	9.0	0.10
	Unspecified	94,347	9.0	10.9	0.03
	All	**199,890**	**8.0**	**9.9**	**0.02**

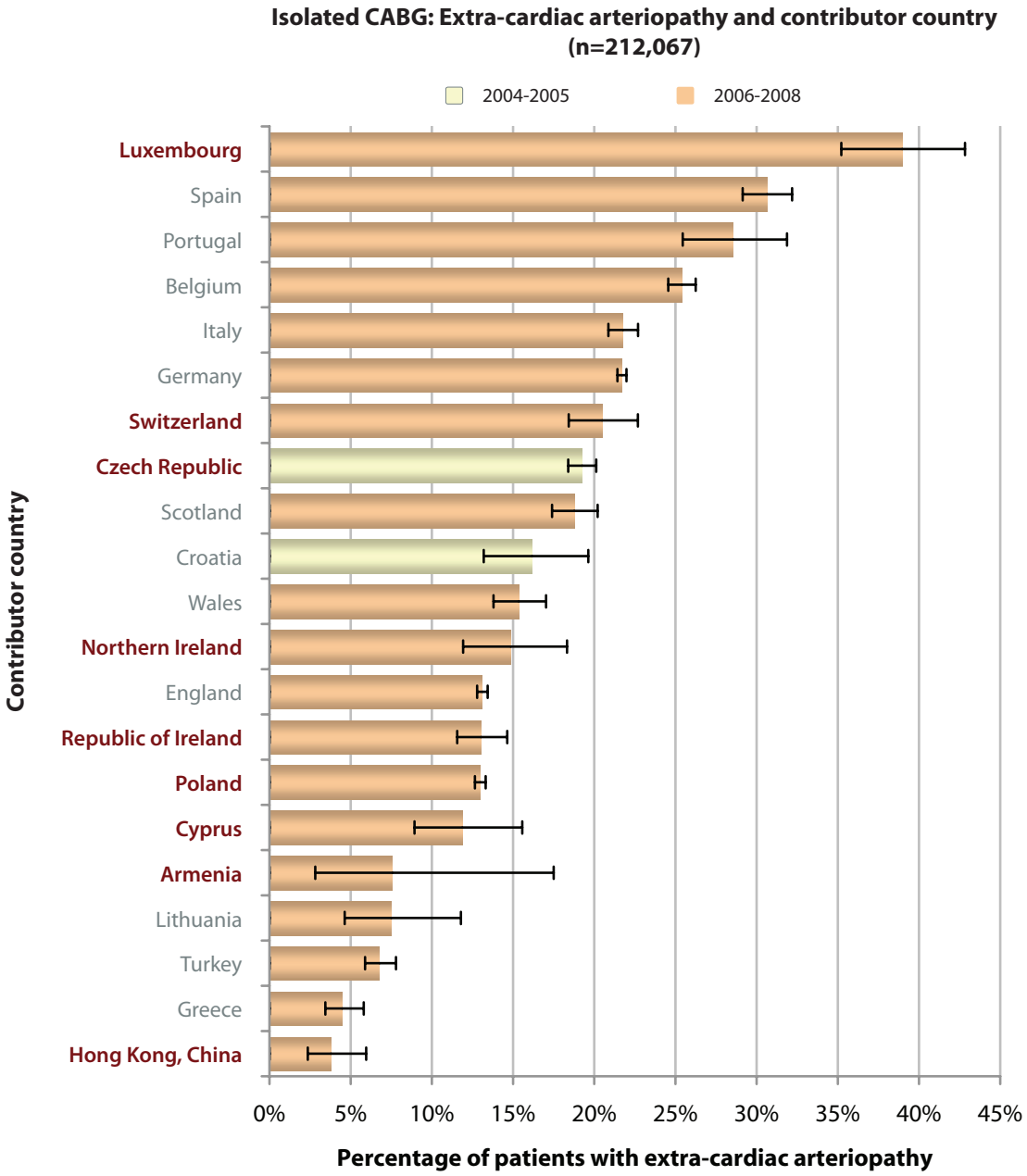


Extra-cardiac arteriopathy

Extra-cardiac arteriopathy distributions

Extra-cardiac arteriopathy and contributor country

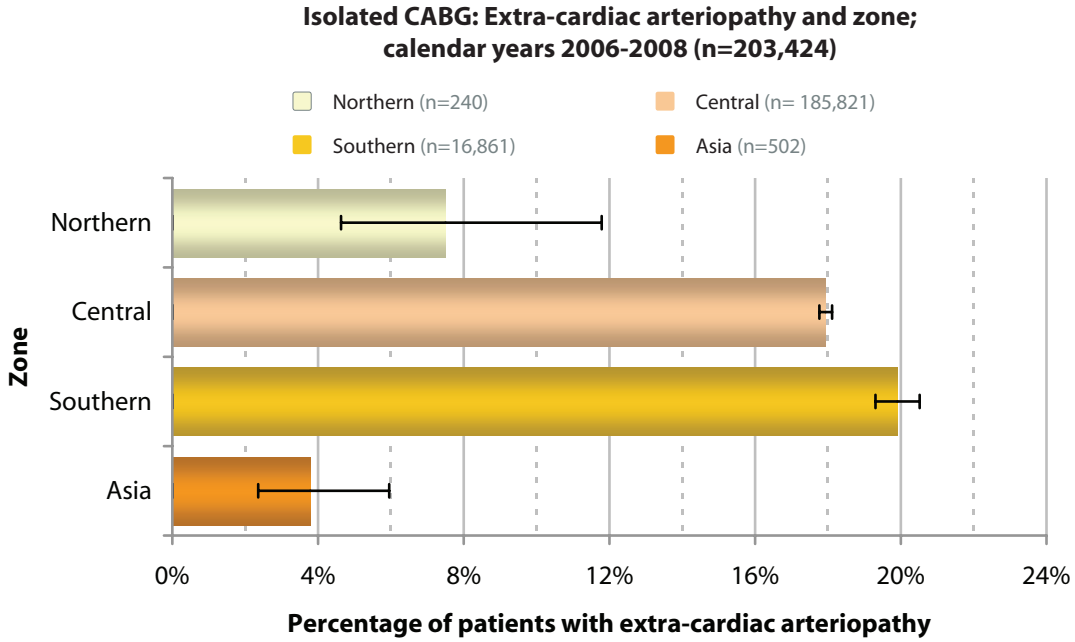
There are many countries that have completeness rates for the extra-cardiac arteriopathy data field of less than 90%. The recorded incidence of this variable is from 3.8% up to 39.0%. The countries at the extremes of the range have completeness rates of greater than 90%, and, as such, there are likely to be real differences between countries in the incidence of this risk factor.

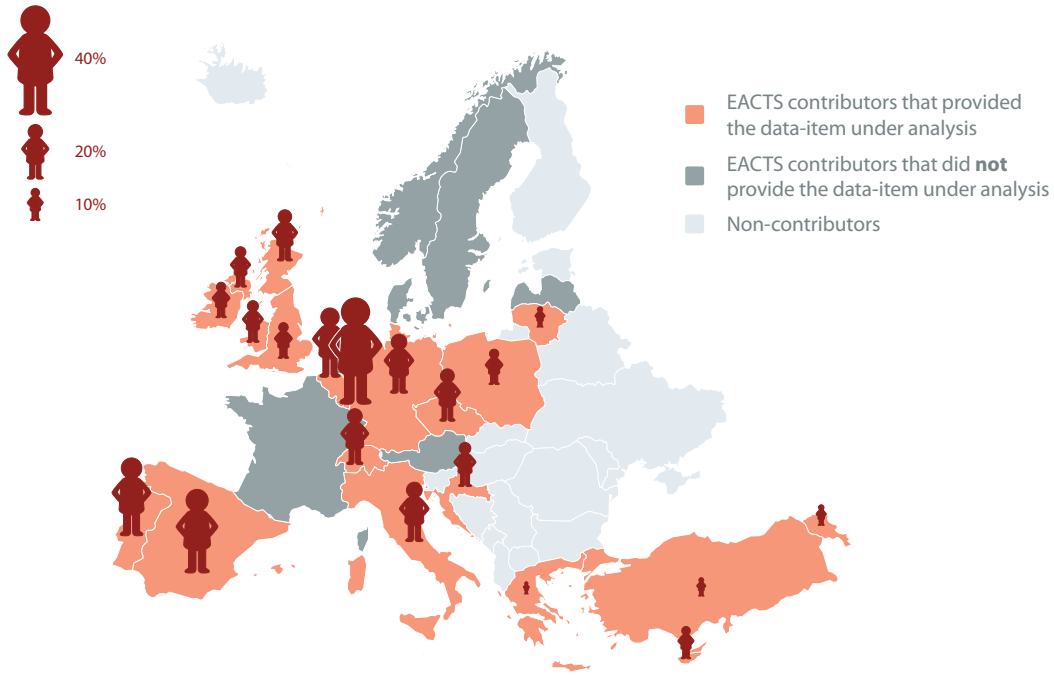


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Extra-cardiac arteriopathy and zone

There are marked variations in the reported proportion of patients with extra-cardiac arteriopathy across the geographical zones, ranging from 3.8% in Asia up to 19.9% in the Southern zone.



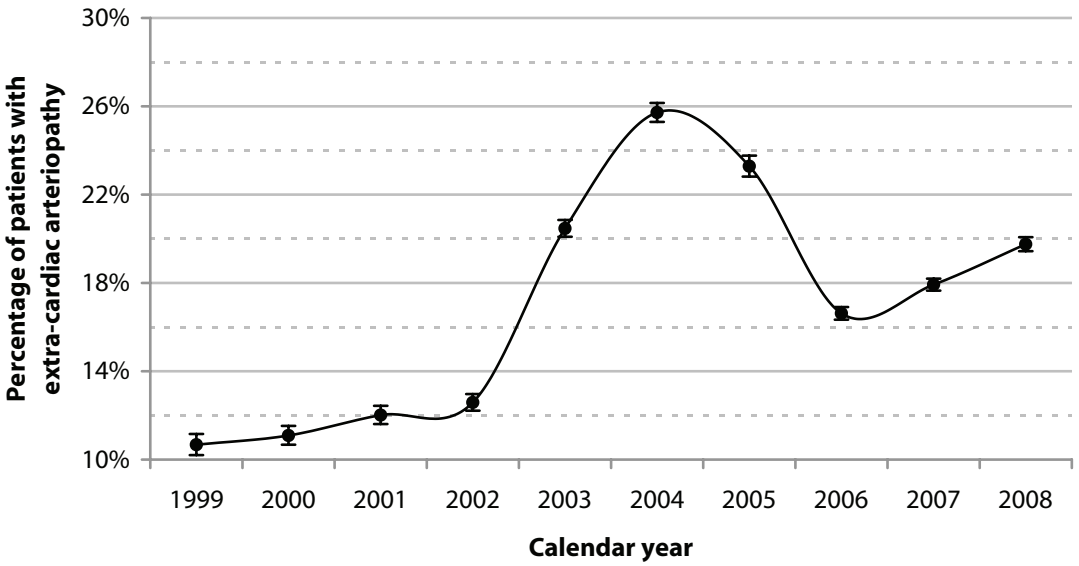


The sizes of the patient icons represent the relative proportions of patients with extra-cardiac arteriopathy in the contributor countries that supplied these data.

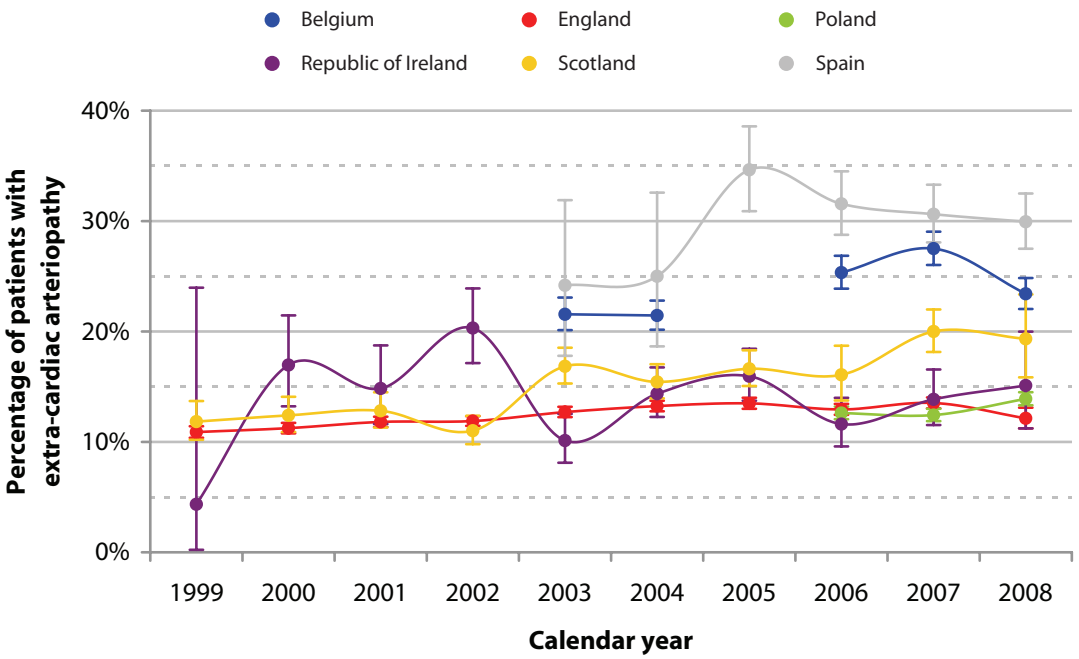
Trends in extra-cardiac arteriopathy distributions

There have been quite marked changes in the incidence of extra-cardiac arteriopathy over time, which represents the influence of new countries submitting to the database; the incidence amongst countries that most regularly submit data is more stable. There is, however, quite a marked difference in the reported incidence in extra-cardiac arteriopathy between, for example, a rate of just over 10% in England up to 30% in Spain.

Isolated CABG: Trends in extra-cardiac arteriopathy distributions (n=408,713)

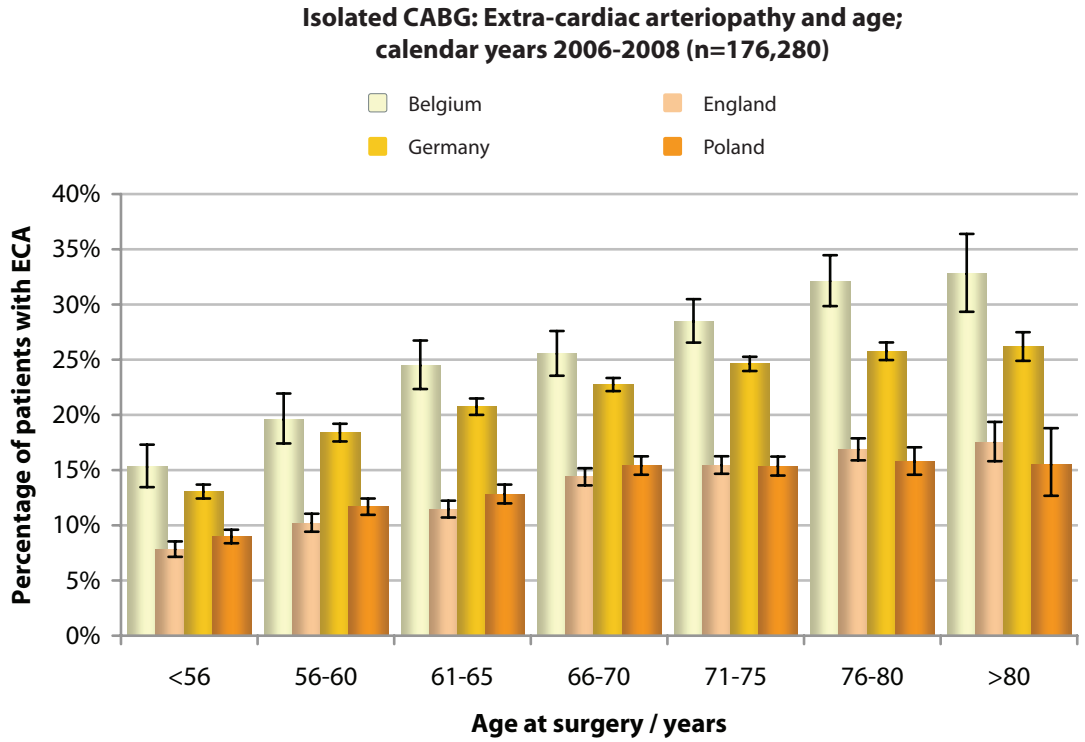


Isolated CABG: Trends in extra-cardiac arteriopathy distributions; selected contributor countries (n=254,088)



Extra-cardiac arteriopathy and age

The reported incidence of extra-cardiac arteriopathy increases with increasing age.



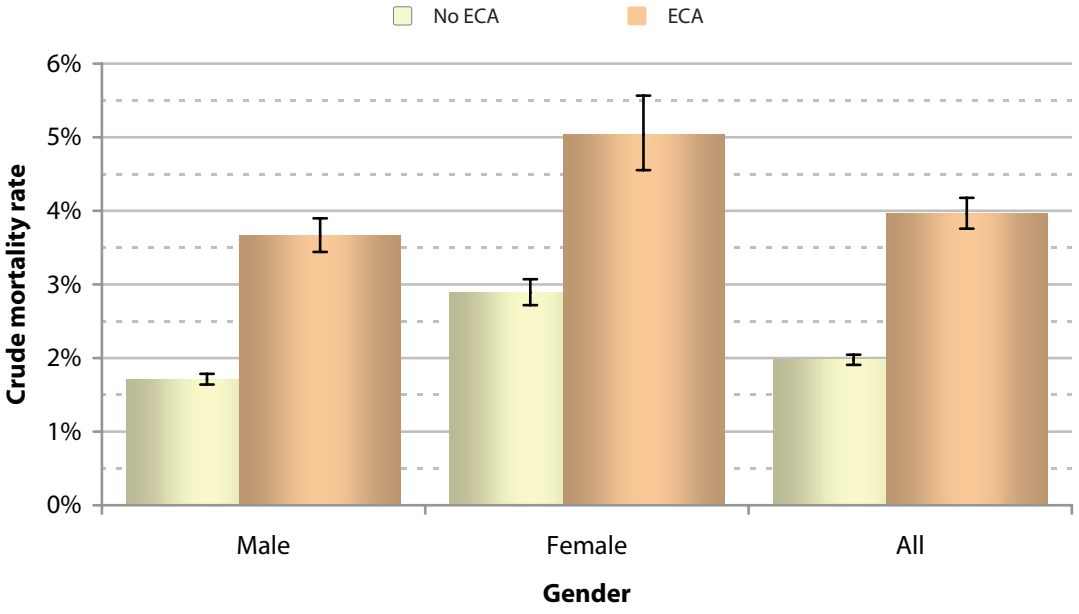
Extra-cardiac arteriopathy and mortality

Extra-cardiac arteriopathy is strongly associated with increased in-hospital mortality ($p<0.001$). Those patients with the risk factor have a mortality that is twice that those who do not have extra-cardiac arteriopathy. This finding applies equally to male and female patients.

Mortality at the time of discharge after isolated CABG surgery broken down by the presence / absence of extra-cardiac arteriopathy; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
ECA	No	154,697	3,117	1,167	2.0%	(1.9-2.0%)
	Yes	32,510	1,341	247	4.0%	(3.8-4.2%)
	Unspecified	26,938	450	57		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and extra-cardiac arteriopathy; calendar years 2006-2008 (n=191,665)



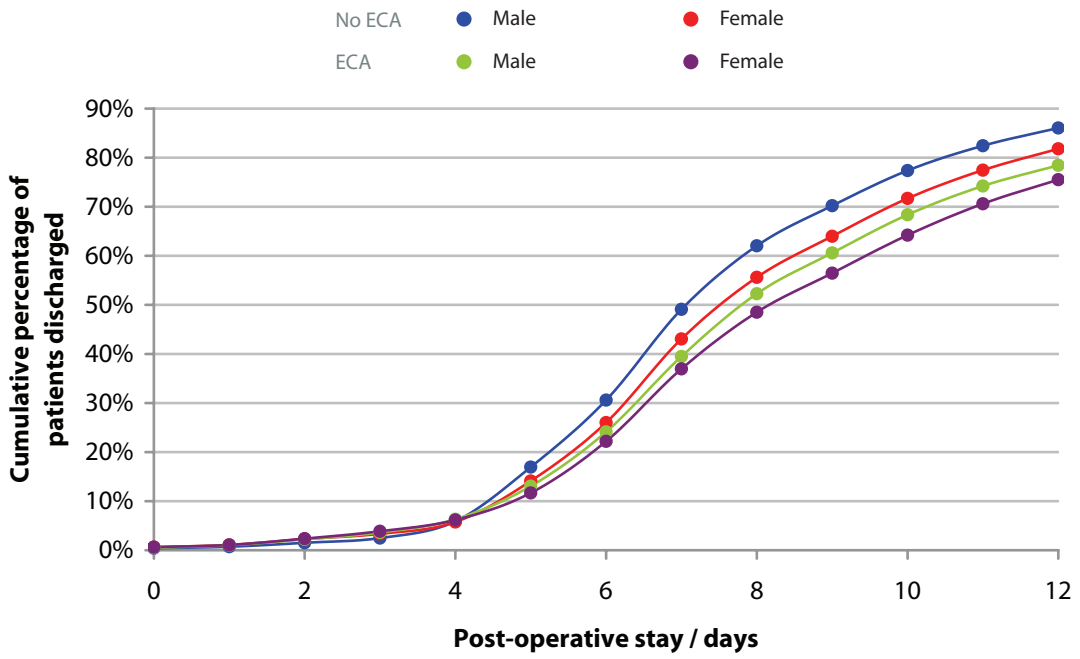
Extra-cardiac arteriopathy and post-operative stay

The presence of extra-cardiac arteriopathy is associated with an increased length of post-operative stay, of about 2 extra days.

Post-operative stay after isolated CABG surgery broken down by the presence / absence of extra-cardiac arteriopathy; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
ECA	No	156,234	8.0	9.6	0.02
	Yes	33,634	8.0	11.2	0.07
	Unspecified	18,288	8.0	11.2	0.09
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: Post-operative stay, gender and extra-cardiac arteriopathy; calendar years 2006-2008 (n=189,861)



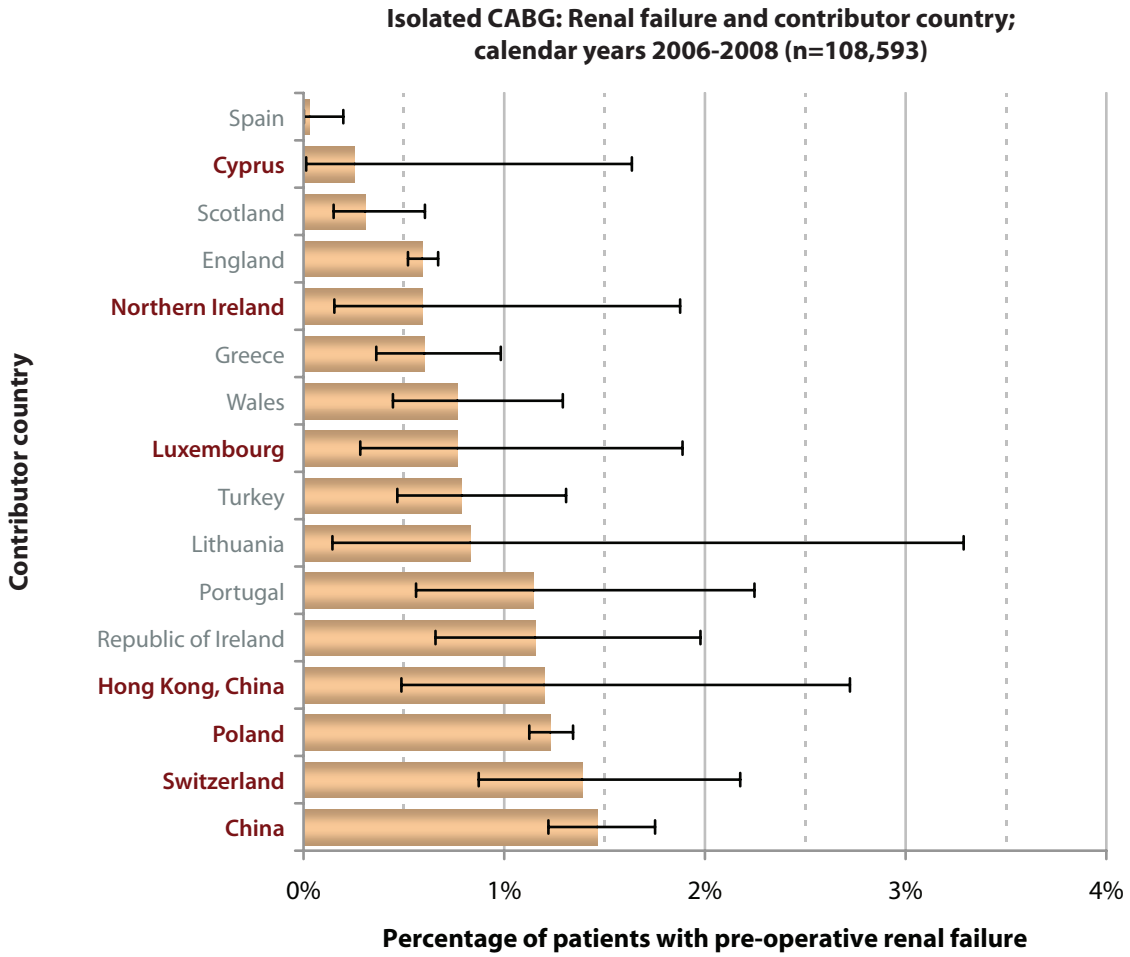
Pre-operative renal failure

Pre-operative renal failure distributions

Renal failure and contributor country

There is a greater than 10% incidence of missing data for many of the countries for this variable and the results need to be interpreted in this context.

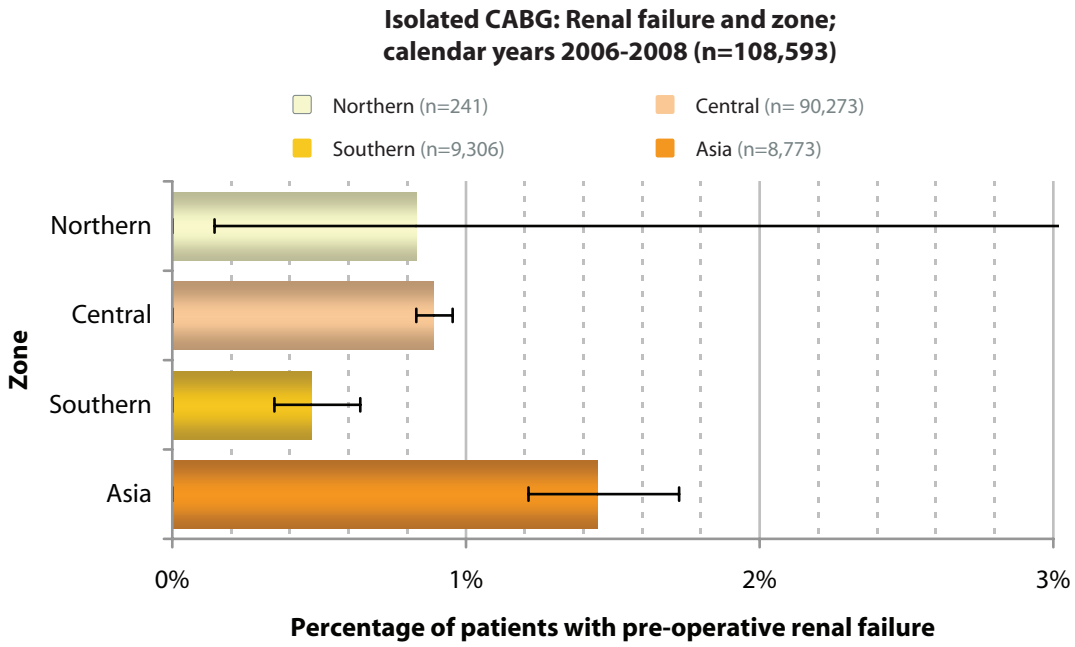
Renal failure is a rare risk factor for patients undergoing coronary artery surgery. The incidence ranges across countries up to a maximum of 1.5%.

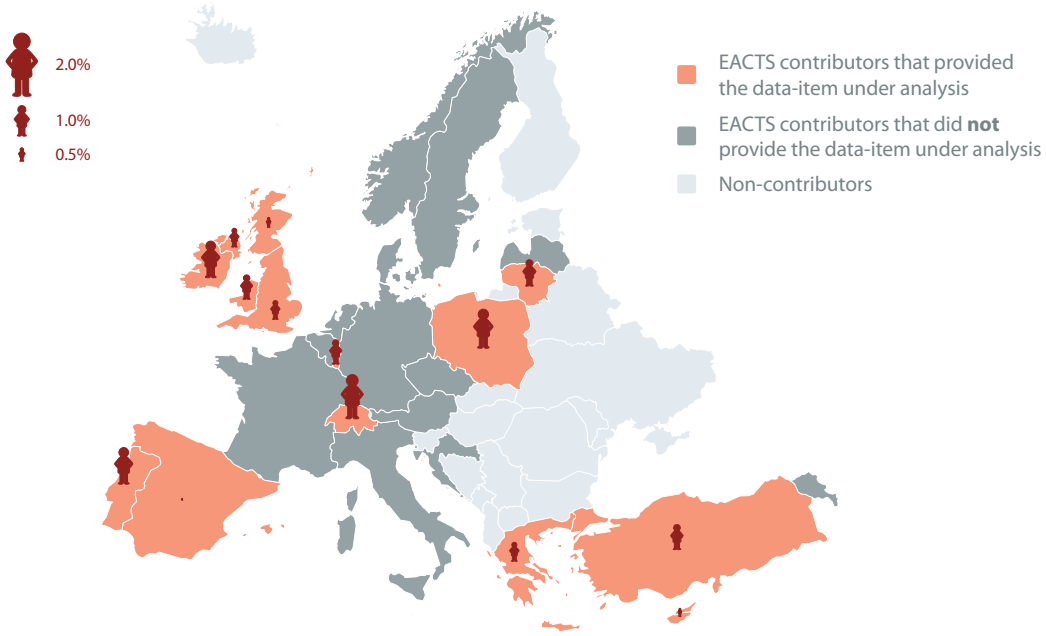


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Renal failure and zone

The incidence of renal failure is higher in Asia than in Central or in Southern Europe. The number of patients reported with renal failure in the Northern zone is insufficient for any conclusions to be drawn.





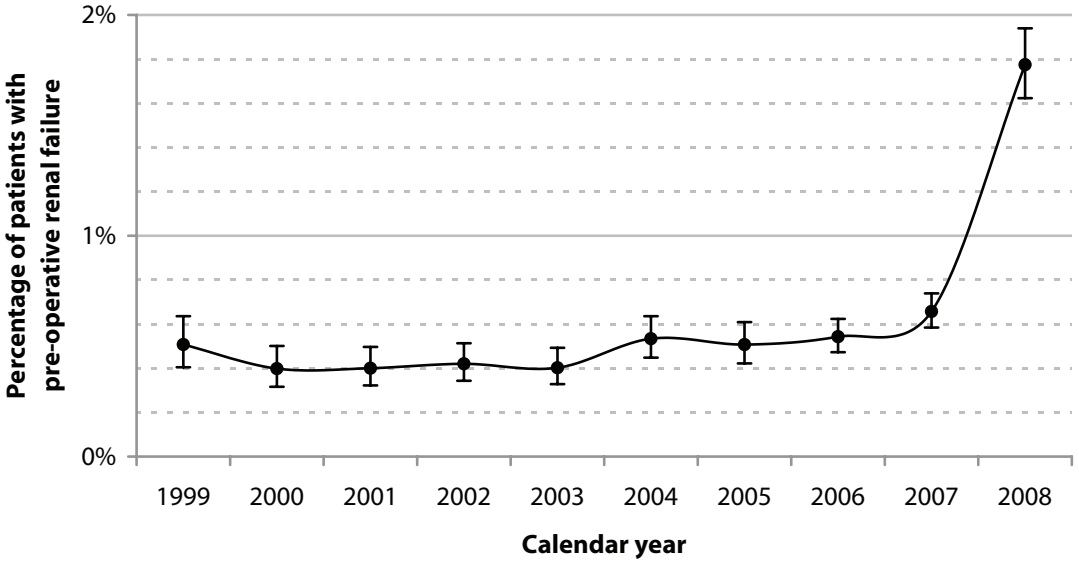
The sizes of the patient icons represent the relative proportions of patients with pre-operative renal failure in the contributor countries that supplied these data.

Trends in renal failure distributions

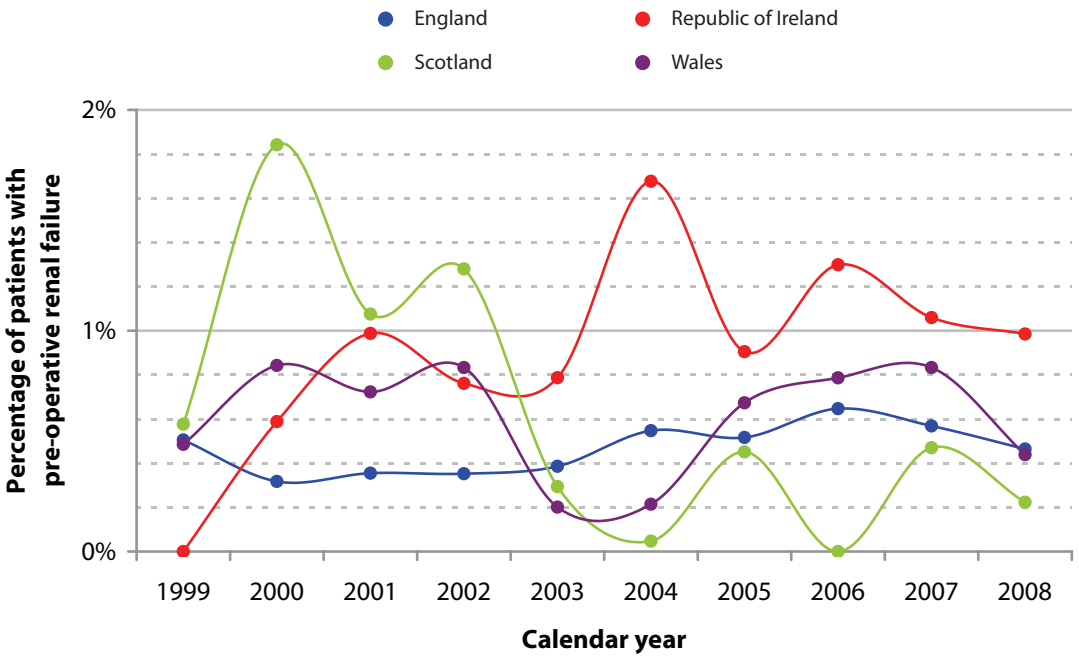
The increase in renal failure in the database in 2008 is due to submissions from Asia.

The changes in incidence of renal failure over time in the major submitting countries show no clear trend.

Isolated CABG: Trends in renal failure distributions (n=260,248)

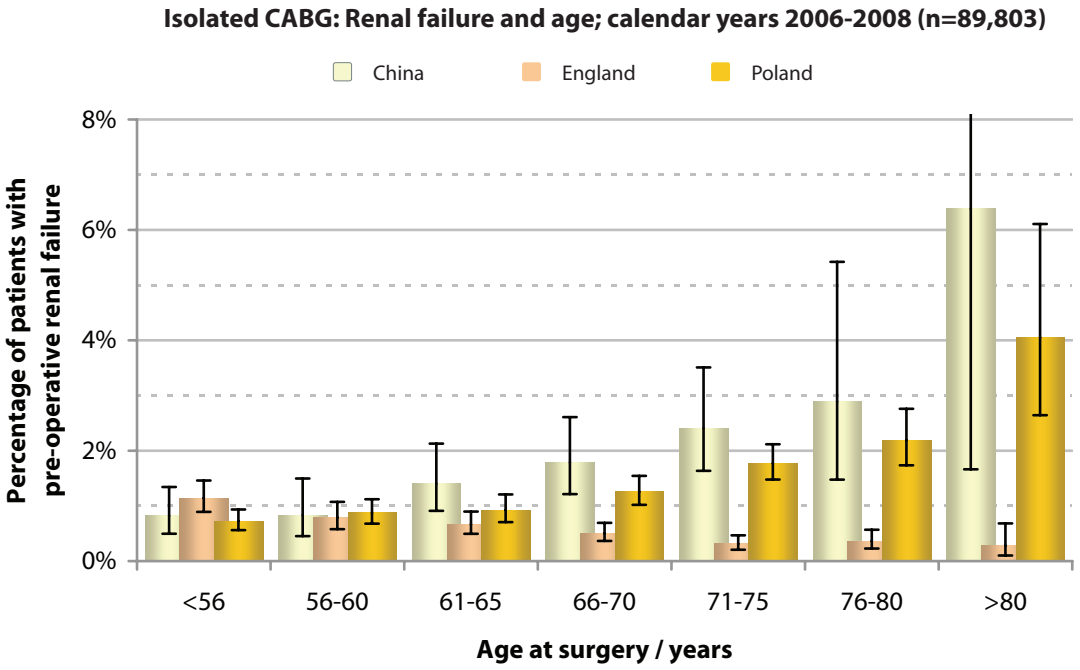


Isolated CABG: Trends in renal failure distributions; selected contributor countries (n=191,862)



Renal failure and age

The reported incidence of renal failure increases with increasing age.

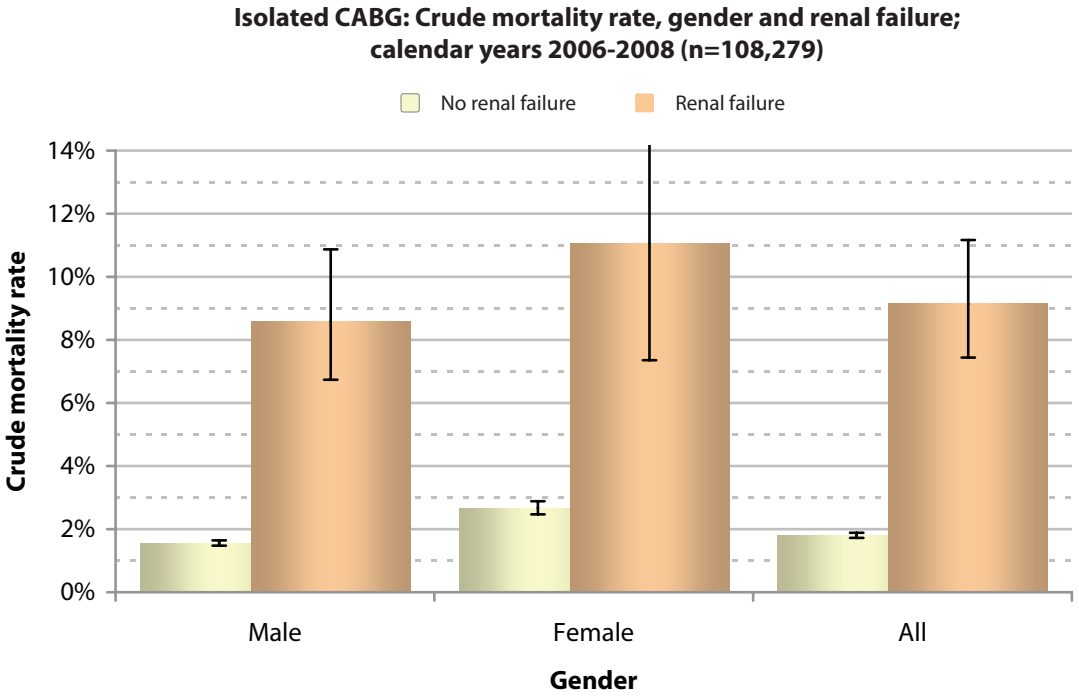


Pre-operative renal failure and mortality

The presence of pre-operative renal failure is strongly associated with increased mortality, & this applies similarly to both male and female patients.

Mortality at the time of discharge after isolated CABG surgery broken down by the presence / absence of pre-operative renal failure; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Renal failure	No	105,371	1,934	311	1.8%	(1.7-1.-9%)
	Yes	885	89	3	9.1%	(7.4-11.2%)
	Unspecified	107,889	2,885	1,157		
	All	**214,145**	**4,908**	**1,471**		



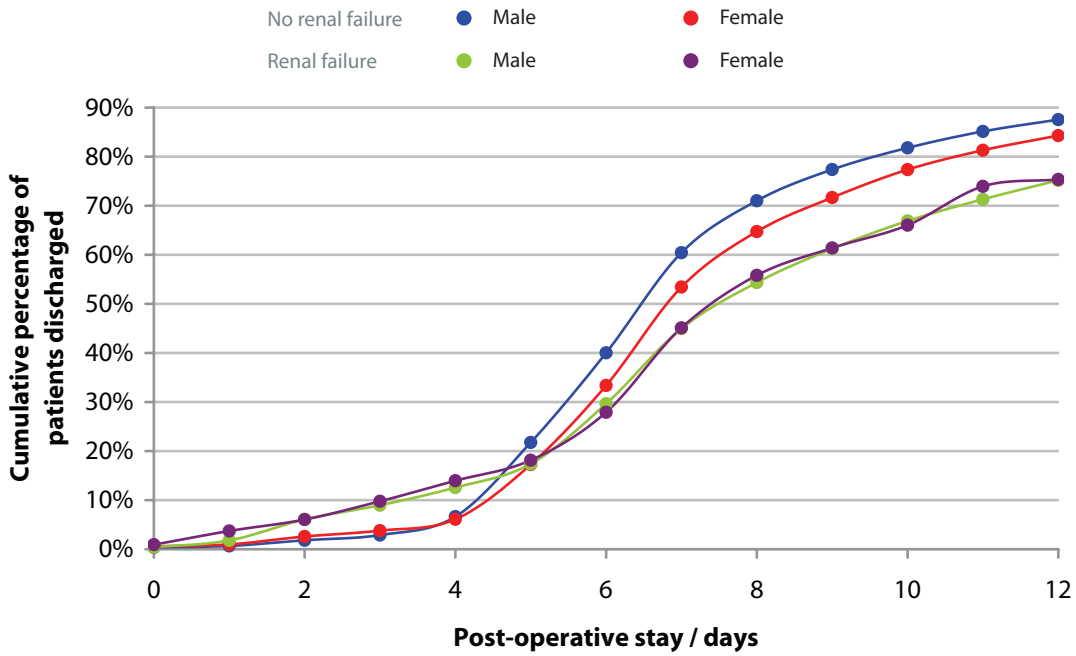
Pre-operative renal failure and post-operative stay

Pre-operative renal failure is associated with a substantial increased average length-of-stay of 2.5 days (p<0.001).

Post-operative stay after isolated CABG surgery broken down by the presence / absence of pre-operative renal failure; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Renal failure	No	105,243	7.0	9.2	0.03
	Yes	940	8.0	11.7	0.42
	Unspecified	101,973	9.0	10.8	0.03
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: Post-operative stay, gender and renal failure; calendar years 2006-2008 (n=106,176)



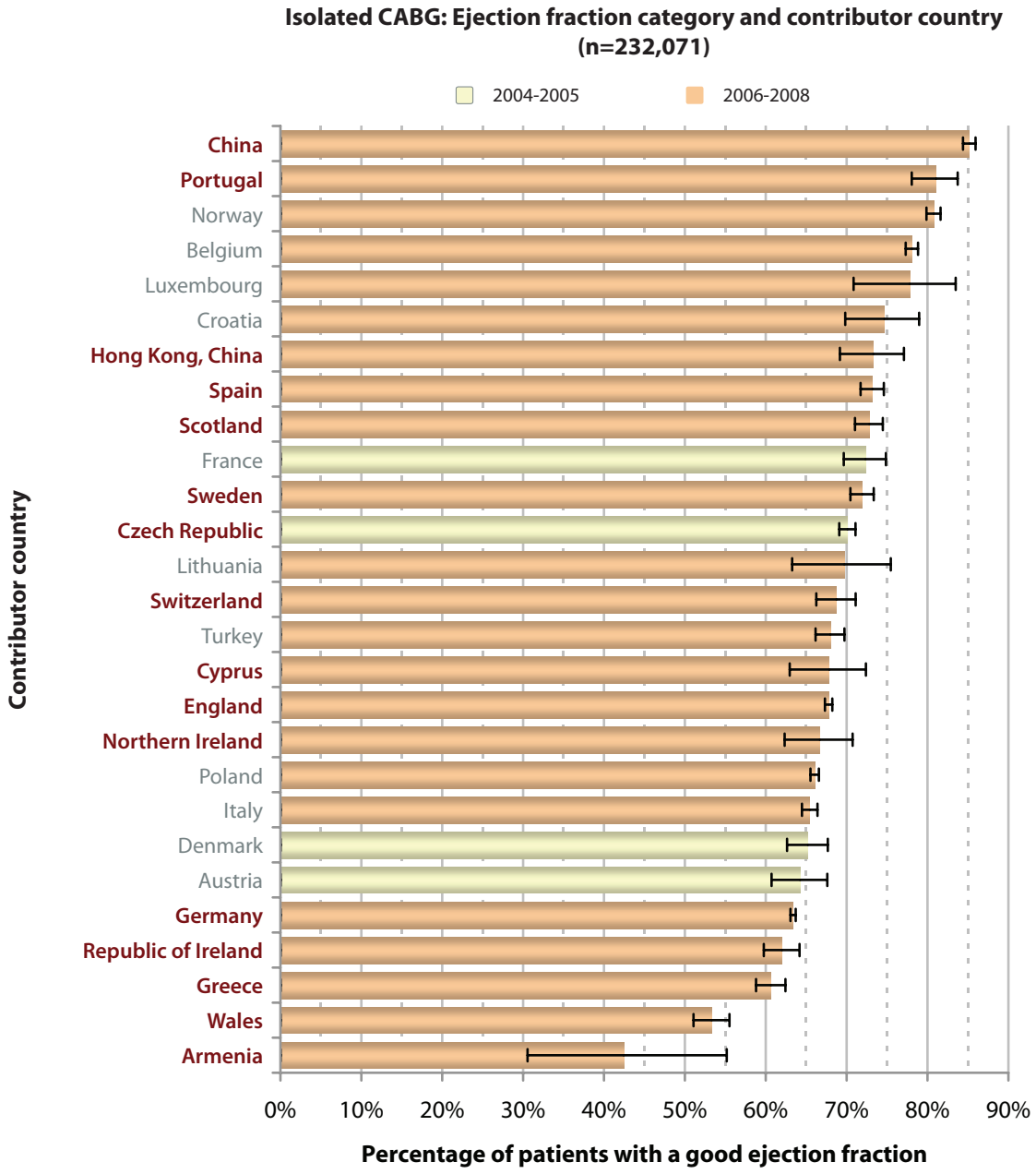
Ejection fraction category

Ejection fraction category distributions

Ejection fraction category and contributor country

The reported range in the proportion of patients with good ejection fraction is from 42.4% up to 85.2%. These are large and important differences as impaired left ventricular function is associated with both higher post-operative mortality and worse longer-term survival.

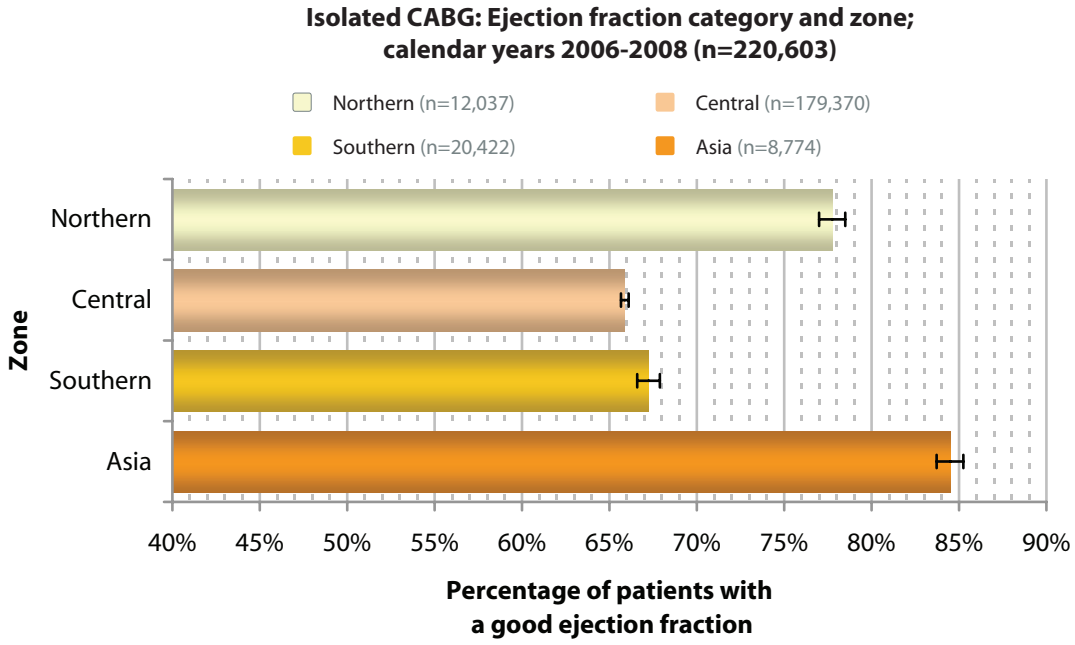
The countries at the extremes of this range all have a >90% rate of completeness for this variable.

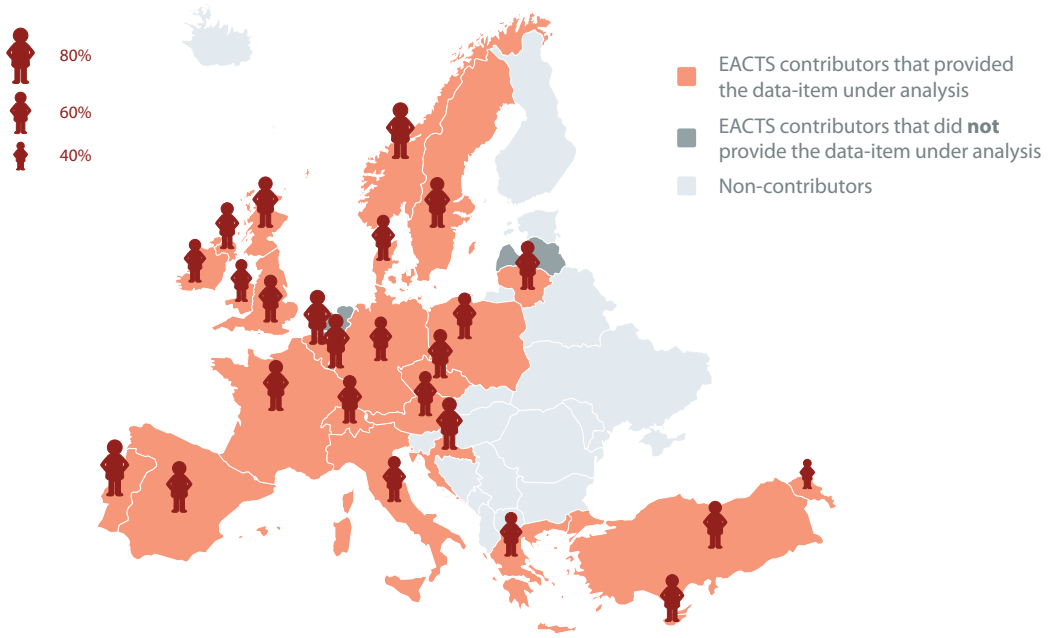


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Ejection fraction category and zone

There is variation in the proportion of patients with good ejection fraction across the geographical zones from 65.9% in Central Europe up to 84.5% in Asia.



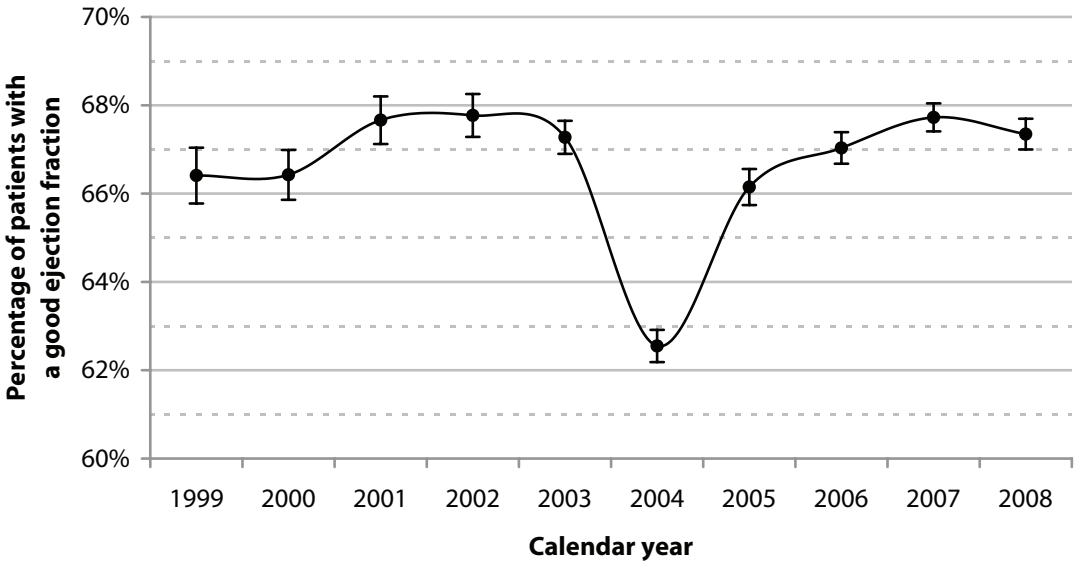


The sizes of the patient icons represent the relative proportions of patients with a good ejection fraction in the contributor countries that supplied these data.

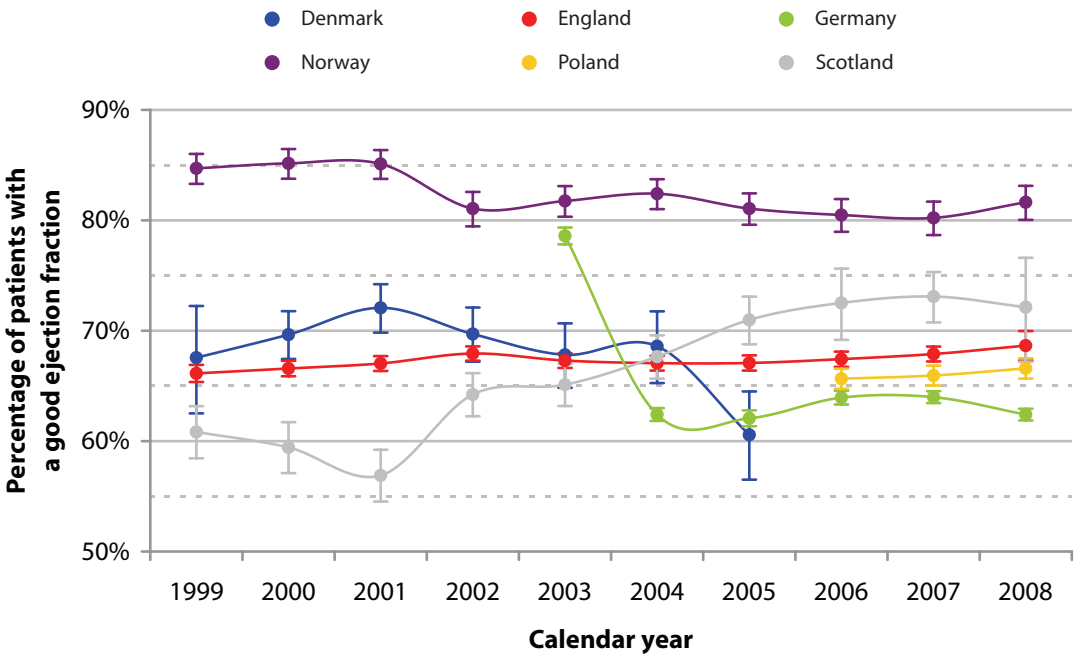
Trends in ejection fraction category distributions

There is no real demonstrable trend in ejection fraction over time, either across the database as a whole or for the major contributing countries.

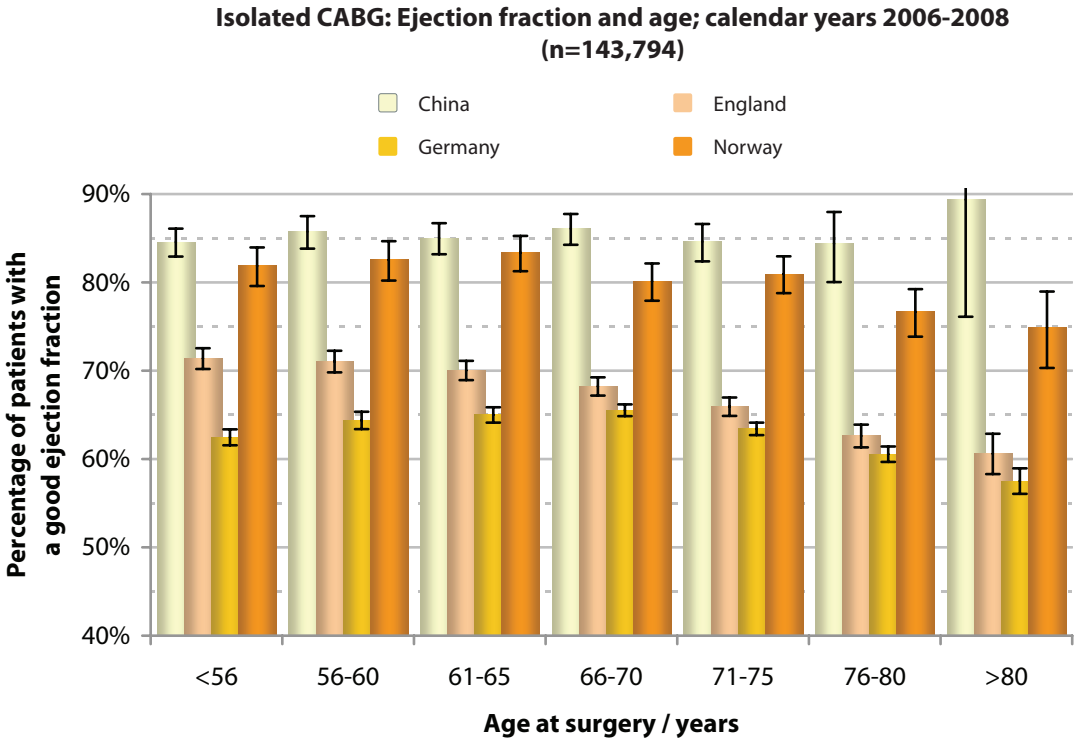
Isolated CABG: Trends in ejection fraction category distributions (n=513,926)



Isolated CABG: Trends in ejection fraction category distributions; selected contributor countries (n=395,101)



Ejection fraction and age



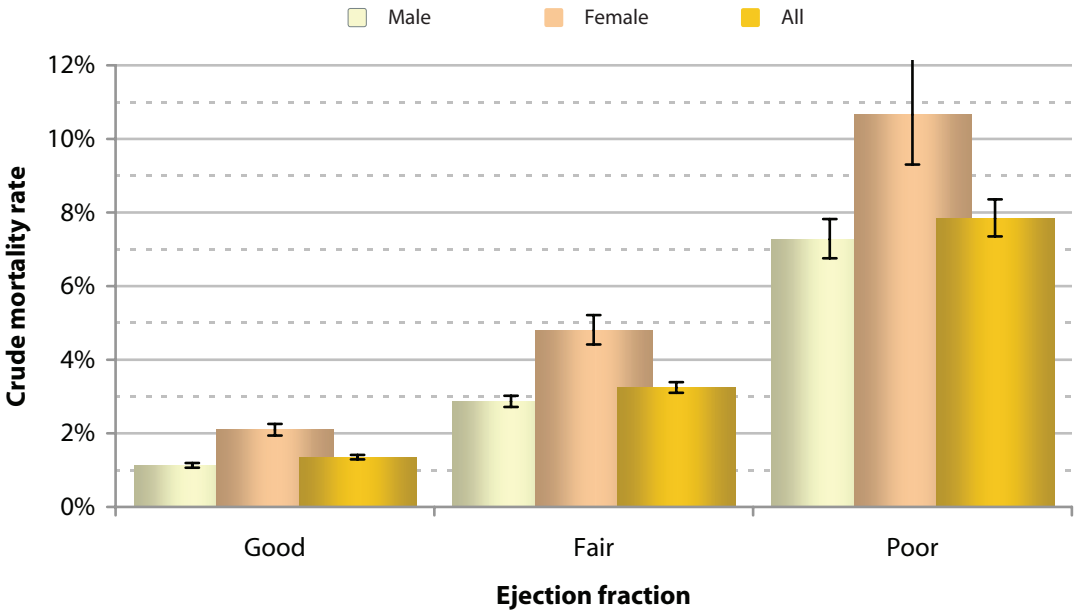
Ejection fraction category and mortality

Impaired ejection fraction is strongly associated with increased mortality, with a crude rate of 3.2% for those with moderate and 7.8% for those with poor ejection fraction ($p<0.001$). The influence of ejection fraction on mortality is similar for the different sexes.

Mortality at the time of discharge after isolated CABG surgery broken down by ejection fraction category; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Ejection fraction category	Good	136,877	1,875	944	1.4%	(1.3-1.4%)
	Fair	55,921	1,874	415	3.2%	(3.1-3.4%)
	Poor	10,263	873	54	7.8%	(7.4-8.4%)
	Unspecified	11,084	286	58		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and ejection fraction category; calendar years 2006-2008 (n=207,683)



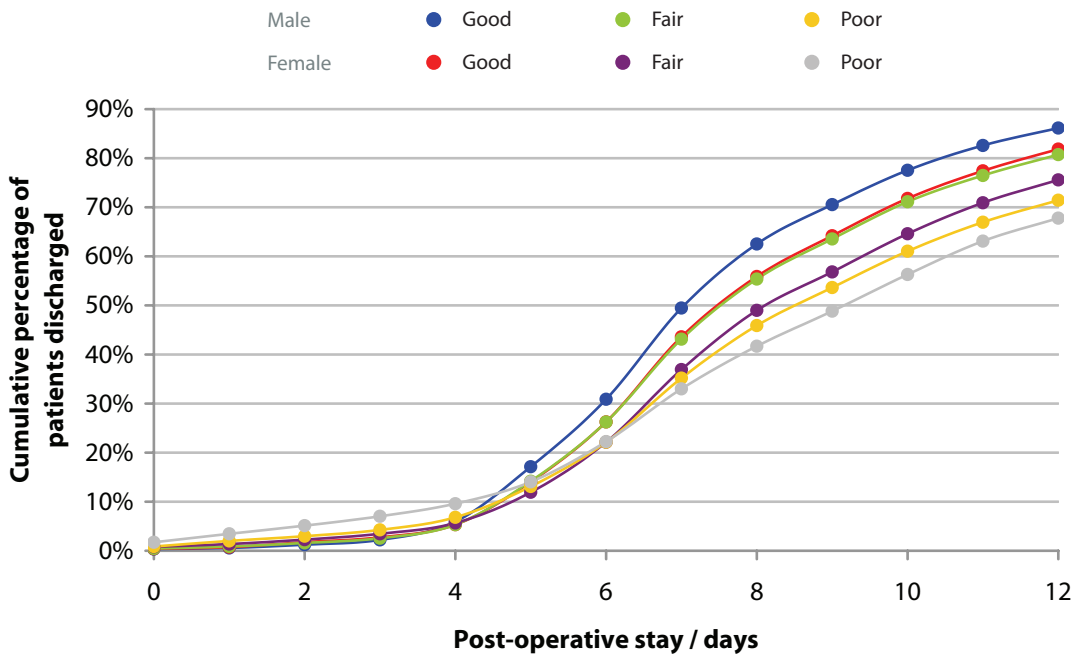
Ejection fraction category and post-operative stay

Increasingly impaired ejection fraction is associated with increasing length-of-stay ($p<0.001$). Patients with poor left ventricular function have an average length-of-stay almost 3 days longer than those with normal ejection fraction.

Post-operative stay after isolated CABG surgery broken down by ejection fraction category; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Ejection fraction category	Good	131,148	8.0	9.6	0.03
	Fair	55,982	8.0	10.7	0.05
	Poor	10,854	9.0	12.4	0.13
	Unspecified	10,172	8.0	9.2	0.08
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: Post-operative stay, gender and ejection fraction category; calendar years 2006-2008 (n=197,980)

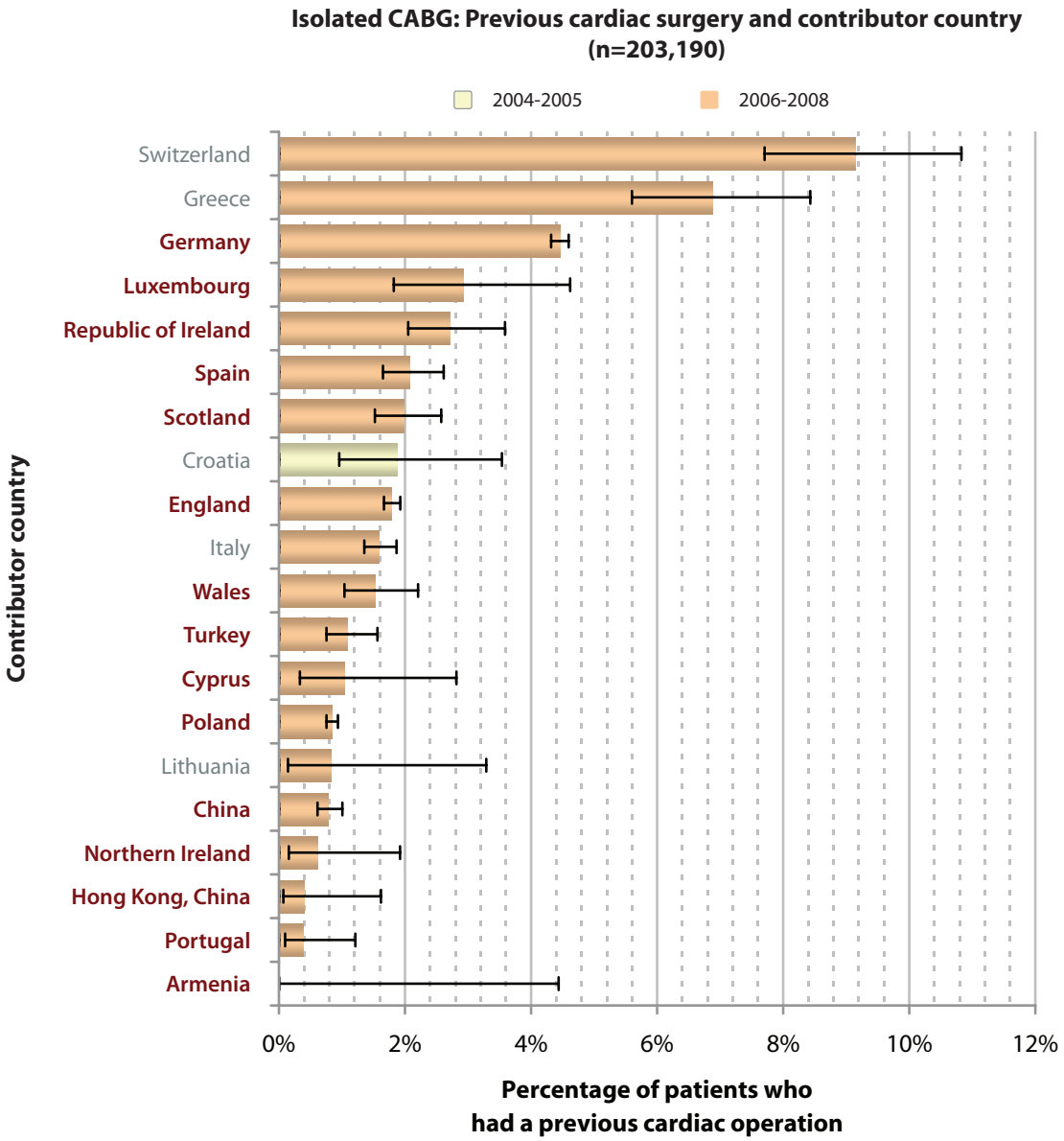


Previous cardiac surgery

Previous cardiac surgery distributions

Previous cardiac surgery and contributor country

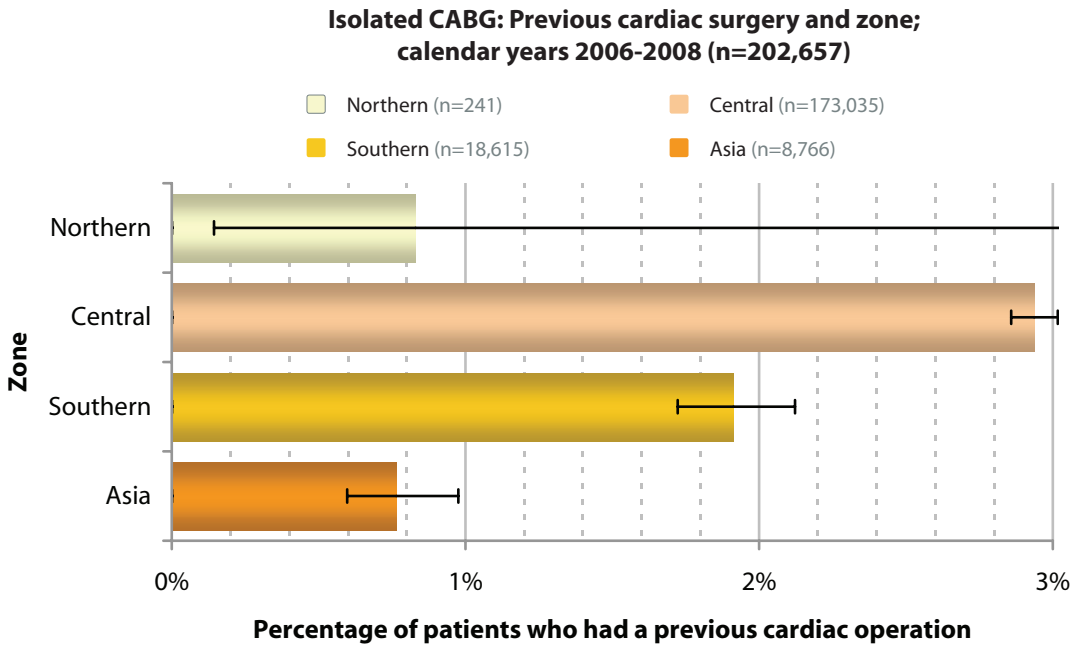
There is marked variation in the reported proportion of patients undergoing isolated CABG surgery who have had previous cardiac surgery, ranging from 0.0% up to 9.2%.

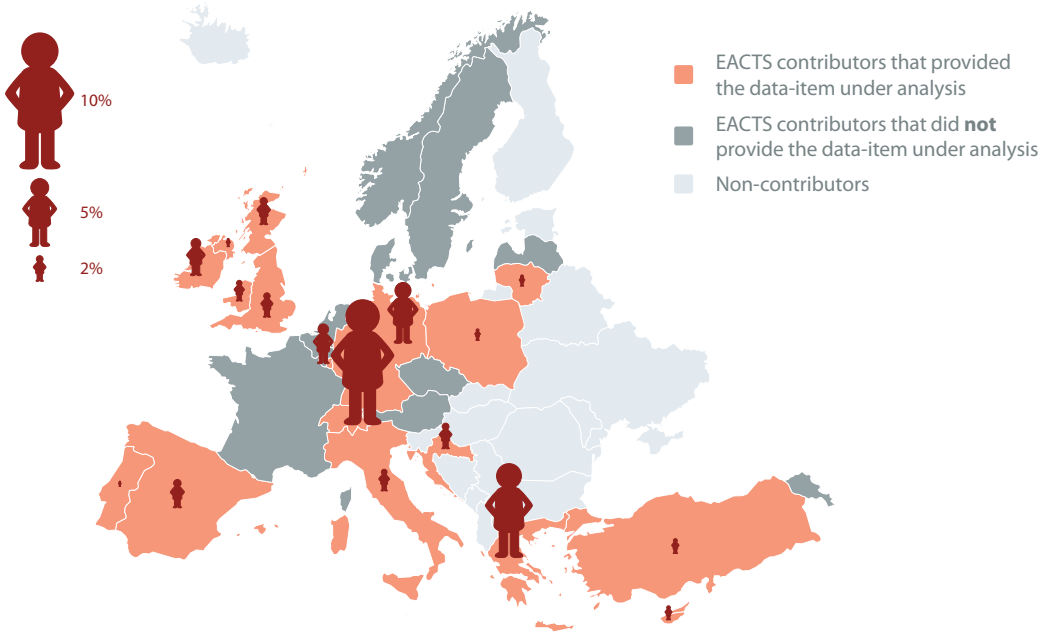


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Previous cardiac surgery and zone

There is variation in the reported incidence of previous cardiac surgery across the geographical zones from 0.8% in Asia up to 2.9% in the Central European zone.

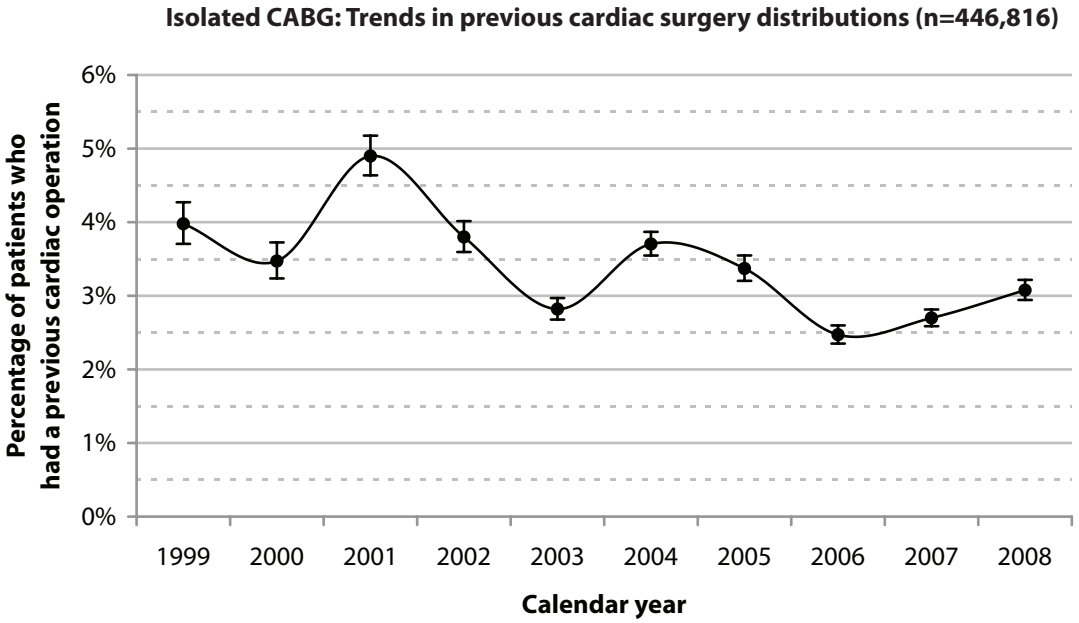


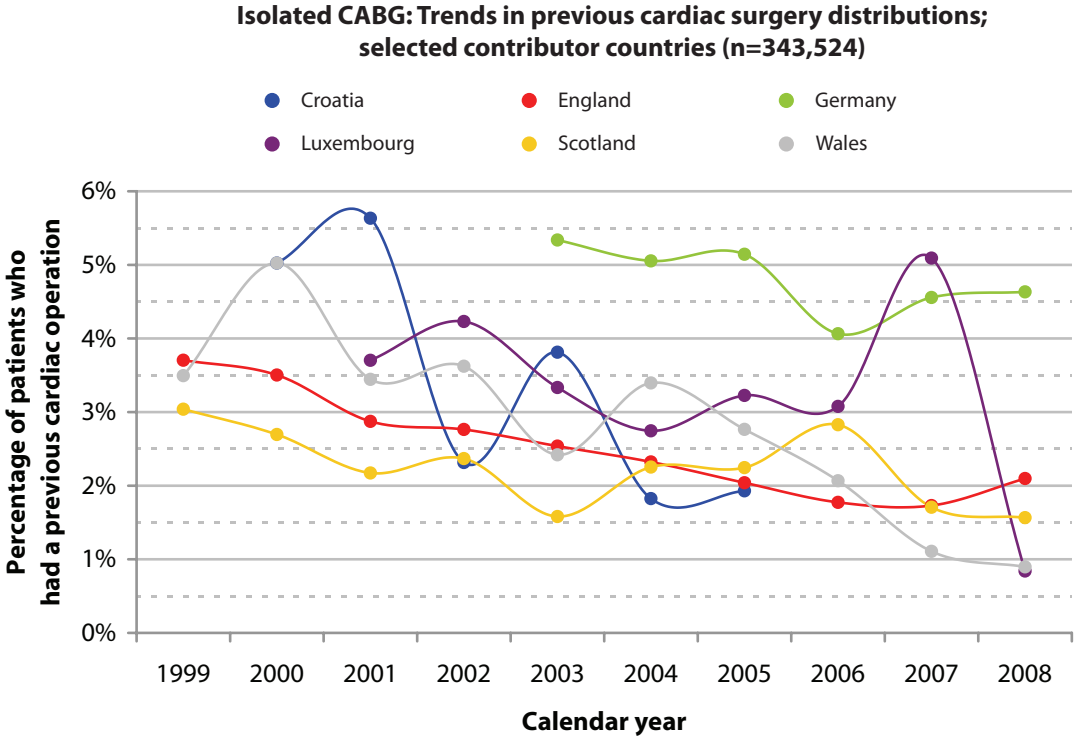


The sizes of the patient icons represent the relative proportions of patients who have had a previous cardiac operation in the contributor countries that supplied these data.

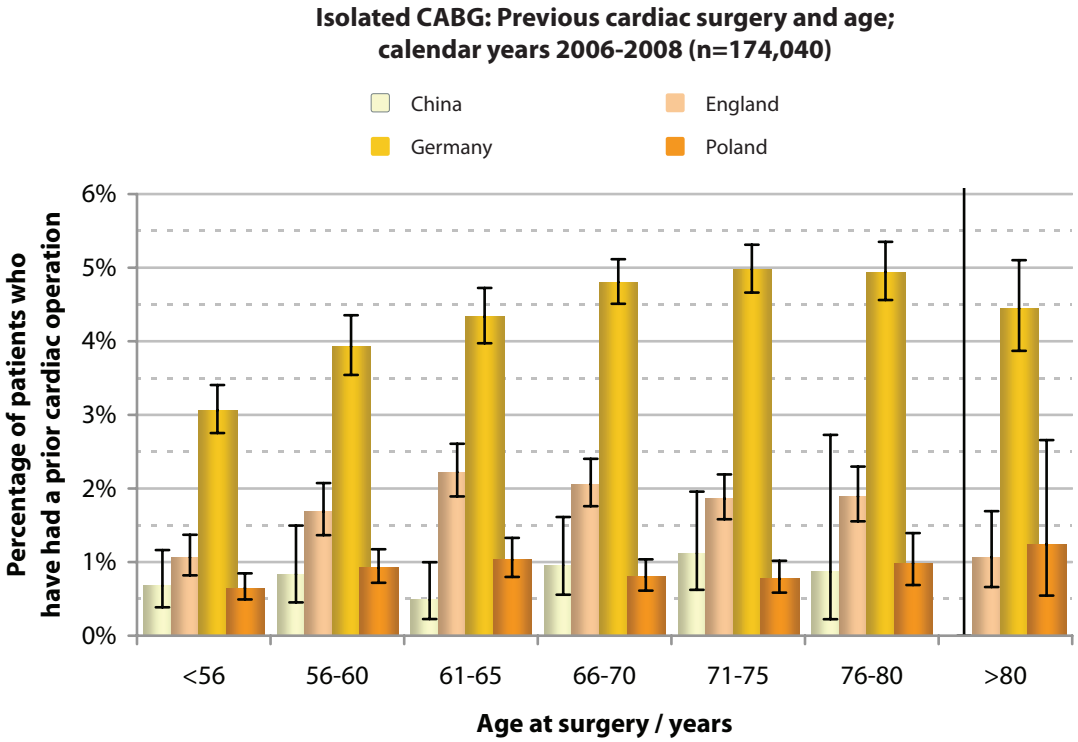
Trends in previous cardiac surgery distributions

There has been a decrease in the reported rate of previous cardiac surgery over time (<0.001). This trend is seen in most of the major contributing countries (Croatia p=0.010; England p<0.001; Germany p<0.001; Luxembourg p=0.253; Scotland p=0.017; and Wales p<0.001). This may be due to better risk-factor modification post-cardiac surgery, greater use of arterial grafts or alternative approaches to patients presenting with recurrent disease after previous coronary artery surgery.





Previous cardiac surgery and age



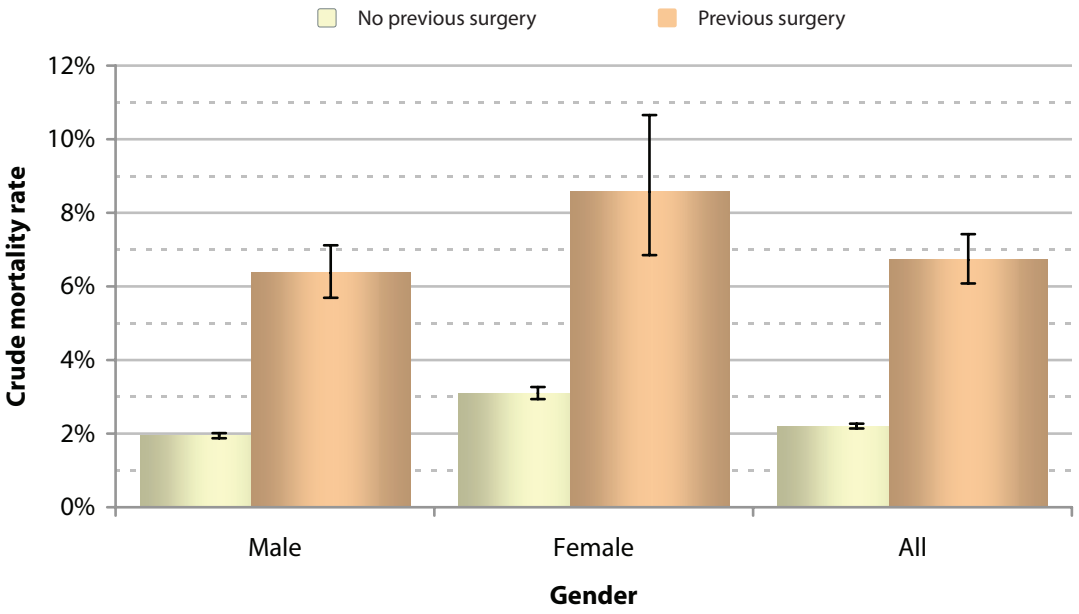
Previous cardiac surgery and mortality

Previous cardiac surgery remains an important risk factor for operative mortality.

Mortality at the time of discharge after isolated CABG surgery broken down by previous cardiac surgery; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Previous surgery	No	191,409	4,307	1,376	2.2%	(2.1-2.3%)
	Yes	5,164	372	29	6.7%	(6.1-7.4%)
	Unspecified	17,572	229	66		
	All	**214,145**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and previous cardiac surgery; calendar years 2006-2008 (n=200,892)



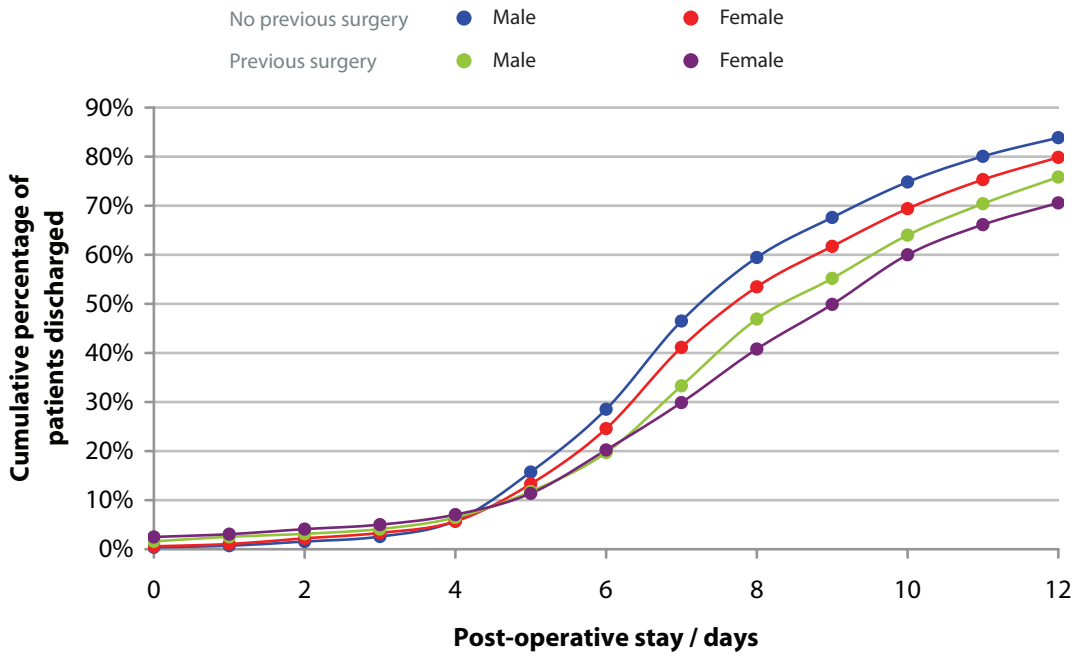
Previous cardiac surgery and post-operative stay

Previous cardiac surgery is associated with an increased length of post-operative stay ($p<0.001$).

Post-operative stay after isolated CABG surgery broken down by previous cardiac surgery; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Previous surgery	No	193,949	8.0	10.0	0.02
	Yes	5,508	9.0	11.4	0.14
	Unspecified	8,699	7.0	8.9	0.13
	All	**208,156**	**8.0**	**10.0**	**0.02**

Isolated CABG: Post-operative stay, gender and previous cardiac surgery; calendar years 2006-2008 (n=199,450)



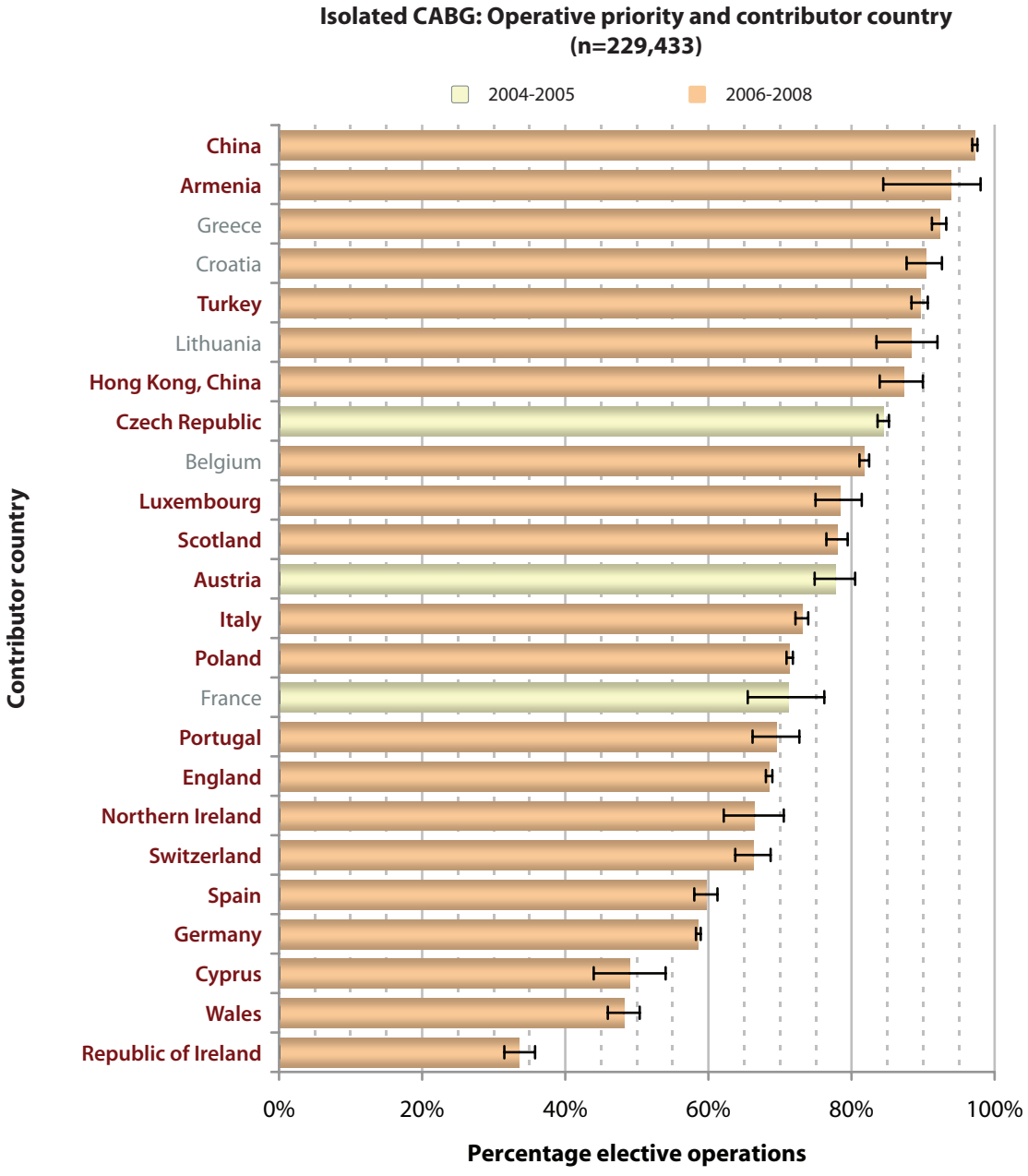
Operative priority

Operative priority distributions

Operative priority and contributor country

There is variation in the proportion of patients who undergo CABG surgery as an elective procedure (*i.e.*, the patient is admitted from home for the operation) from 33.6% up to 97.3%. This is a huge variation, which may reflect different presentations of patients with ischaemic heart disease to healthcare services (either due to the nature of the disease or structural, social and cultural aspects), the local definitions used or the way in which the disease is managed within those services (for example different approaches to routine interventional strategies for patients with acute coronary syndromes).

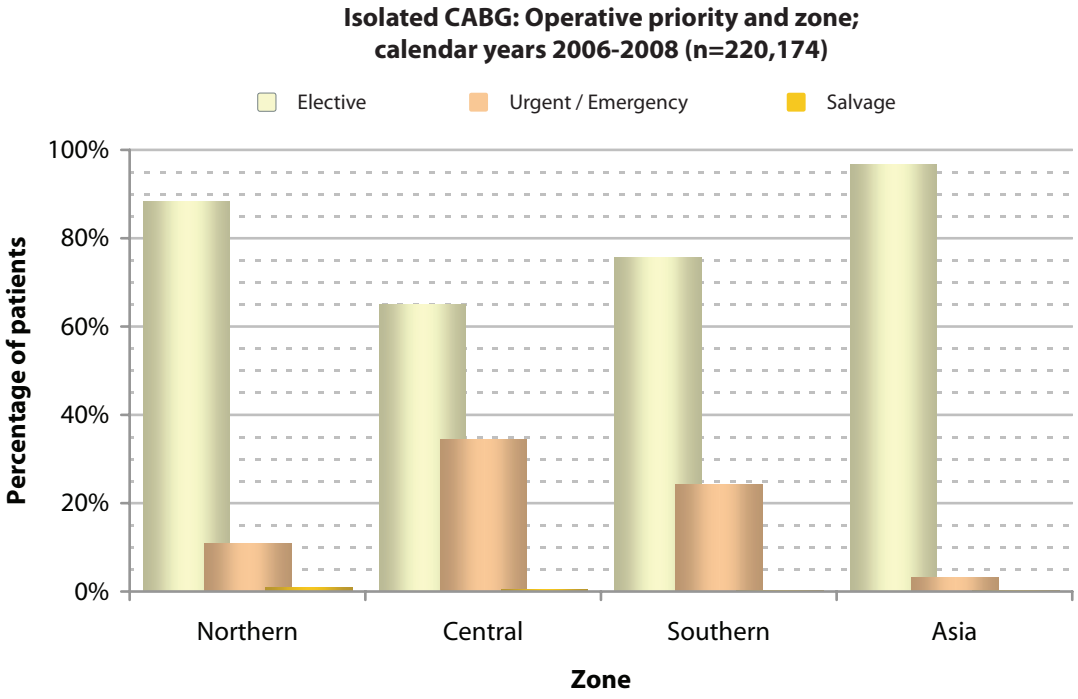
The completion rate for this variable is >90% for most countries.

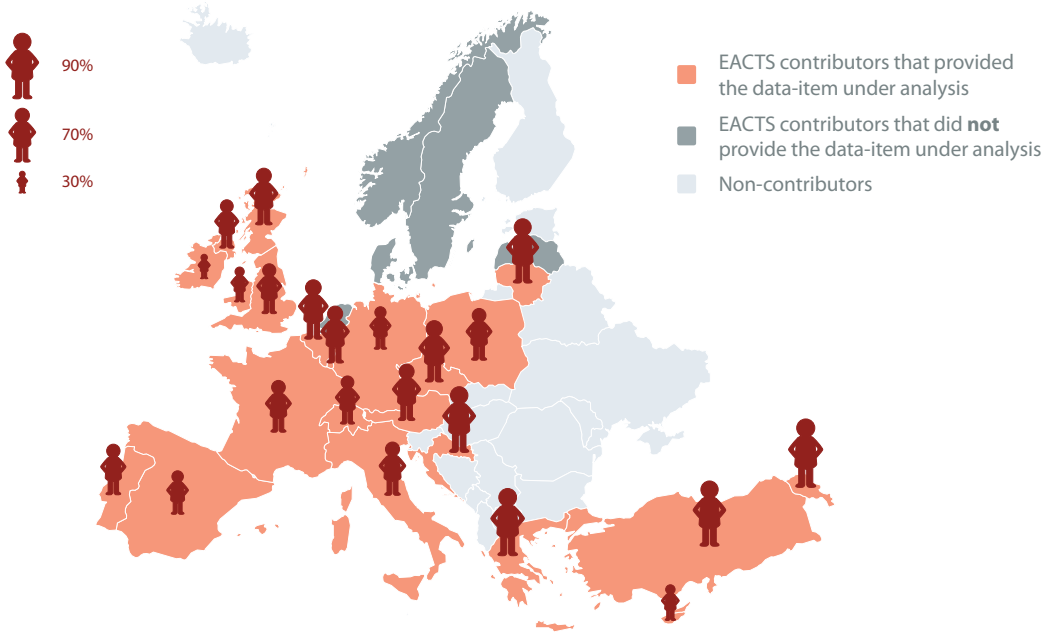


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Operative urgency and zone

There are major differences in the recorded operative urgency across the geographical zones, with the highest incidence of elective patients seen in Asia. In the Central European zone about one-third of all patients undergo surgery as an urgency / emergency, compared to less than 5% in Asia.

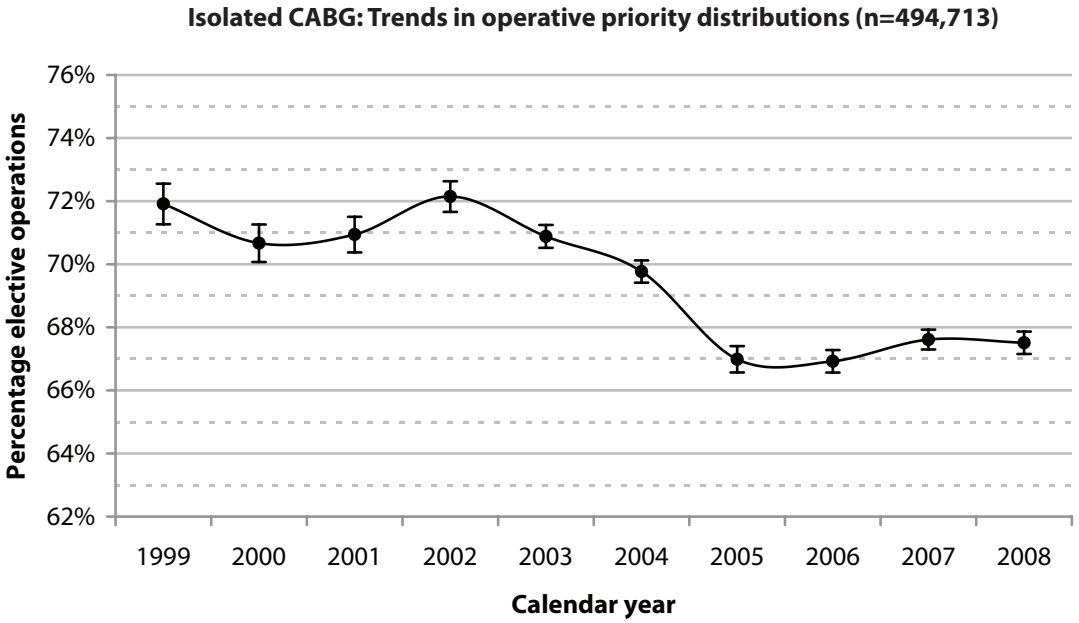




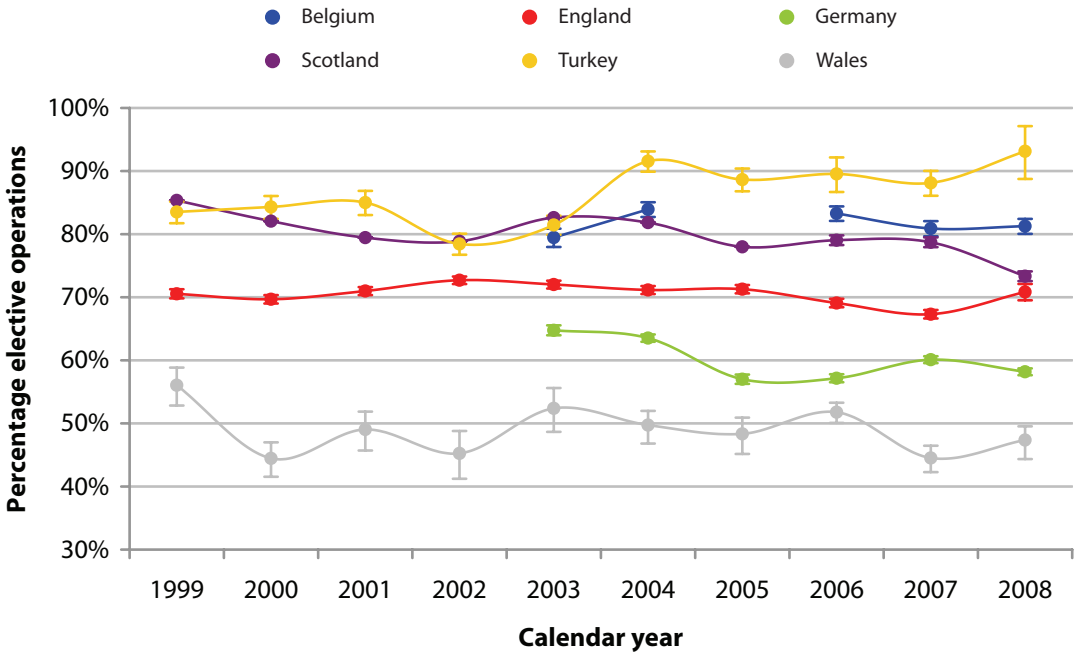
The sizes of the patient icons represent the relative proportions of patients who undergo elective surgery in the contributor countries that supplied these data.

Trends in operative priority distributions

Overall the proportion of patients undergoing elective coronary artery surgery has decreased over time, but this probably represents an effect of submissions from newly-contributing countries, as the incidence in larger contributors has been much more stable. It is important to note, however, that there are major differences in operative urgency for these countries ranging around 50% elective surgery in Wales up to 90% in Turkey.



Isolated CABG: Trends in operative priority distributions; selected contributor countries (n=411,750)



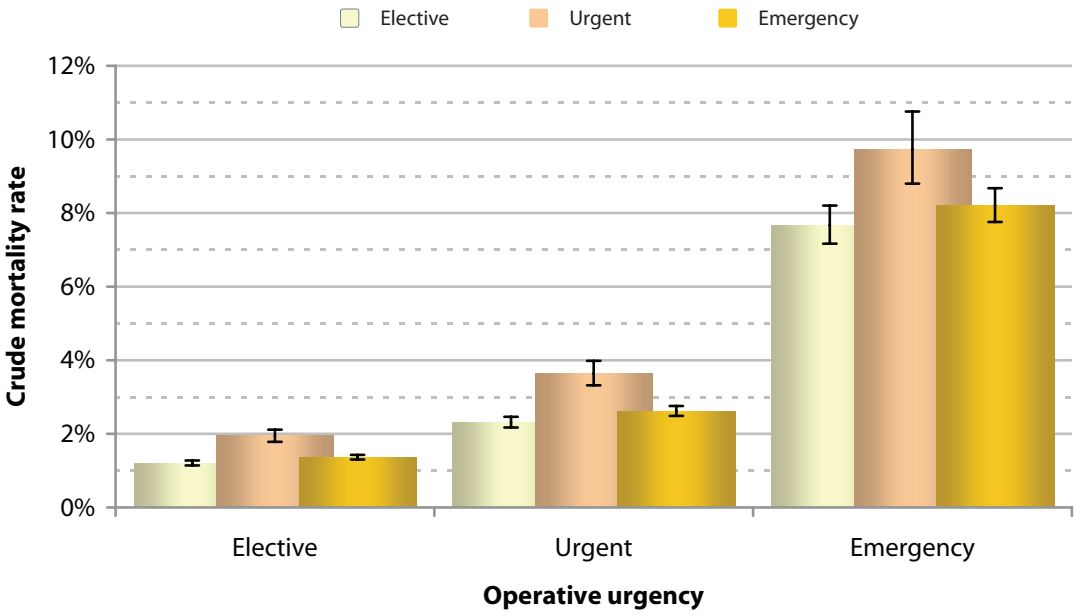
Operative priority and mortality

Operative priority is strongly associated with in-hospital mortality (elective *versus* urgent, urgent *versus* emergency and emergency *versus* salvage all comparisons p<0.001).

Mortality at the time of discharge after isolated CABG surgery broken down by operative priority; countries that submitted mortality data excluding the data from China [1]; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Operative priority	Elective	127,143	1,758	1,038	1.4%	(1.3-1.4%)
	Urgent	52,765	1,419	357	2.6%	(2.5-2.8%)
	Emergency	12,832	1,147	44	8.2%	(7.8-8.7%)
	Salvage	436	309	3	41.5%	(37.9-45.1%)
	Unspecified	12,869	103	29		
	All	**206,045**	**4,736**	**1,471**		

Isolated CABG: Crude mortality rate, gender and operative priority; calendar years 2006-2008 (n=197,064)



1 The data from China were excluded from these analyses as their data were classified as *Elective*, *Urgent/emergency* and *Salvage*. Their inclusion would have meant that the *Urgent* and *Emergency* classes would have had to have been merged, and much of the power of this story would have been lost. The Chinese *Elective* and *Salvage* data were excluded in order to avoid and skewing of the results for these two sub-divisions of the urgency data field due to any putative Country-effect.

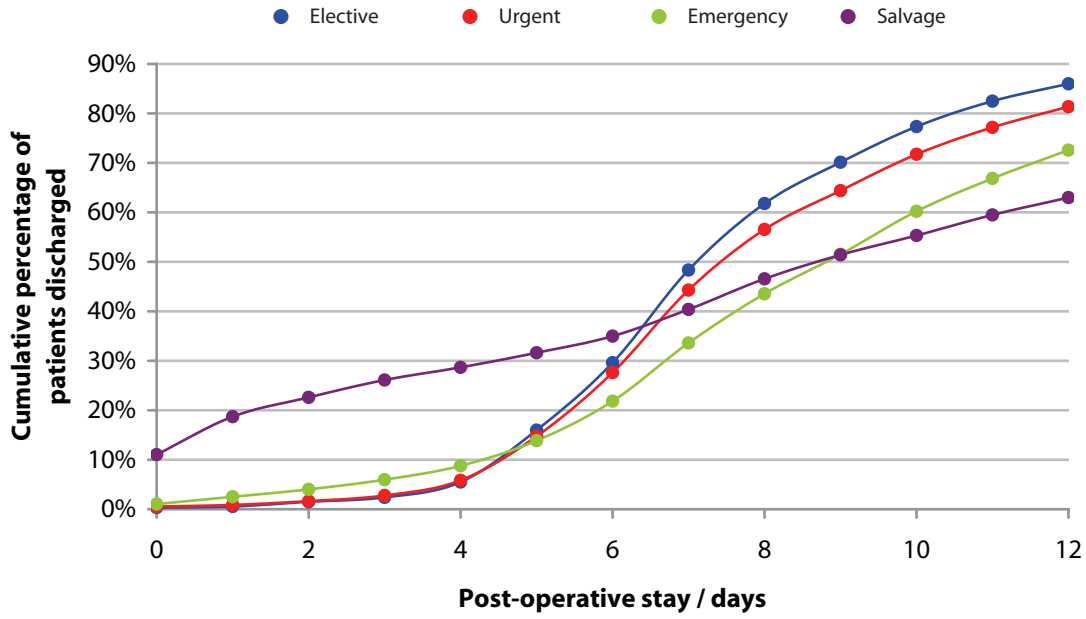
Operative priority and post-operative stay

Length-of-stay is strongly associated with operative priority, with salvage patients staying on average 4 days longer than elective cases ($p<0.001$).

Post-operative stay after isolated CABG surgery broken down by operative priority, excluding data from China; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Operative priority	Elective	127,554	8.0	9.5	0.03
	Urgent	53,775	8.0	10.3	0.05
	Emergency	13,903	9.0	12.0	0.10
	Salvage	743	9.0	13.5	0.72
	Unspecified	3,915	6.0	7.4	0.14
	All	**199,890**	**8.0**	**9.9**	**0.02**

Isolated CABG: Post-operative stay and operative priority; calendar years 2006-2008 (n=195,975)



Other risk factors for isolated CABG surgery

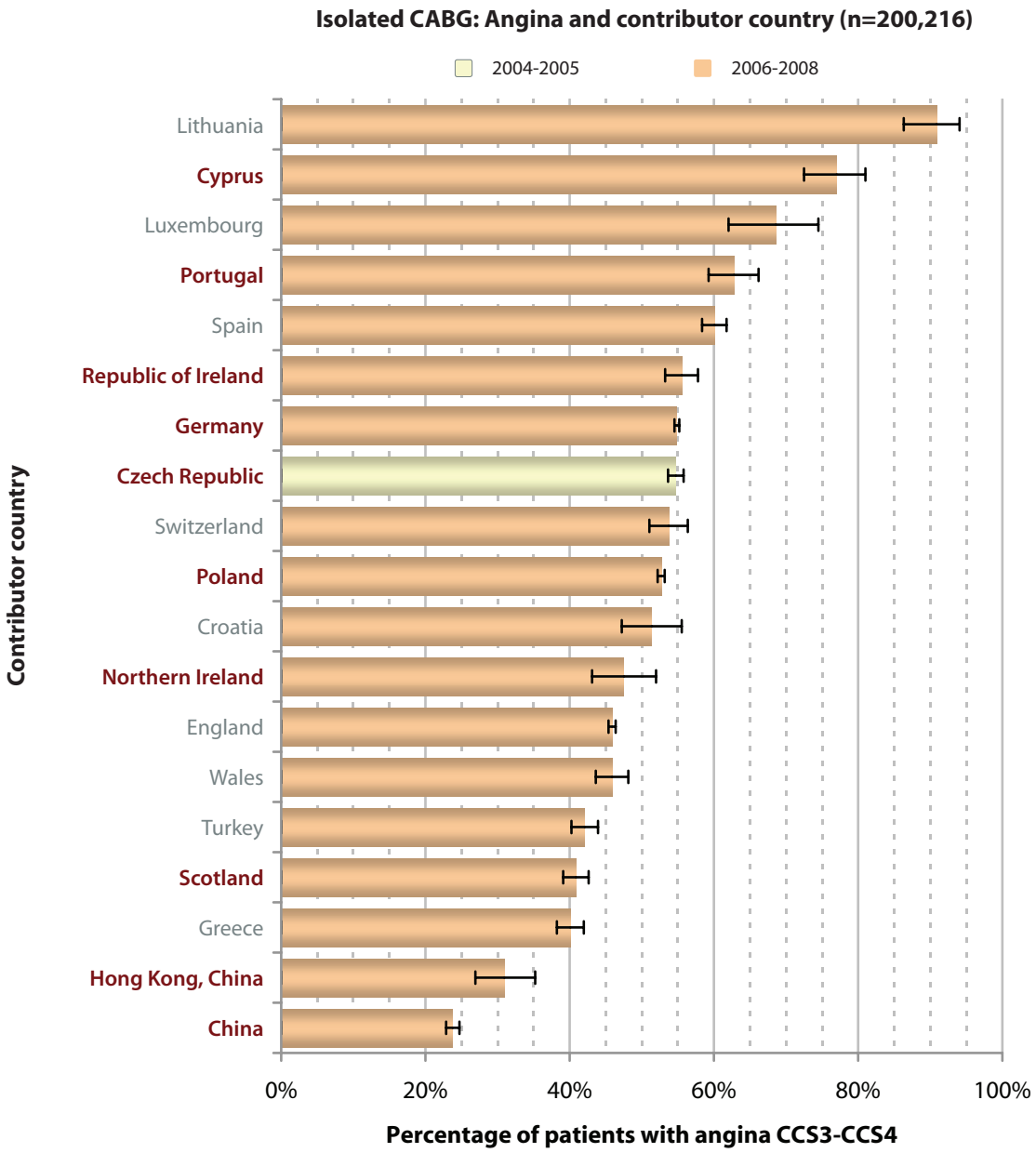
The following tables give, for completeness, the incidence of the various risk factors not reported in detail above. The overall incidence of these factors and their variation across the contributing countries and European zones are presented.

Distributions, mortality and post-operative stay for other major risk factors not reported in detail; calendar years 2006-2008

			Counts by zone	
			Northern	Central
Risk factor	Angina	CCS 0	12	16,370
		CCS 1	1	11,286
		CCS 2	9	55,145
		CCS 3	143	66,641
		CCS 4	76	22,923
		Unspecified	12,680	24,004
	Dyspnoea	NYHA 1	841	43,740
		NYHA 2	2,368	58,135
		NYHA 3	4,275	45,585
		NYHA 4	1,474	8,889
		Unspecified	3,963	39,840
	Hypertension	No	44	22,628
		Yes	97	68,594
		Unspecified	12,680	105,147
	Left main stem disease	No	6,134	119,087
		Yes	2,387	50,470
		Unspecified	4,400	26,812

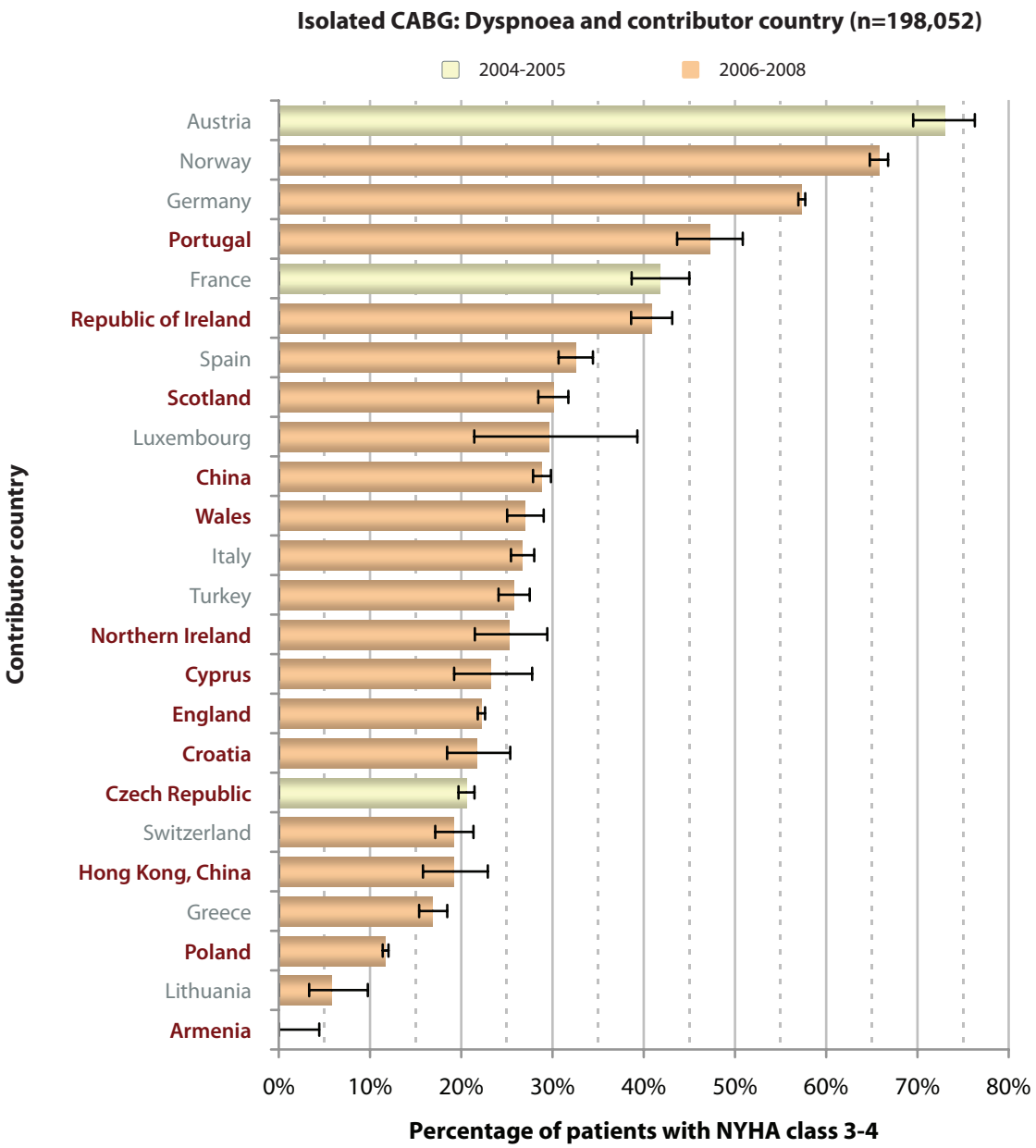
Counts by zone			Mortality rate	Post-operative stay
Southern	Asia	All	% (count; 95 % CI)	av. days (count; SE)
723	2,999	**20,104**	2.3% (20,089; 2.1-2.5%)	10.4 (19,954; 0.06)
807	872	**12,966**	1.2% (12,904; 1.0-1.4%)	9.5 (12,772; 0.08)
3,669	2,778	**61,601**	1.3% (61,501;1.2-1.4%)	9.3 (60,881; 0.03)
3,726	1,401	**71,911**	2.3% (71,799; 2.2-2.4%)	10.3 (70,967; 0.04)
1,575	720	**25,294**	5.9% (25,269; 5.6-6.2%)	11.6 (24,971; 0.08)
10,499	4	**47,187**		
4,147	1,399	**50,127**	1.3% (49,906; 1.2-1.4%)	8.7 (48,564; 0.04)
6,009	4,889	**71,581**	1.4% (71,013; 1.3-1.5%)	9.6 (68,016; 0.04)
3,135	2,228	**55,223**	2.7% (54,956; 2.6-2.8%)	11.0 (50,501; 0.05)
544	253	**11,160**	9.0% (11,121; 8.5-9.6%)	13.1 (9,595; 0.15)
7,164	5	**50,972**		
5,169	3,030	30,871	1.4% (30,514; 1.3-1.6%)	8.8 (30,112; 0.06)
14,107	5,744	88,642	2.0% (87,570; 1.9-2.1%)	9.4 (86,162; 0.04)
1,723	0	**119,550**		
12,635	5,970	143,826	2.0% (142,864; 1.9-2.1%)	9.9 (136,021; 0.03)
5,170	2,802	60,829	3.1% (60,395; 2.9-32%)	10.5 (57,598; 0.05)
3,194	2	**34,408**		

Angina and contributor country



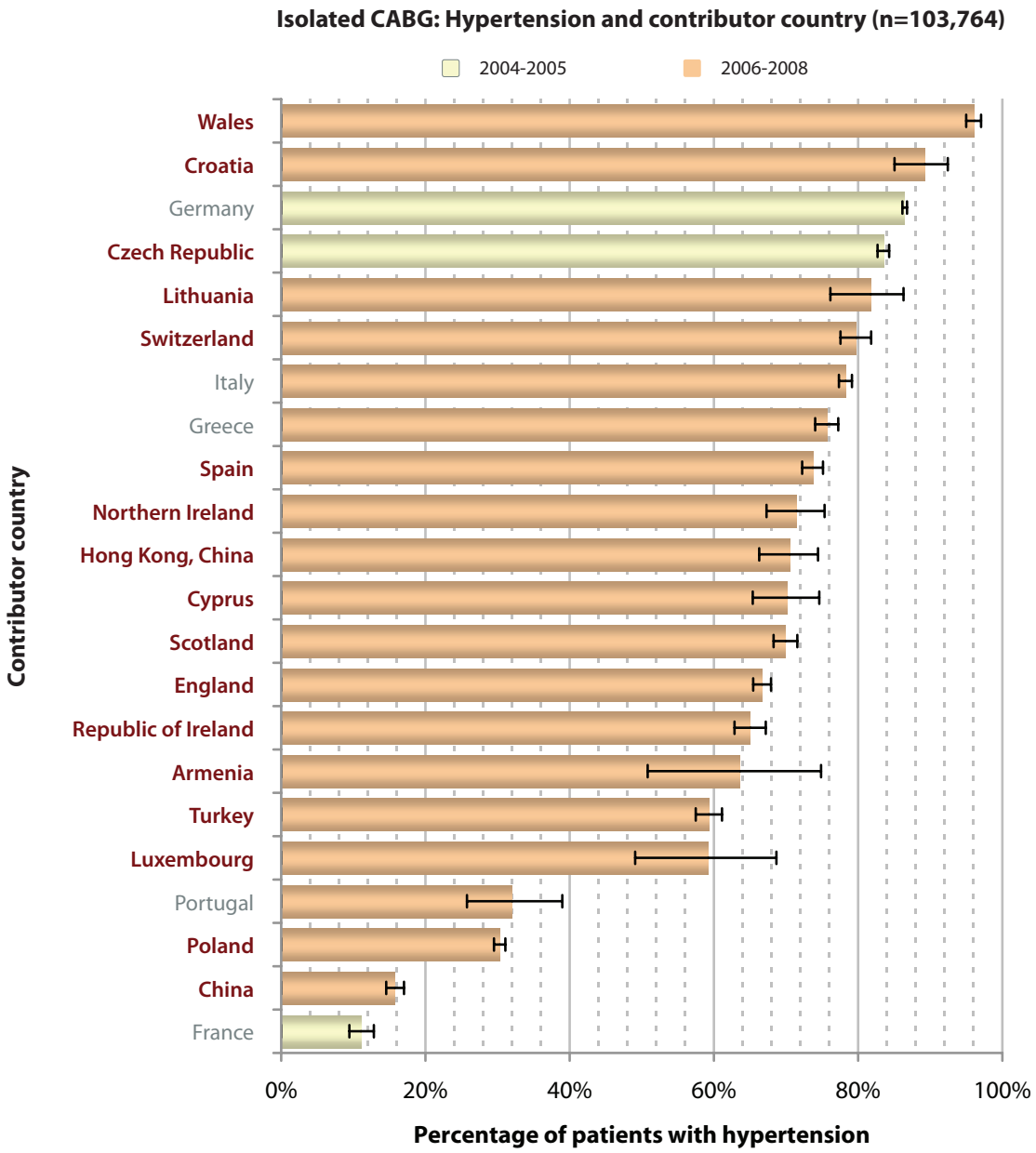
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Dyspnoea and contributor country



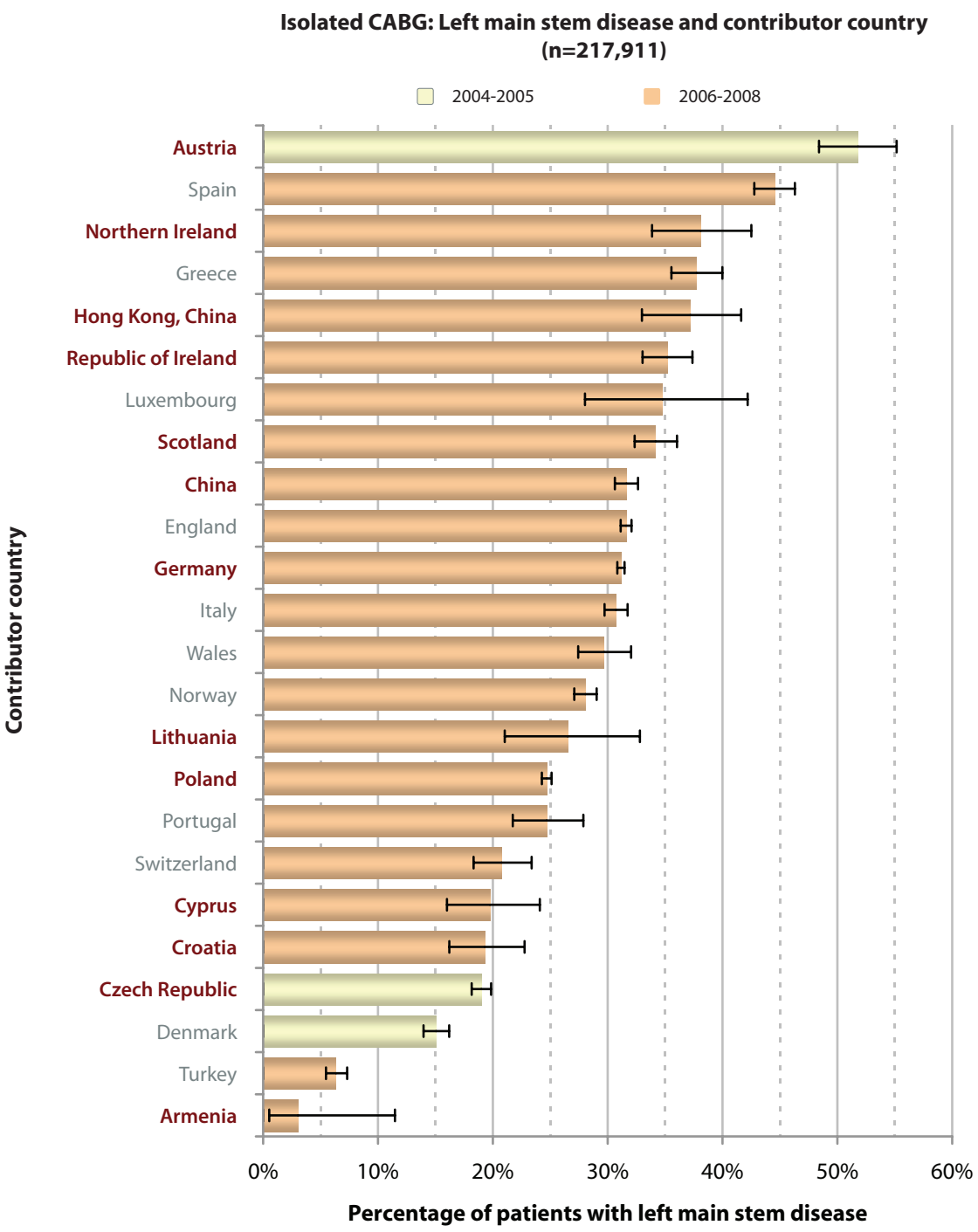
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Hypertension and contributor country



n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

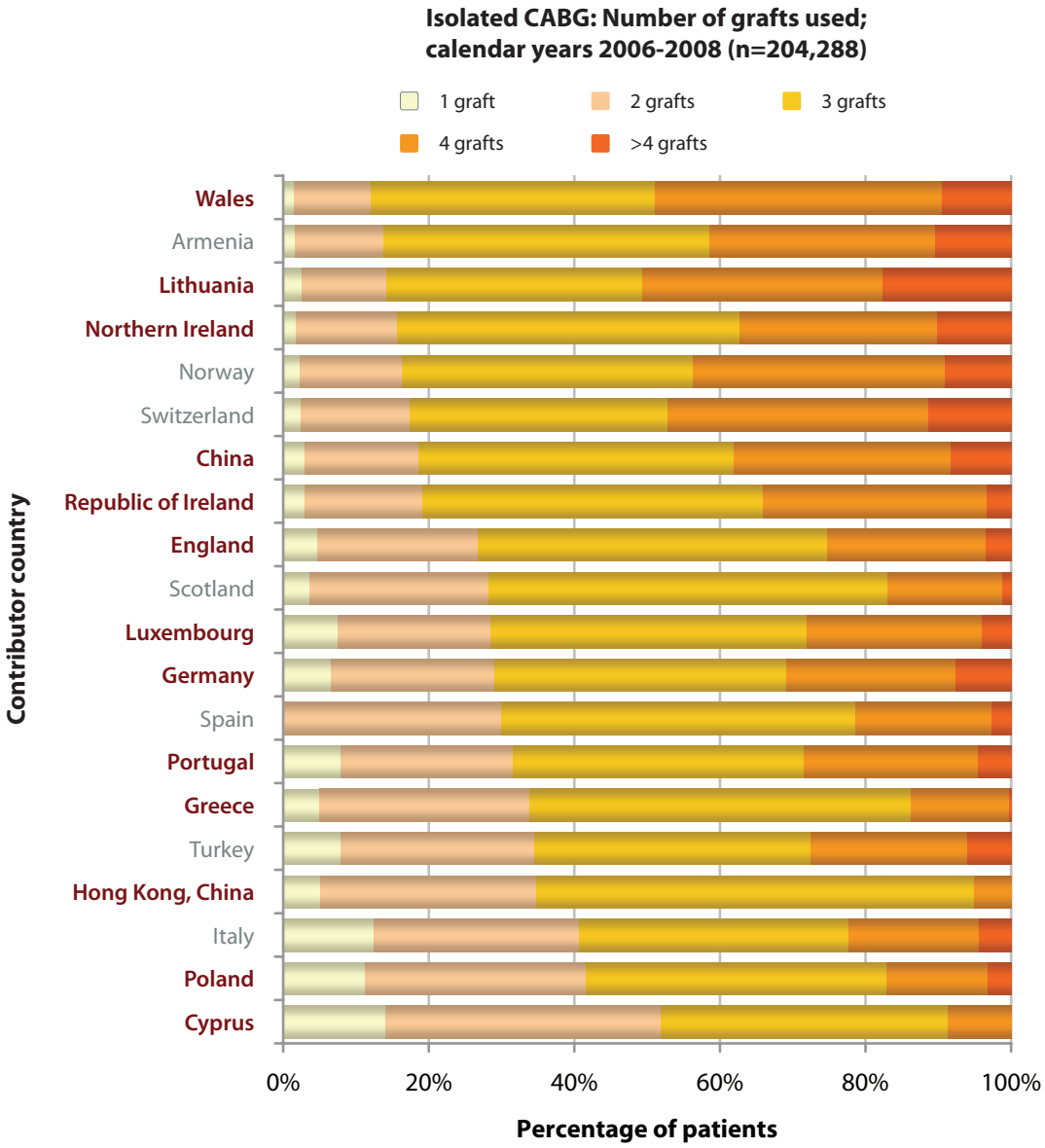
Left main stem disease and contributor country



n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

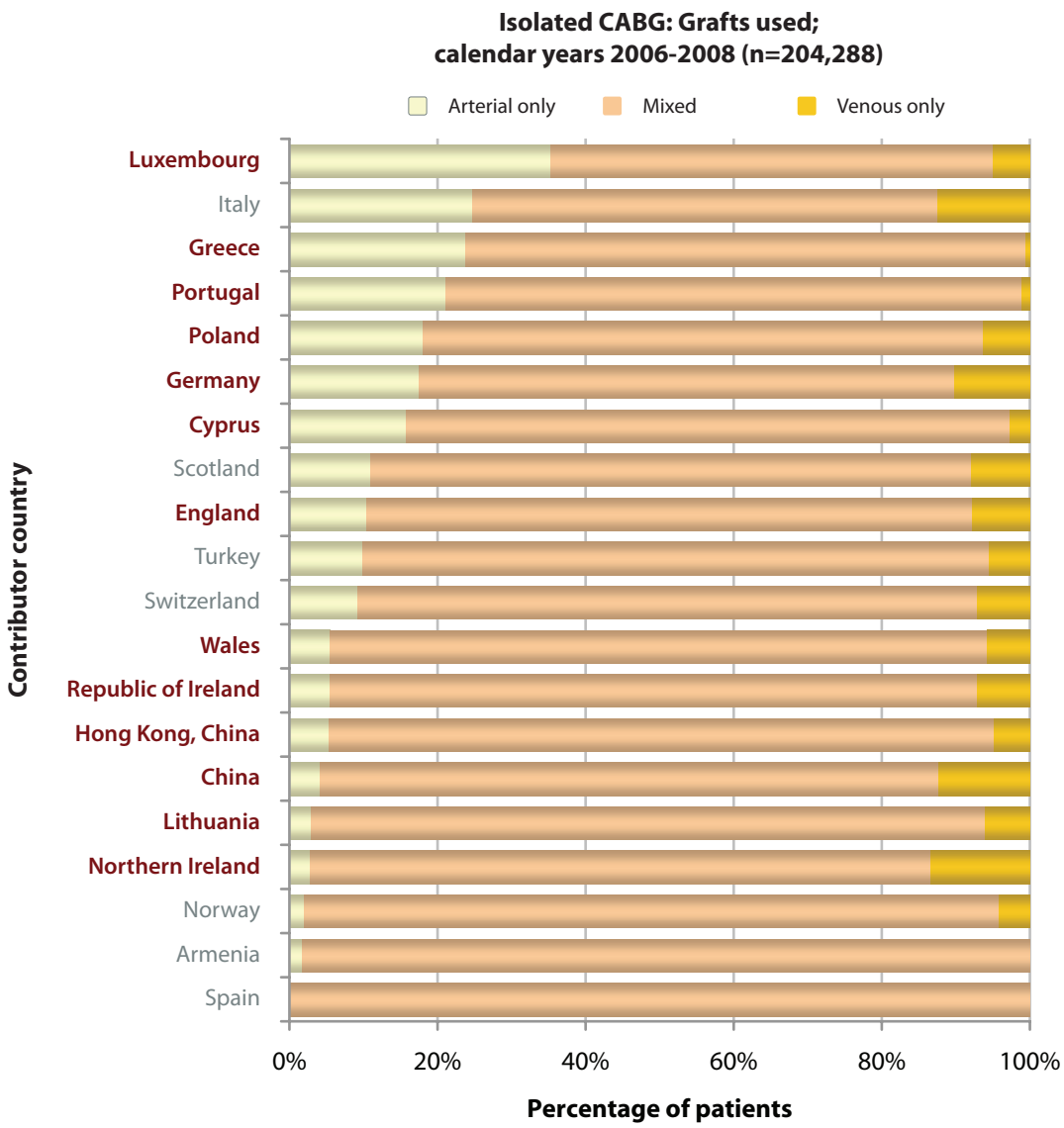
Aspects of coronary grafting

Single-graft coronary artery bypass surgery is a rarely-performed operation in contemporary practice, with a highest reported incidence of 14.1% and an average of 5.3%. The median number of grafts is 3, with differing proportions having 4 or more grafts between countries.

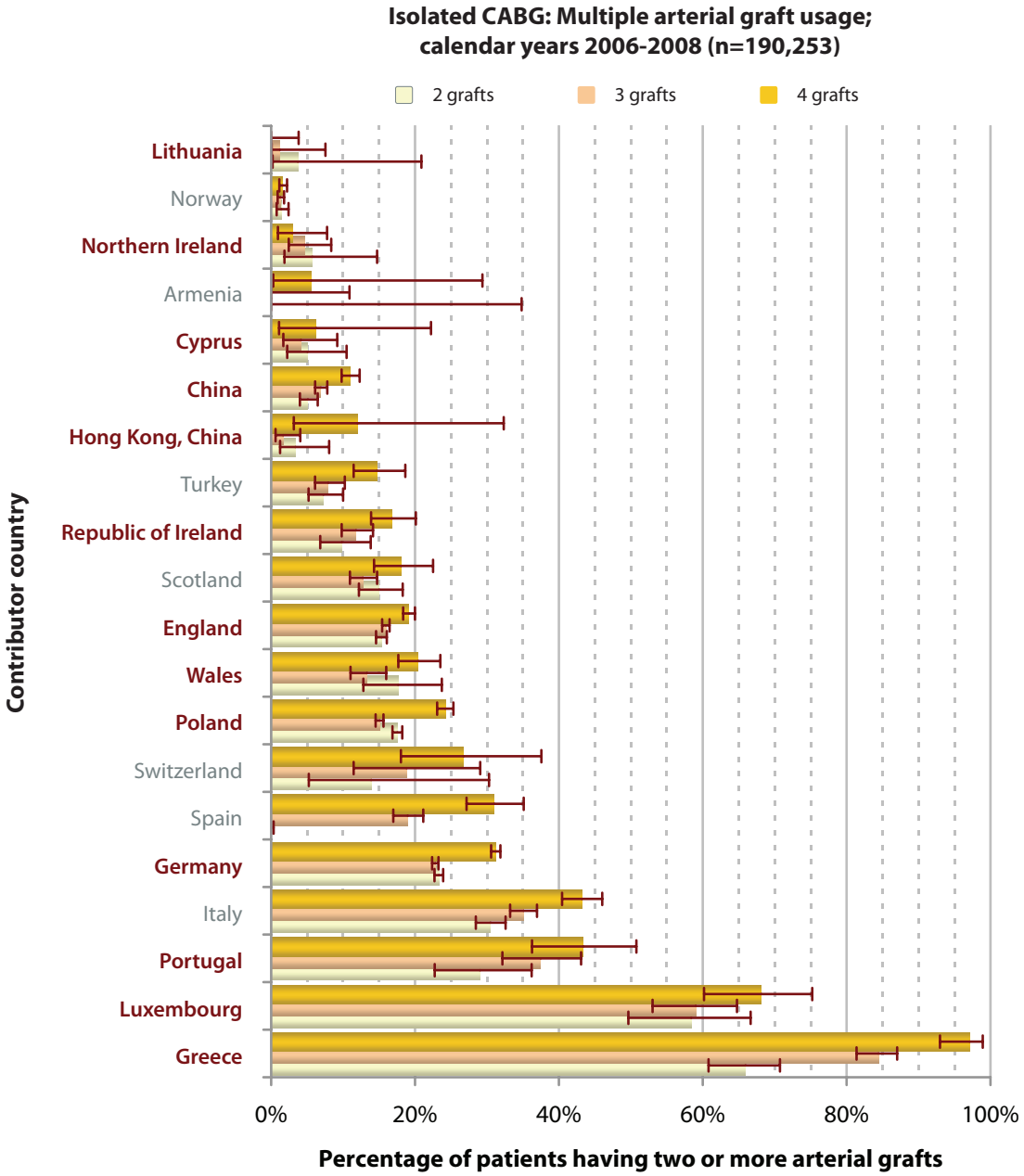


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Coronary artery surgery utilising only venous grafts is also an operation that is no longer performed frequently. The proportion of coronary surgery utilising total arterial grafts varies from a very low incidence, up to a maximum reported rate of 35.3%. The rates reported below should be seen in the context of data-quality as evidenced by the completeness rates.



n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.



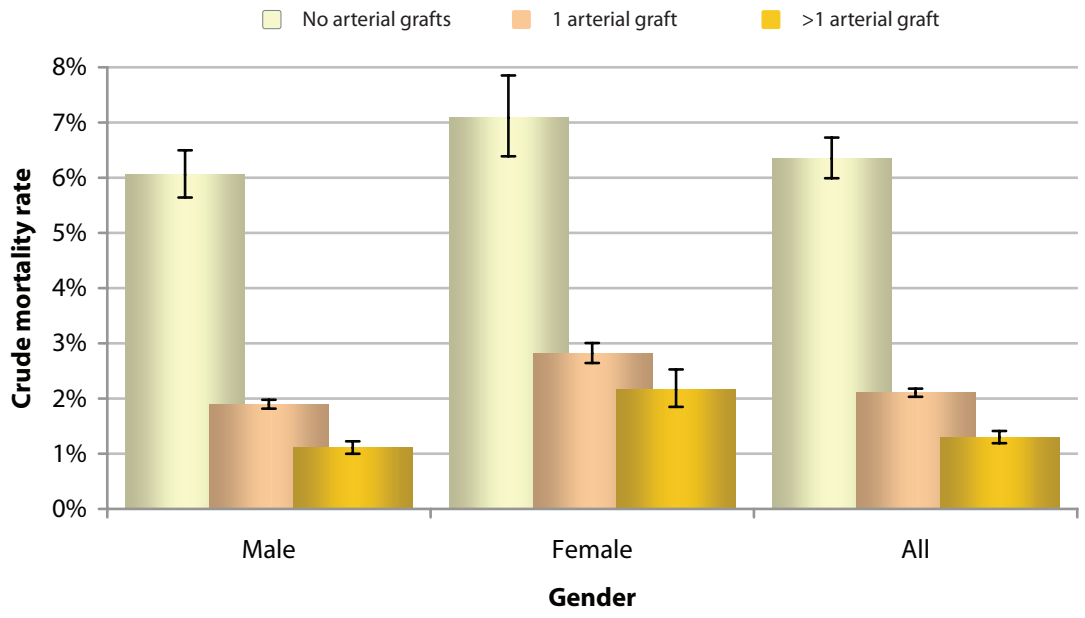
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

There is differential mortality for those patients receiving no, one and more than one arterial grafts, which almost certainly reflects casemix with the most urgent and high-risk patients receiving only venous grafts [1]. To derive a more detailed understanding of the issue from these data would require more complex analysis including the use of advanced statistical-matching techniques, which is beyond the remit of this current report.

Mortality at the time of discharge after isolated CABG surgery broken down by the number of arterial grafts used; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
Arterial grafts used	None	15,975	1,083	267	6.3%	(6.0-6.7%)
	One	141,915	3,050	730	2.1%	(2.0-2.2%)
	More than one	40,483	532	253	1.3%	(1.2-1.4%)
	Unspecified	15,772	243	221		
	All	**214,415**	**4,908**	**1,471**		

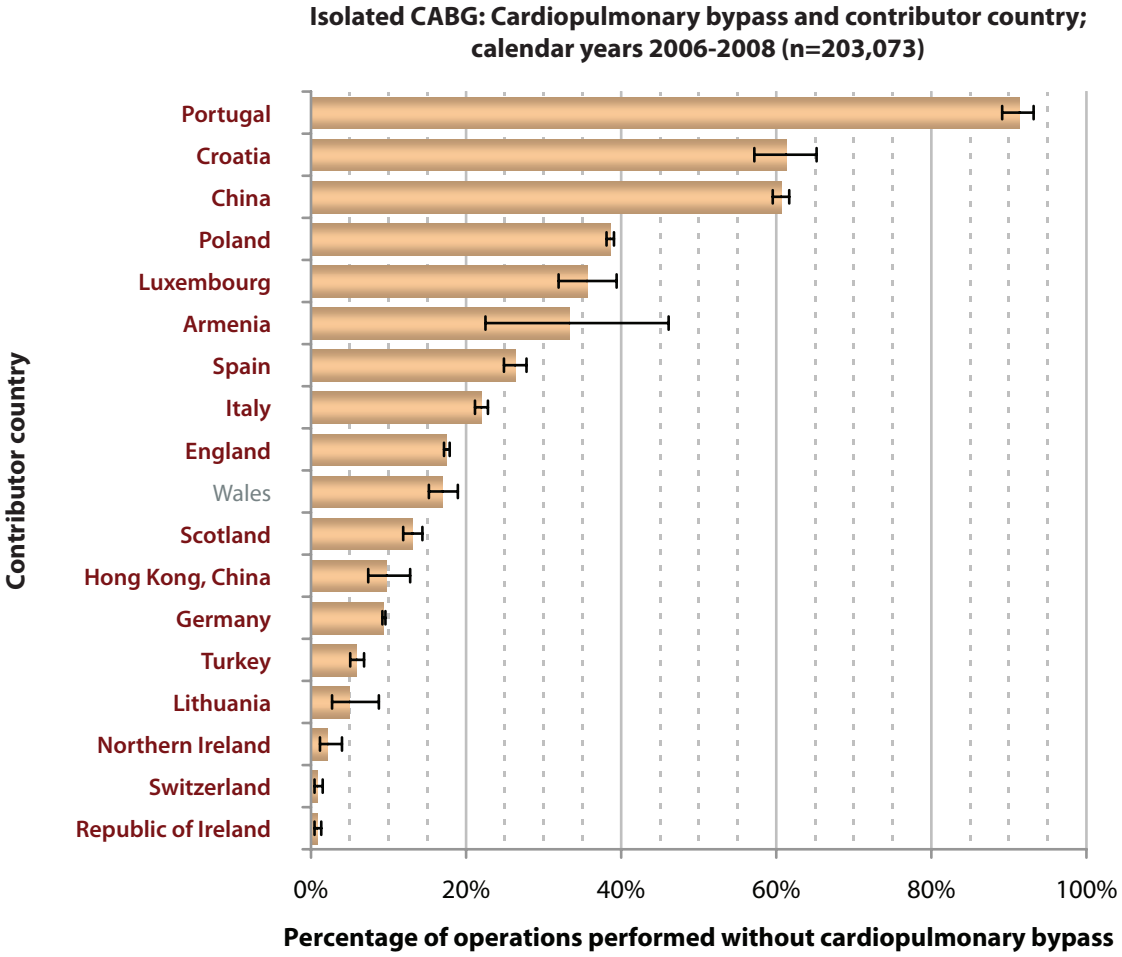
Isolated CABG: Crude mortality rate, gender and number of arterial grafts used; calendar years 2006-2008 (n=203,038)



1 Demonstrating quality: The Sixth National Adult Cardiac Surgery database report: Bridgewater B, Kinsman R, Walton P and Keogh B. Published by Dendrite Clinical Systems Ltd. Henley-on-Thames. ISBN 1-903968-23-2.

Cardiopulmonary bypass

There is an enormous variation in the proportion of patients undergoing surgery utilising off-pump techniques. Overall, 21% of those patients undergoing CABG surgery in which the technique was reported, underwent off-pump surgery. This varied between countries from 0.8% up to 91.4%.



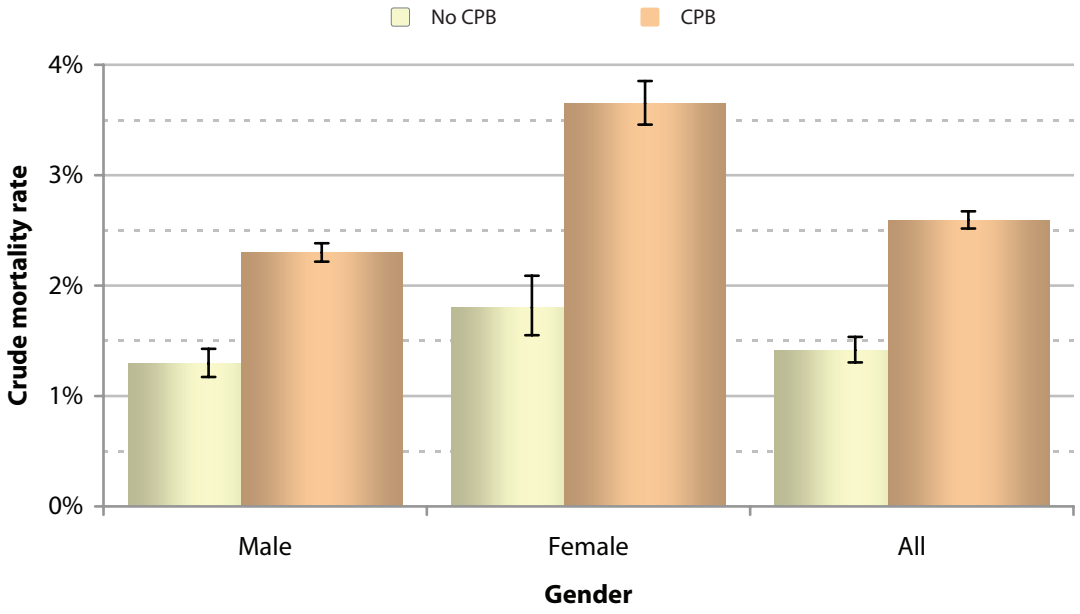
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Off-pump surgery is associated with lower mortality rates, but we know from previous large-registry studies that patients undergoing on-pump surgery are more likely to be at high risk of operative mortality [1]. A more detailed understanding of the relative risk of the two techniques would require a detailed analysis adjusting for all relevant risk factors and utilising complex statistical matching techniques.

Mortality at the time of discharge after isolated CABG surgery broken down by the use of cardio-pulmonary bypass; countries that submitted mortality data; calendar years 2006-2008

		Patient outcome at discharge				
		Alive	Died	Unspecified	Mortality rate (95% CI)	
CPB	No	40,271	578	268	1.4%	(1.3-1.5%)
	Yes	156,689	4,172	1,095	2.9%	(2.5-2.7%)
	Unspecified	17,185	158	108		
	All	**214,415**	**4,908**	**1,471**		

Isolated CABG: Crude mortality rate, gender and the use of bypass; calendar years 2006-2008 (n=201,710)



1 Demonstrating quality: The Sixth National Adult Cardiac Surgery database report: Bridgewater B, Kinsman R, Walton P and Keogh B. Published by Dendrite Clinical Systems Ltd. Henley-on-Thames. ISBN 1-903968-23-2.

The *EuroSCORE* and coronary artery surgery

As has been shown consistently throughout this report, there are marked variations in the incidence of most risk factors between countries, and these variables are strongly associated with in-hospital mortality and length-of-stay. Similar variation has also been demonstrated across hospitals within a country [1] and between surgeons in a defined geographical region [2]. It is, therefore, unwise to compare outcomes following coronary artery surgery without compensation for this variation, and that is usually done with a risk-prediction model.

Risk-prediction tools have found a number of uses:

- To compare risk-adjusted mortality outcomes between hospitals or surgeons, or to compare outcomes with a given standard for reporting purposes.
- To give information on expected outcomes of surgery for informed consent.
- To provide data on expected outcomes following surgery to enable the best decision to be made on possible treatment options.

For a mortality risk-prediction tool to be used for any of these applications it must be able to discriminate between patients of low and high risk (discrimination), and the number generated as a predicted mortality rate should equate to the mortality rate observed in practice (calibration).

The first risk-prediction model to be used in common practice for cardiac surgical patients in Europe was the Parsonnet score [3], but, not that long after its widespread introduction, it was demonstrated that this model over-predicted observed mortality [4]. The next important risk model in cardiac surgery in widespread uses in Europe was the ***EuroSCORE***. This model was developed using data from a number of countries across Europe, using the logistic regression modelling technique. It was initially published in an additive format, in which the regression coefficients that transformed the presence of the various risk factors into a predicted mortality were allocated simple integer values so that they could be simply summed to give a mortality prediction [5]. This had the advantages that it was easily understood by surgeons and patients and the score could be calculated *at the end of the bed*.

The additive ***EuroSCORE*** initially displayed both good discriminatory ability and calibration, but over time both the discriminatory ability for higher-risk patients and the calibration were questioned. In 2003 the originators of the ***EuroSCORE*** responded by publishing the original logistic regression coefficients and the equation of the ***EuroSCORE*** as the **logistic *EuroSCORE*** [6]. It was claimed that this update to the model had better discriminatory ability and calibration than the additive model.

The logistic ***EuroSCORE*** has found widespread use around the world, and was initially accepted to be a useful and accurate model. However, from about 2004, some observers in specific hospitals and countries started to question its accuracy, because of a problem with calibration drift: the mortality associated with cardiac surgery has fallen over time, and this has happened in parallel with an increase in the predicted risk for patients coming to surgery. An inevitable consequence is that the logistic ***EuroSCORE*** has been shown to over-predict observed mortality around the world [7], and it is probably no longer useful in its originally published format (*i.e.*, unless it has been recalibrated), as shown by the analyses presented below.

Calibration drift is not necessarily a problem if the model is being used to calculate risk-adjusted mortalities for comparative analysis, based on comparisons to a contemporary group average; but it can create major errors if a local mortality rate is simply compared to that predicted by the model. For example, false reassurance can be gained when observed mortality is equivalent to predicted, when in reality all other hospitals or surgeons may have mortality significantly lower than predicted. Another concern is that data derived from an outdated risk model could be used to give erroneously high predicted mortality rates from cardiac surgery, which could confuse decisions about the appropriateness of other treatments (such as Percutaneous Coronary Intervention, PCI, or Trans-catheter Aortic Valve Implantation, TAVI) for particular patients.

The data presented below should provide useful information to allow countries, hospitals or surgeons to compare themselves with a large multi-national and contemporary benchmark. They should also allow an appropriate manipulation of ***EuroSCORE*** data, if clinicians choose to use it for patient consent or decision-making.

Recently the Society of Thoracic Surgeons published a series of risk models for coronary artery surgery, isolated valve surgery and combined valve & CABG surgery. The models predict both mortality and other outcomes of interest [8]. The dataset required for these models shows some differences to that collected and submitted for this report, and it is not yet clear whether or not the Society of Thoracic Surgeons models will find widespread use worldwide.

The ***EuroSCORE*** team have responded to the above issues and are currently in the process of collecting data from around the world to create a new score, ***EuroSCORE 2010***, which should become available soon (www.euroscore.org).

In the following sections we have analysed:

- The overall completion rate of the various ***EuroSCORE*** variables by submitting country.
- The proportion of submitted records with specified number of missing ***EuroSCORE*** variables by submitting country.
- The average ***EuroSCORE*** by submitting country (which needs to be seen in the context of the data-quality information).
- The overall association between ***EuroSCORE*** and observed mortality.

Because of the issues around data quality and the political sensitivity of mortality data, we have not provided information on crude or risk-adjusted mortality rates by country in this report (see the discussion on page 60). EACTS have, however, contacted each submitting association to offer them a confidential, bespoke report containing a description of data quality, crude mortality and risk-adjusted mortality, benchmarked against the database standard and have produced a web-based tool to allow professional societies, hospital or individuals to benchmark themselves online against the database standard.

This tool is available at www.e-dendrite.com or www.eacts.org.

1 Demonstrating quality: The Sixth National Adult Cardiac Surgery database report: Bridgewater B, Kinsman R, Walton P and Keogh B. Published by Dendrite Clinical Systems Ltd. Henley-on-Thames. ISBN 1-903968-23-2.

2 Bridgewater B, Grayson AD, Jackson M, Brooks NH, Grotte GJ, Keenan DMJ, Millner R, Fabri BM, Jones MT. Surgeon specific mortality in adult cardiac surgery: comparison between crude and risk adjusted data. *BMJ*. 2003; **327:** 13-17.

3 Parsonnet V, Dean D and Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in acquired heart disease. *Circulation*. 1989; **79:** I3-I12.

4 Wynn Jones K, Jackson M, Grotte GJ and Bridgewater B. Limitations of the Parsonnet score for measuring risk stratified mortality in the North West of England. The North West Regional Cardiac Surgery Audit Steering Group. *Heart*. 2000; **84(1):** 71-78.

5 Roques F, Nashef SA, Michel P, Gauducheau E, de Vincentiis C, Baudet E, Cortina J, David M, Faichney A, Gabrielle F, Gams E, Harjula A, Jones MT, Pintor PP, Salamon R and Thulin L. Risk factors and outcome in European cardiac surgery: analysis of the ***EuroSCORE*** multinational database of 19,030 patients. *European Journal of Cardio-Thoracic Surgery*. 1999; **15:** 1: 81-822; discussion 822-823.

6 Roques F, Michel P, Goldstone AR and Nashef SA. The logistic ***EuroSCORE***. *European Heart Journal*. 2003; **24(9):** 882-883.

7 Choong CK, Sergeant P, Nashef S, Smith JA and Bridgewater B. The ***EuroSCORE*** Risk Stratification System in the Current Era: How accurate is it and what should be done if it is inaccurate? *European Journal of Cardio-Thoracic Surgery*. 2009; **5(1):** 5961.

8 Shahian DM and Edwards FH. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: introduction. *Annals of Thoracic Surgery*. 2009; **Jul 88 (1 Suppl):** S1.

We have analysed the submitted data to the database with respect to the logistic ***EuroSCORE*** variables. For a patient to be given an accurate score all 14 relevant fields within the ***EuroSCORE*** should be completed in full, with a response recording whether that risk factor is present or absent. The data shown below suggest that the data are less than complete.

We have shown the completeness rates for all the relevant ***EuroSCORE*** fields for different submitting countries in the following tables, and we would hope that will drive data quality.

Isolated CABG: Rates of missing ***EuroSCORE*** data by country for the calendar years 2006-2008

Greater than 90% missing

Contributor country	***EuroSCORE*** variables						
	Age	Gender	Chronic pulmonary disease	Extra-cardiac arteriopathy	Neurological dysfunction	Previous cardiac surgery	Serum creatinine
Armenia	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	9.1%
Belgium	0.0%	0.1%	100.0%	44.2%	43.8%	100.0%	100.0%
China	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%
Croatia	0.2%	0.0%	100.0%	100.0%	0.0%	100.0%	100.0%
Cyprus	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.8%
England	0.1%	0.0%	0.7%	0.8%	2.5%	1.8%	0.8%
Germany	0.0%	0.0%	100.0%	2.3%	0.0%	1.7%	3.4%
Greece	0.0%	0.0%	1.8%	55.2%	3.1%	53.9%	0.4%
Hong Kong, China	0.0%	0.0%	0.0%	0.0%	0.0%	1.6%	0.2%
Italy	0.2%	0.0%	100.0%	18.0%	0.7%	0.9%	18.8%
Lithuania	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%
Luxembourg	0.0%	0.0%	100.0%	0.0%	0.0%	0.5%	0.0%
Northern Ireland	0.0%	0.0%	1.2%	0.6%	0.6%	3.0%	0.6%
Norway	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Poland	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%
Portugal	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
Republic of Ireland	0.0%	0.0%	1.8%	0.4%	0.3%	1.9%	36.4%
Scotland	16.1%	0.2%	0.0%	0.0%	0.0%	3.9%	3.7%
Spain	0.5%	0.0%	9.0%	4.1%	74.1%	3.6%	0.5%
Sweden	0.8%	0.0%	100.0%	100.0%	0.0%	100.0%	0.2%
Switzerland	0.0%	0.0%	2.3%	2.0%	0.8%	5.4%	0.8%
Turkey	0.0%	0.0%	30.4%	2.9%	29.4%	0.9%	28.4%
Wales	0.0%	0.1%	1.8%	0.1%	5.9%	3.2%	0.6%
All	**0.3%**	**0.0%**	**54.5%**	**14.9%**	**12.7%**	**15.2%**	**14.6%**

Contributor country	*EuroSCORE* variables						
	Critical pre-operative state	Unstable angina	LV dysfunction	Recent myocardial infarction	Pulmonary hypertension	Emergency	Count
Armenia	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	66
Belgium	100.0%	39.7%	37.9%	100.0%	100.0%	31.8%	18,539
China	100.0%	0.0%	0.0%	40.5%	93.9%	0.0%	8,272
Croatia	100.0%	0.0%	37.4%	100.0%	100.0%	0.0%	586
Cyprus	100.0%	0.0%	0.3%	18.2%	98.7%	0.0%	396
England	19.4%	0.6%	1.4%	49.4%	85.1%	0.1%	41,784
Germany	100.0%	0.0%	0.0%	100.0%	100.0%	0.0%	86,397
Greece	55.3%	55.1%	0.1%	14.0%	56.1%	0.2%	2,838
Hong Kong, China	0.4%	0.0%	0.0%	53.8%	0.0%	0.0%	502
Italy	100.0%	21.5%	1.2%	100.0%	100.0%	0.6%	9,710
Lithuania	0.0%	0.0%	4.1%	0.0%	100.0%	0.0%	241
Luxembourg	71.8%	0.0%	72.4%	86.0%	100.0%	0.0%	652
Northern Ireland	1.2%	0.8%	0.8%	61.8%	0.8%	0.2%	508
Norway	100.0%	100.0%	9.8%	100.0%	100.0%	100.0%	8,875
Poland	11.9%	10.3%	21.0%	53.8%	98.8%	0.0%	40,109
Portugal	0.4%	0.0%	2.9%	50.6%	99.7%	0.0%	788
Republic of Ireland	37.7%	0.0%	0.8%	34.7%	34.3%	0.5%	1,912
Scotland	5.9%	0.0%	13.8%	60.1%	84.1%	0.0%	3,043
Spain	43.7%	4.4%	0.6%	4.6%	81.1%	4.6%	3,743
Sweden	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%	3,805
Switzerland	90.1%	2.1%	1.5%	1.5%	99.9%	1.2%	1,455
Turkey	35.3%	0.2%	6.7%	3.7%	70.8%	0.8%	2,872
Wales	6.4%	5.9%	0.0%	56.8%	2.2%	0.2%	1,970
All	**65.5%**	**11.9%**	**7.7%**	**75.1%**	**93.9%**	**7.9%**	**239,063**

Isolated CABG: Numbers of missing ***EuroSCORE*** variables by country for the calendar years 2006-2008

For inclusion in the ***EuroSCORE*** analyses; >90% of entries with <6 variables missing

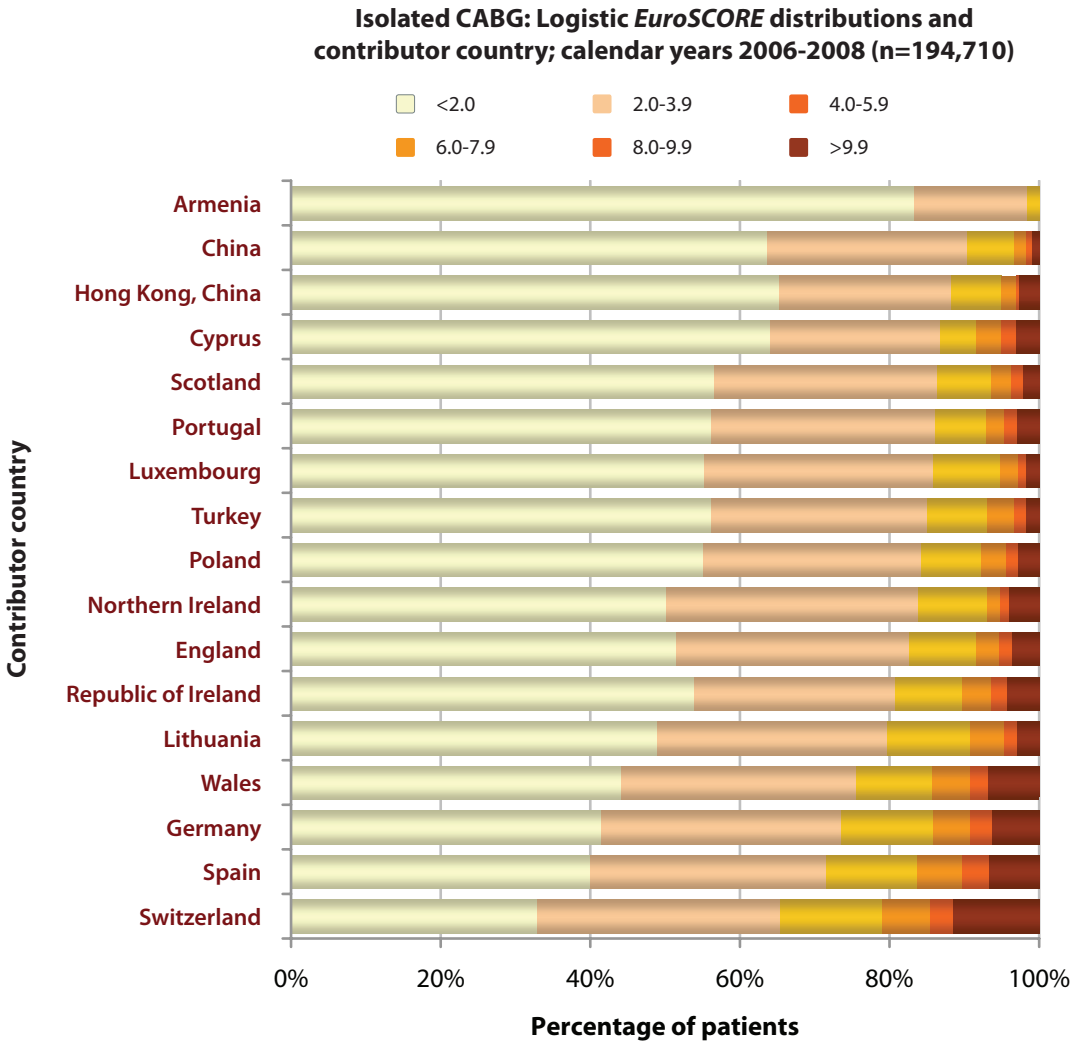
Contributor country	Number of missing *EuroSCORE* variables						
	0	1	2	3	4	5	6
Armenia	0.0%	0.0%	0.0%	0.0%	0.0%	90.9%	9.1%
Belgium	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.3%
China	0.0%	0.0%	0.0%	3.4%	58.9%	37.8%	0.0%
Croatia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cyprus	0.0%	0.5%	79.0%	19.9%	0.5%	0.0%	0.0%
England	6.3%	39.4%	42.4%	10.4%	1.2%	0.1%	0.0%
Germany	0.0%	0.0%	0.0%	0.0%	92.8%	7.0%	0.2%
Greece	42.9%	1.8%	0.1%	0.0%	1.3%	37.4%	14.8%
Hong Kong, China	45.4%	53.2%	1.4%	0.0%	0.0%	0.0%	0.0%
Italy	0.0%	0.0%	0.0%	0.0%	73.7%	7.2%	3.3%
Lithuania	0.0%	95.4%	4.6%	0.0%	0.0%	0.0%	0.0%
Luxembourg	0.0%	0.0%	12.1%	15.5%	2.5%	69.5%	0.5%
Northern Ireland	37.8%	58.1%	3.3%	0.0%	0.0%	0.0%	0.0%
Norway	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poland	0.5%	27.8%	50.2%	18.0%	3.1%	0.4%	0.0%
Portugal	0.1%	48.1%	49.2%	2.4%	0.0%	0.1%	0.0%
Republic of Ireland	15.0%	28.2%	51.7%	4.2%	0.5%	0.2%	0.2%
Scotland	0.1%	42.2%	39.2%	13.4%	1.6%	0.3%	3.2%
Spain	4.0%	25.8%	31.4%	22.2%	9.9%	5.3%	1.1%
Sweden	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Switzerland	0.0%	8.9%	83.1%	6.0%	1.0%	0.0%	0.3%
Turkey	27.9%	29.1%	10.0%	2.7%	1.0%	28.0%	0.8%
Wales	41.3%	50.2%	2.6%	0.1%	3.1%	1.8%	0.8%
All	**2.7%**	**14.1%**	**18.2%**	**5.7%**	**39.5%**	**5.3%**	**4.4%**

Contributor country	Number of missing *EuroSCORE* variables						
	7	8	9	10	>10	Count	<6
Armenia	0.0%	0.0%	0.0%	0.0%	0.0%	**66**	90.9%
Belgium	7.6%	2.5%	4.9%	3.1%	31.5%	**18,539**	0.0%
China	0.0%	0.0%	0.0%	0.0%	0.0%	**8,272**	100.0%
Croatia	62.5%	37.5%	0.0%	0.0%	0.0%	**586**	0.0%
Cyprus	0.0%	0.0%	0.0%	0.0%	0.0%	**396**	100.0%
England	0.0%	0.1%	0.1%	0.1%	0.0%	**41,784**	99.7%
Germany	0.0%	0.0%	0.0%	0.0%	0.0%	**86,397**	99.8%
Greece	1.5%	0.2%	0.0%	0.0%	0.0%	**2,838**	83.5%
Hong Kong, China	0.0%	0.0%	0.0%	0.0%	0.0%	**502**	100.0%
Italy	15.2%	0.5%	0.0%	0.1%	0.0%	**9,710**	80.9%
Lithuania	0.0%	0.0%	0.0%	0.0%	0.0%	**241**	100.0%
Luxembourg	0.0%	0.0%	0.0%	0.0%	0.0%	**652**	99.5%
Northern Ireland	0.2%	0.0%	0.6%	0.0%	0.0%	**508**	99.2%
Norway	0.0%	0.0%	0.0%	90.2%	9.8%	**8,875**	0.0%
Poland	0.0%	0.0%	0.0%	0.0%	0.0%	**40,109**	100.0%
Portugal	0.0%	0.0%	0.0%	0.0%	0.0%	**788**	100.0%
Republic of Ireland	0.1%	0.0%	0.0%	0.0%	0.0%	**1,912**	99.7%
Scotland	0.0%	0.0%	0.0%	0.0%	0.0%	**3,043**	96.8%
Spain	0.3%	0.1%	0.0%	0.0%	0.0%	**3,743**	98.5%
Sweden	0.0%	99.0%	0.9%	0.0%	0.0%	**3,805**	0.0%
Switzerland	0.0%	0.0%	0.0%	0.1%	0.8%	**1,455**	98.9%
Turkey	0.2%	0.2%	0.1%	0.0%	0.0%	**2,872**	98.7%
Wales	0.1%	0.0%	0.1%	0.0%	0.0%	**1,970**	99.0%
All	**1.4%**	**1.9%**	**0.4%**	**3.6%**	**2.8%**	**239,063**	**85.5%**

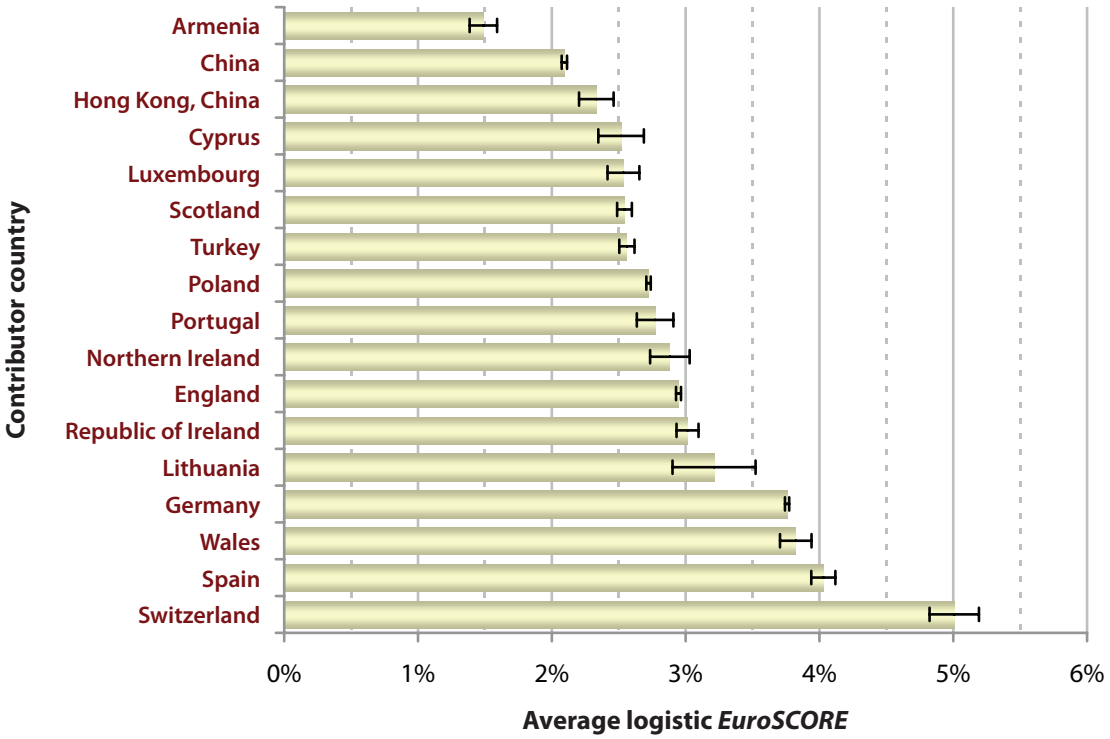
Logistic *EuroSCORE* and contributor country

When a risk factor is recorded as present we can be assured that that factor should be scored. When data for a risk factor are missing it may be because information on that factor has not been collected at all. In some other circumstances we know that data are collected in such a way that if the factor is present it is recorded, but when it is absent the database field is left blank.

For the remainder of the ***EuroSCORE*** analyses presented here we have only utilised data from countries that have more than 90% of patient records with fewer than 6 ***EuroSCORE*** fields missing. For these records we have scored all risk factors that are present, but for the fields with missing data we have made the assumption that the risk factor is absent. This will systematically underscore predicted risk, and will do so by more for countries with a higher incidences of missing data. We fully understand the limitations inherent with this methodology, but we believe it provides interesting and useful information.

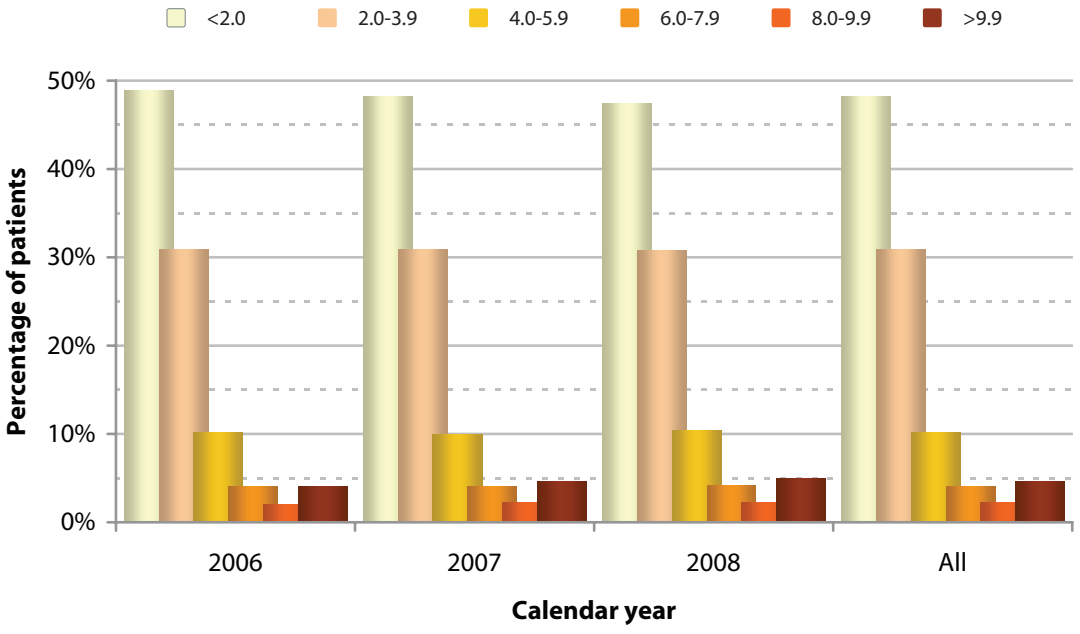


Isolated CABG: Average logistic *EuroSCORE* and contributor country; calendar years 2006-2008 (n=194,710)



Logistic *EuroSCORE* and calendar year

Isolated CABG: Logistic *EuroSCORE* distributions over time; calendar years 2006-2008 (n=194,710)



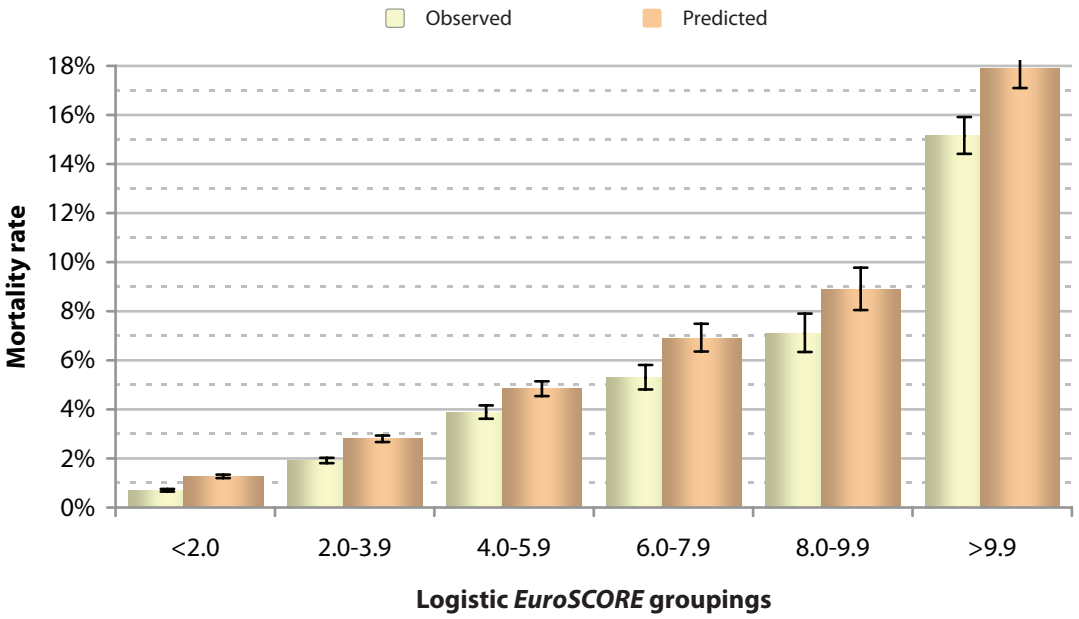
Logistic *EuroSCORE* and mortality

The logistic ***EuroSCORE*** significantly over predicts observed mortality. The over-prediction is marked at low levels of risk. Because we have assumed that missing data represents the risk factor being absent, it likely that we have systematically underscored predicted risk to some extent, and, as such, the degree of *over-prediction* by the ***EuroSCORE*** is probably greater than displayed; we have included in the table the observed to expected (O / E) mortality ratio for the differing ***EuroSCORE*** groupings. These data suggest that the logistic ***EuroSCORE*** should no longer be used it is originally published from (*i.e.* without re-calibration) for giving predicted risk to patients, or for institutional or individual mortality performance monitoring [1].

Mortality at the time of discharge after isolated CABG surgery broken down by logistic ***EuroSCORE*** group; countries that submitted both mortality data and >90% of database entries with fewer than 6 ***EuroSCORE*** fields missing; calendar years 2006-2008

		Patient outcome at discharge						
		Alive	Died	Unspec'd	Predicted	O / E	Mortality rate (95% CI)	
EuroSCORE group	<2.0	92,926	656	170	1,185.6	0.553	0.7%	(0.6-0.8%)
	2.0-3.9	58,844	1,148	95	1,678.0	0.684	1.9%	(1.8-2.0%)
	4.0-5.9	18,975	766	32	954.5	0.803	3.9%	(3.6-4.2%)
	6.0-7.9	7,486	418	10	545.5	0.766	5.3%	(4.8-5.8%)
	8.0-9.9	3,962	302	5	378.4	0.798	7.1%	(6.3-7.9%)
	>9.9	7,556	1,349	10	1,592.6	0.847	15.1%	(14.4-15.9%)
	Unspecified	0	0	0	NA	NA		
	All	**189,749**	**4,639**	**322**	**6,334.5**	**0.732**		

Isolated CABG: *EuroSCORE* and mortality; calendar years 2006-2008 (n=194,388)



1 Choong CK, Sergeant P, Nashef S, Smith JA and Bridgewater B. The ***EuroSCORE*** Risk Stratification System in the Current Era: How accurate is it and what should be done if it is inaccurate? *European Journal of Cardio-Thoracic Surgery.* 2009; **5(1):** 5961.


~ 1986 ~

Valve surgery

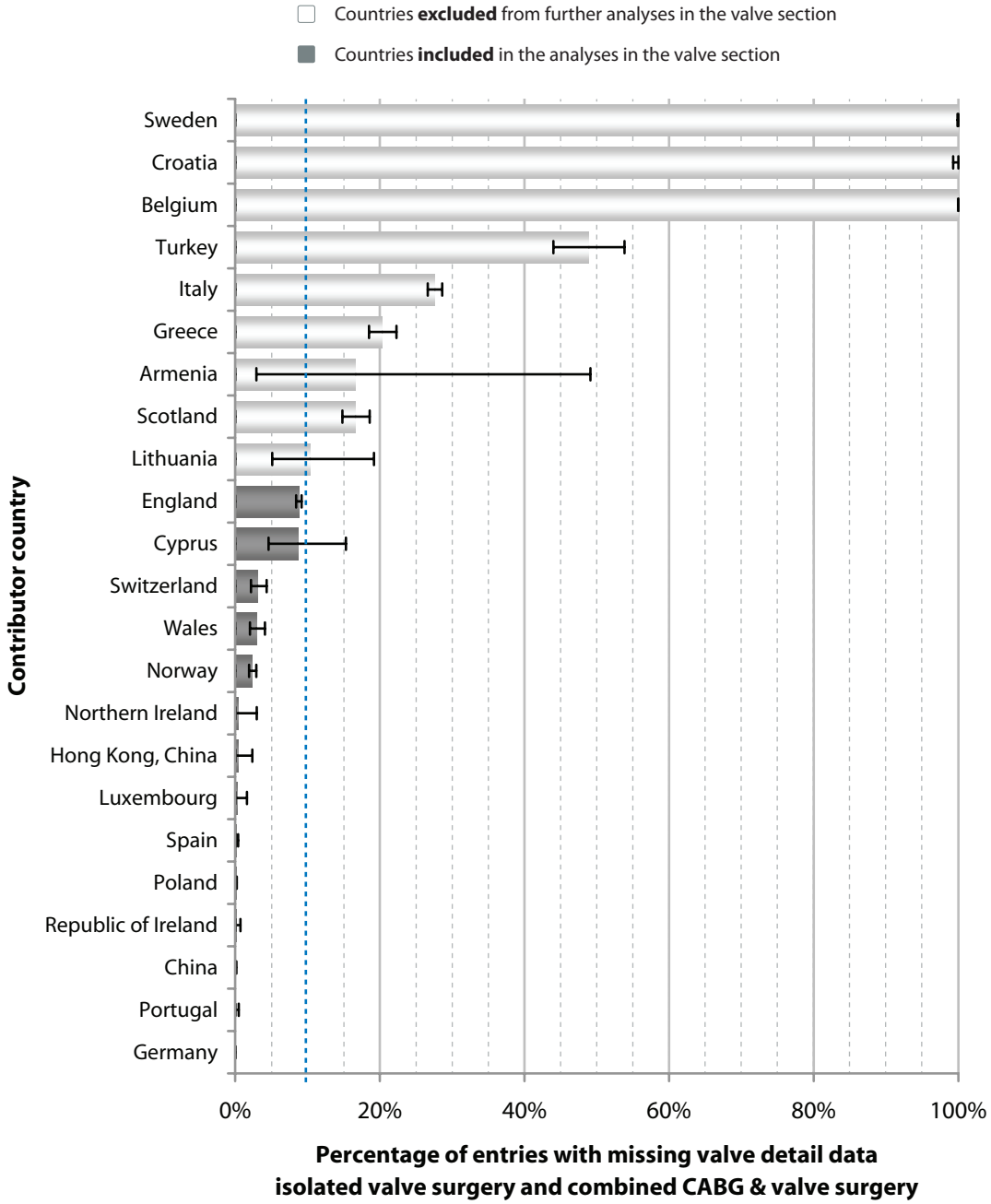
Valve surgery

Overview

The previous EACTS database reports have not drilled down into valve surgery in any great detail. For some countries we have a return that indicates that a valve operation has been undertaken, but we do not have details of the valve site being treated. This incidence of unspecified valve site data is shown in the following graph. For those countries where the rate of missing data on valve site is less than 10%, we have undertaken a more detailed analysis.

For data in the EACTS database be to be deemed to be *correct* it must be collected fully at source, according to the prescribed dataset, and there must be no errors in transmission, import or analysis. If there are issues in the process that have led to misrepresentation in the following tables and graphs, we would hope the data presented will be used to drive data quality and data management processes in future.

Valve surgery: Missing valve site data in isolated valve and combined CABG & valve surgery records; calendar years 2006-2008 (n=124,892)



Details on the kinds of valves treated in both isolated valve surgery and combined CABG & valve surgery; calendar years 2006-2008; countries that submitted data for the type of valve treated for >90% of their database entries

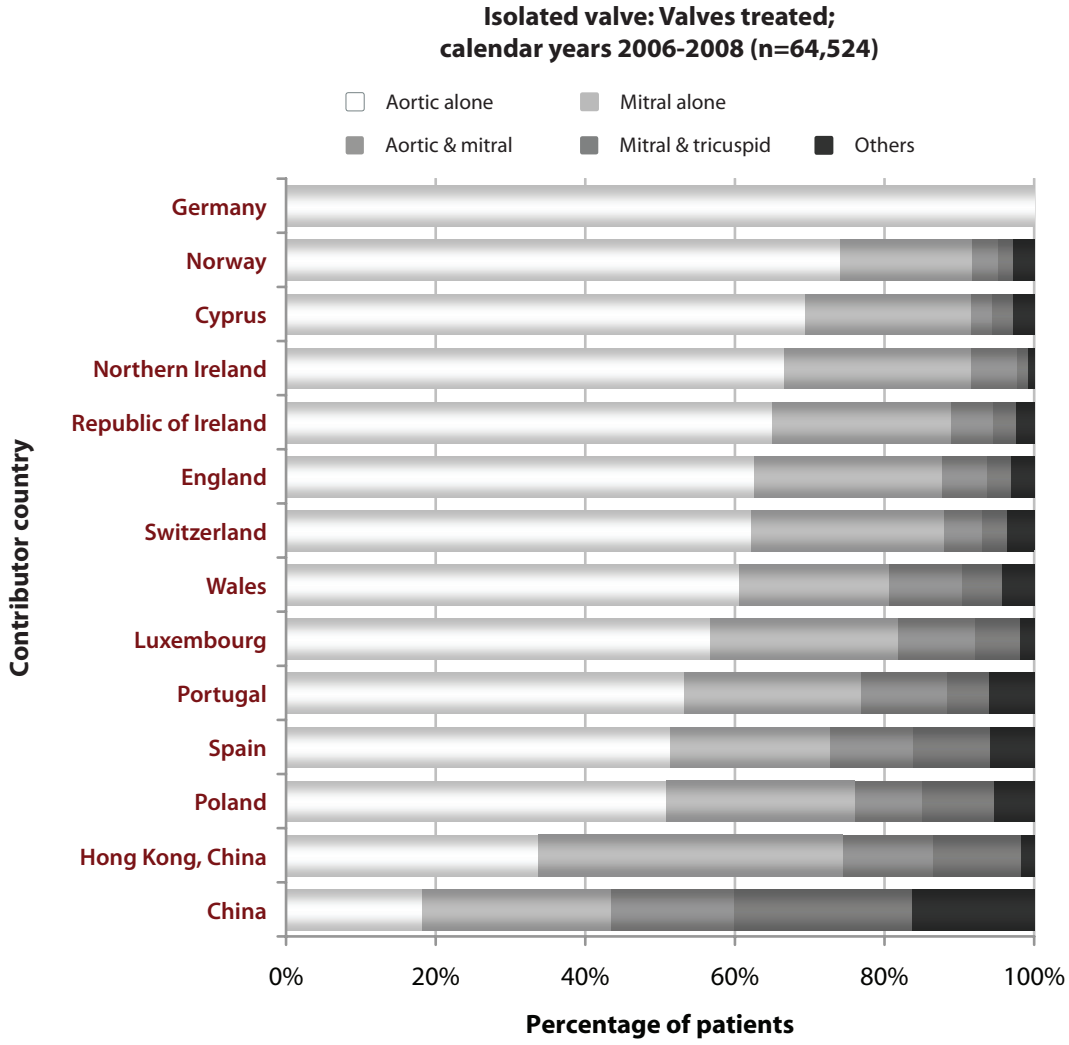
		Valves treated					
		All	Unknown	Single			
				A	M	P	T
Isolated valve	China	10,927	8	1,992	2,751	2	120
	Cyprus	77	5	50	16	0	2
	England	13,491	1,146	7,735	3,102	67	92
	Germany [1]	21,487	0	21,487	0	0	0
	Hong Kong, China	232	1	78	94	0	0
	Luxembourg	215	0	122	54	0	3
	Northern Ireland	132	0	88	33	0	0
	Norway	2,027	48	1,468	348	13	31
	Poland	10,850	14	5,514	2,730	9	167
	Portugal	421	0	224	100	0	2
	Republic of Ireland	553	1	359	132	2	2
	Spain	4,233	10	2,170	901	0	30
	Switzerland	609	18	368	152	1	8
	Wales	542	21	316	104	1	1
	Total	**65,796**	**1,272**	**41,971**	**10,517**	**95**	**458**
Combined CABG & valve	China	925	3	277	342	1	16
	Cyprus	50	6	33	9	0	0
	England	8,226	766	5,581	1,429	2	18
	Germany [1]	14,568	0	14,568	0	0	0
	Hong Kong, China	37	0	15	19	0	0
	Luxembourg	178	1	118	39	0	0
	Northern Ireland	81	1	61	16	0	1
	Norway	1,715	41	1,426	198	0	11
	Poland	5,169	10	2,435	1,936	1	50
	Portugal	179	0	111	43	0	0
	Republic of Ireland	326	0	237	72	0	2
	Spain	1,209	3	804	246	0	0
	Switzerland	488	16	324	107	0	2
	Wales	588	12	409	113	0	2
	Total	**33,739**	**859**	**26,399**	**4,569**	**4**	**102**

1 Germany only submitted data on isolated CABG surgery, isolated AV surgery and combined AV & CABG surgery in the current round of submissions.

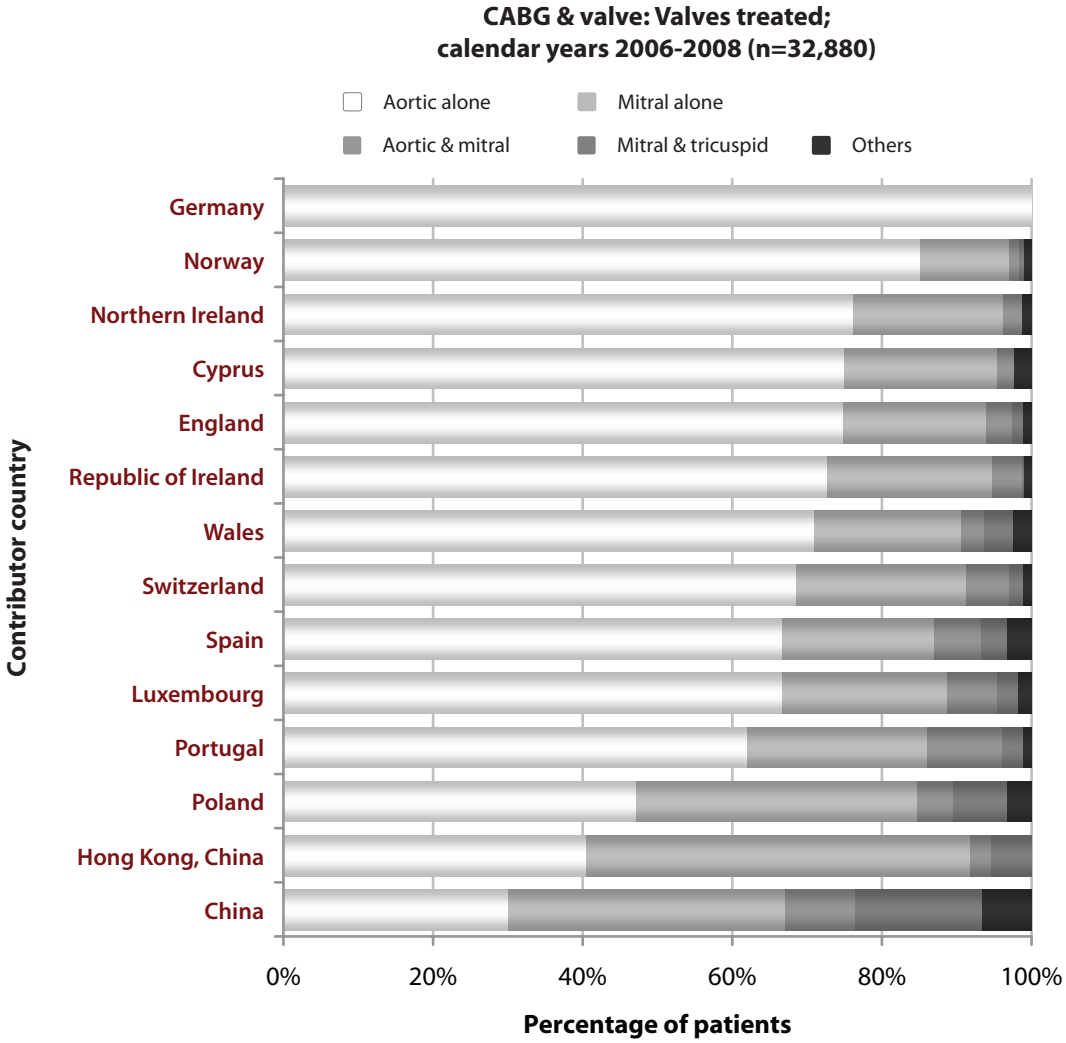
		Valves treated					
		Double			Triple		All 4
		AM	MT	Other	AMT	Other	AMPT
Isolated valve	China	1,085	2,595	64	1,588	2	0
	Cyprus	2	2	0	0	0	0
	England	732	404	77	114	12	10
	Germany [1]	0	0	0	0	0	0
	Hong Kong, China	28	27	0	4	0	0
	Luxembourg	22	13	0	1	0	0
	Northern Ireland	8	2	0	1	0	0
	Norway	69	39	8	3	0	0
	Poland	971	1,047	89	300	2	7
	Portugal	48	24	0	23	0	0
	Republic of Ireland	31	17	4	3	2	0
	Spain	470	437	24	191	0	0
	Switzerland	30	20	4	8	0	0
	Wales	51	28	6	14	0	0
	Total	**4,267**	**4,655**	**276**	**2,250**	**18**	**17**
Combined CABG & valve	China	86	157	2	40	1	0
	Cyprus	1	0	1	0	0	0
	England	255	114	14	44	1	2
	Germany [1]	0	0	0	0	0	0
	Hong Kong, China	1	2	0	0	0	0
	Luxembourg	12	5	1	2	0	0
	Northern Ireland	2	0	0	0	0	0
	Norway	23	12	2	2	0	0
	Poland	252	369	31	77	1	7
	Portugal	18	5	1	1	0	0
	Republic of Ireland	13	1	1	0	0	0
	Spain	76	42	6	32	0	0
	Switzerland	27	9	1	2	0	0
	Wales	18	22	6	6	0	0
	Total	**784**	**738**	**66**	**206**	**3**	**9**

1 Germany only submitted data on isolated CABG surgery, isolated AV surgery and combined AV & CABG surgery in the current round of submissions.

The types of valves submitted to the database are shown here: as has been noted earlier, Germany only submitted isolated aortic valve data to the database in the most recent round of data submissions. For those countries that submitted all types of valve, there is a marked variation in the proportion of the different valves requiring surgery, which presumably reflects differing aetiology of valve pathology, and also, possibly, different philosophies on intervention (for combined mitral and tricuspid surgery).



n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

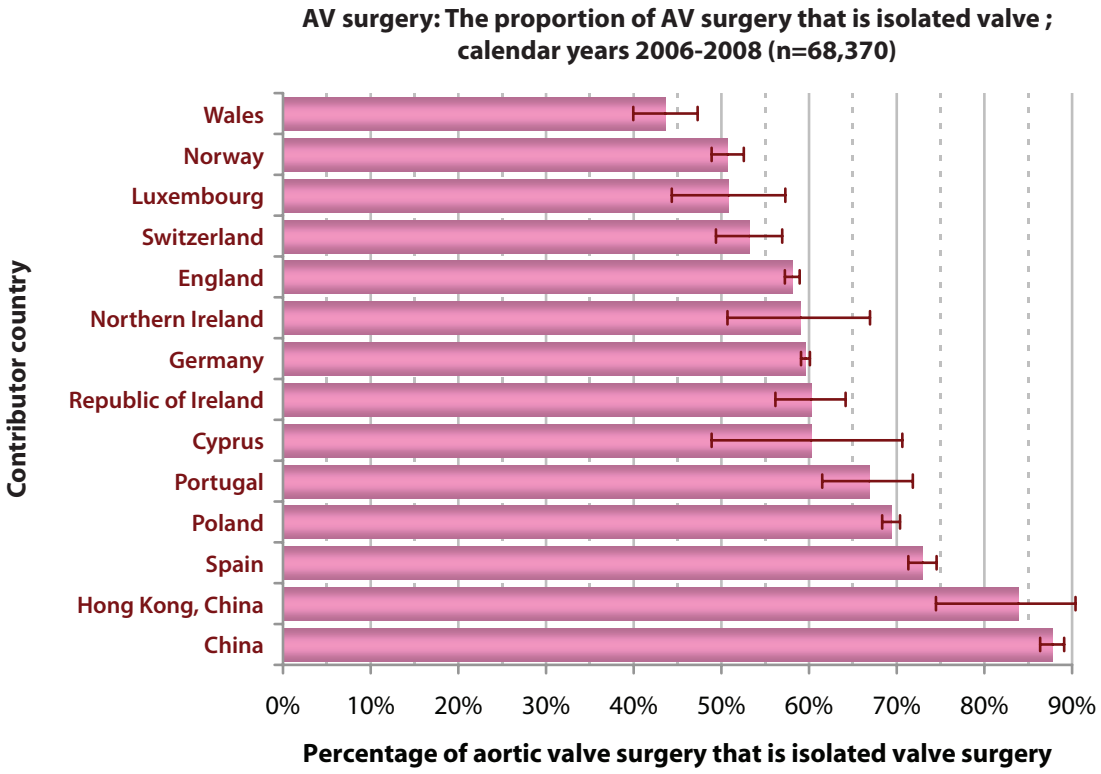


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Aortic valve surgery

Isolated AV surgery *versus* combined AV & CABG surgery

There are quite marked differences between countries in the proportion of AV surgery that is undertaken in isolation (rather than in conjunction with concomitant CABG) from 43.6% up to 87.8%.

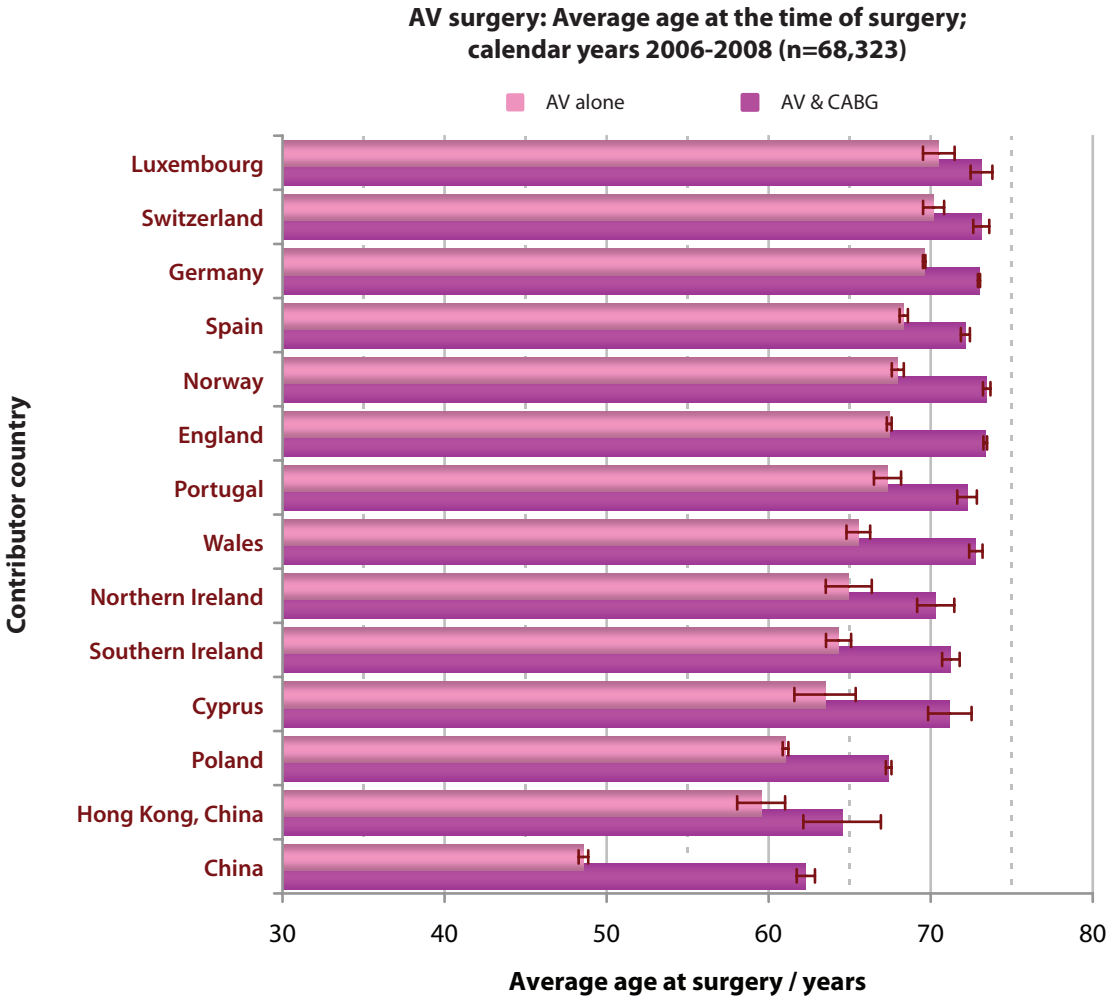


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Age at surgery

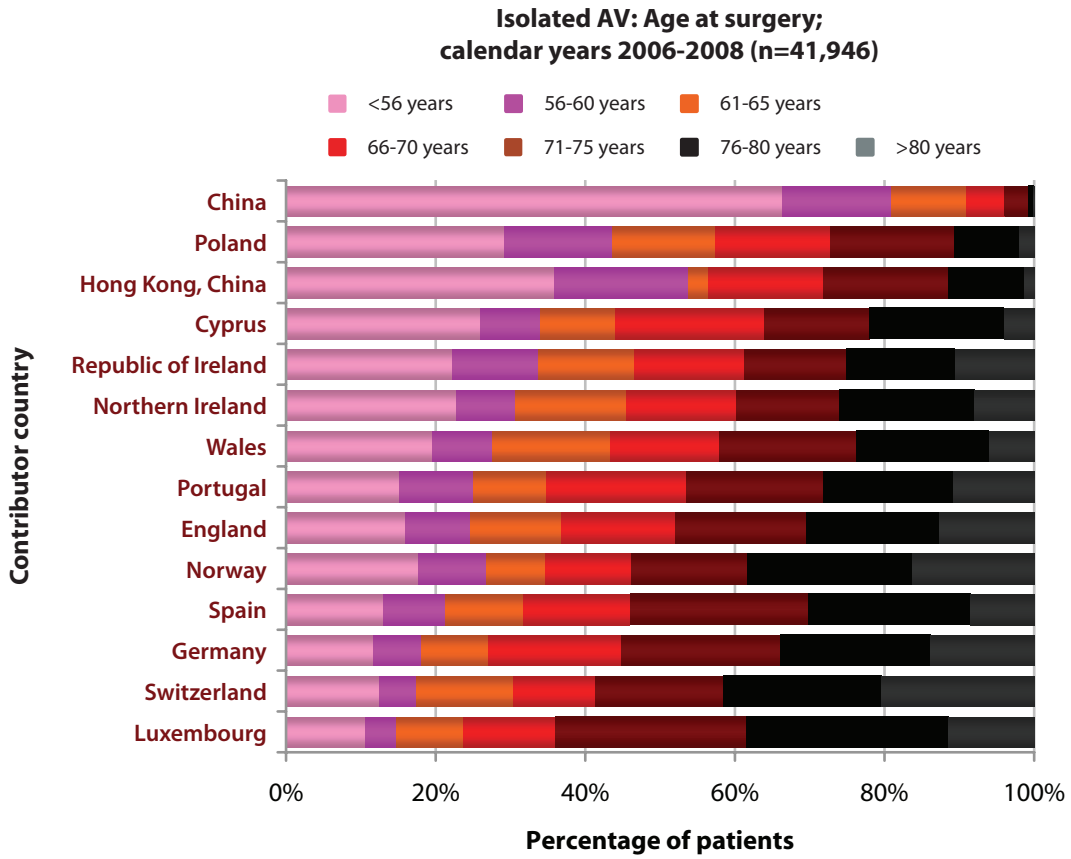
Age distributions

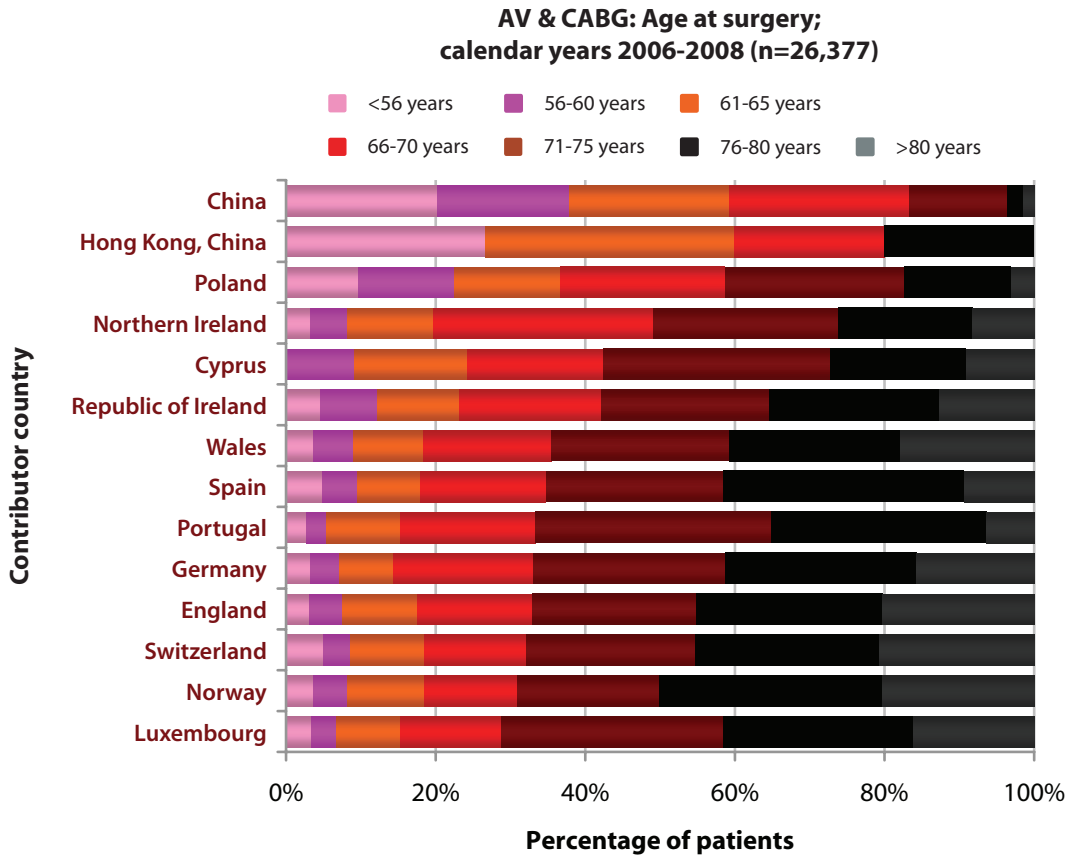
The average ages for patients undergoing isolated AV surgery and combined AV & CABG surgery are 66.8 years and 72.4 years respectively. There are marked variations in average age between countries.



The charts on the following page show that the age categories for patients undergoing isolated AV surgery vary enormously between countries. Some are undertaking over 20% of all AV surgery on patients over the age of 80 years.

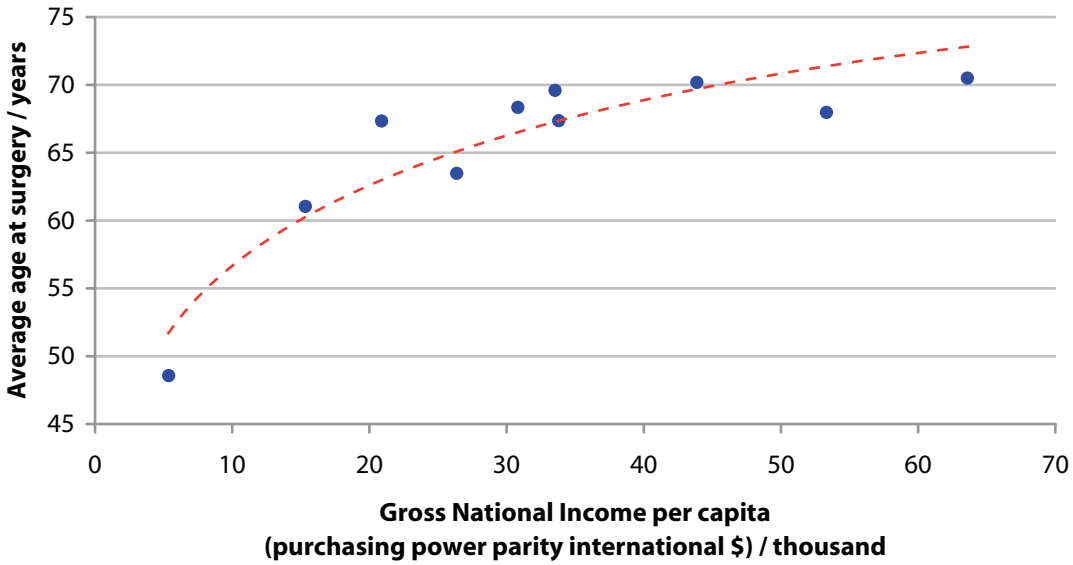
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.


Isolated AV: Age at surgery;
calendar years 2006-2008 (n=41,946)
<56 years
56-60 years
61-65 years
66-70 years
71-75 years
76-80 years
>80 years
Contributor country
China
Poland
Hong Kong, China
Cyprus
Republic of Ireland
Northern Ireland
Wales
Portugal
England
Norway
Spain
Germany
Switzerland
Luxembourg
0%
20%
40%
60%
80%
100%
Percentage of patients


AV & CABG: Age at surgery;
calendar years 2006-2008 (n=26,377)
<56 years
56-60 years
61-65 years
66-70 years
71-75 years
76-80 years
>80 years
Contributor country
China
Hong Kong, China
Poland
Northern Ireland
Cyprus
Republic of Ireland
Wales
Spain
Portugal
Germany
England
Switzerland
Norway
Luxembourg
0%
20%
40%
60%
80%
100%
Percentage of patients

There is a significant correlation between the WHO-reported Gross National Income *per capita* and the average age of patients undergoing isolated AV surgery, with wealthy countries having higher average age (Average age / years = ln (GNI *per* capita / 1,000) + C; r=0.929; r^2=0.847; p<0.001).

The relationship between WHO-reported Gross National Income *per* capita and the average age of patients undergoing isolated AV surgery in the EACTS database



Age and mortality

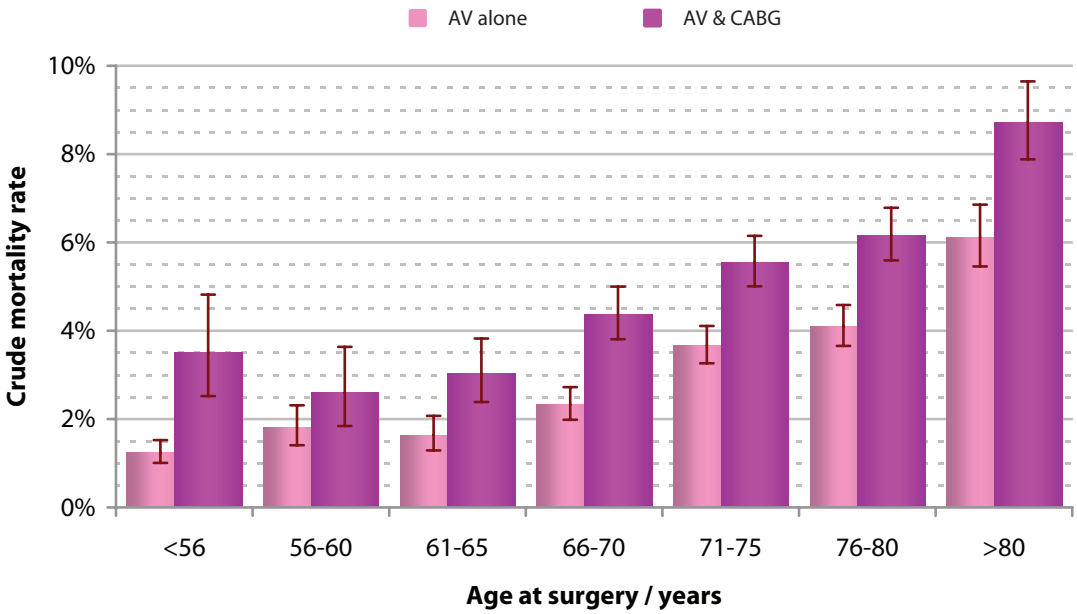
The in-hospital mortality following AV surgery is dependent on age, rising from 1.2% for patients under the age of 56 years undergoing isolated AV surgery, up to 8.7% for those over 80 for combined AV & CABG surgery.

These are important data in the current era where elderly and higher-risk patients are being considered for novel approaches to the treatment of aortic valve disease.

Mortality at the time of discharge after aortic valve surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Age at surgery / years	Isolated AV	**All patients**	**40,662**	**1,255**	**54**	**2.9%**	**(2.8-3.1%)**
		<56	7,409	93	7	1.2%	(1.0-1.5%)
		56-60	3,531	65	2	1.8%	(1.4-2.3%)
		61-65	4,263	71	6	1.6%	(1.3-2.1%)
		66-70	6,508	155	7	2.3%	(2.0-2.7%)
		71-75	7,575	288	13	3.7%	(3.3-4.1%)
		76-80	6,979	298	10	4.1%	(3.7-4.6%)
		>80	4,372	285	9	6.1%	(5.5-6.9%)
		Unspecified	25	0	0		
	AV & CABG	**All patients**	**24,890**	**1,455**	**54**	**5.5%**	**(5.3-5.8%)**
		<56	1,048	38	1	3.5%	(2.5-4.8%)
		56-60	1,312	35	4	2.6%	(1.8-3.6%)
		61-65	2,275	71	4	3.0%	(2.4-3.8%)
		66-70	4,491	205	10	4.4%	(3.8-5.0%)
		71-75	6,007	353	6	5.6%	(5.0-6.1%)
		76-80	6,045	397	15	6.2%	(6.5-6.8%)
		>80	3,693	353	14	8.7%	(7.9-9.6%)
		Unspecified	19	3	0		

AV surgery: Mortality and age at the time of surgery; calendar years 2006-2008 (n=68,215)

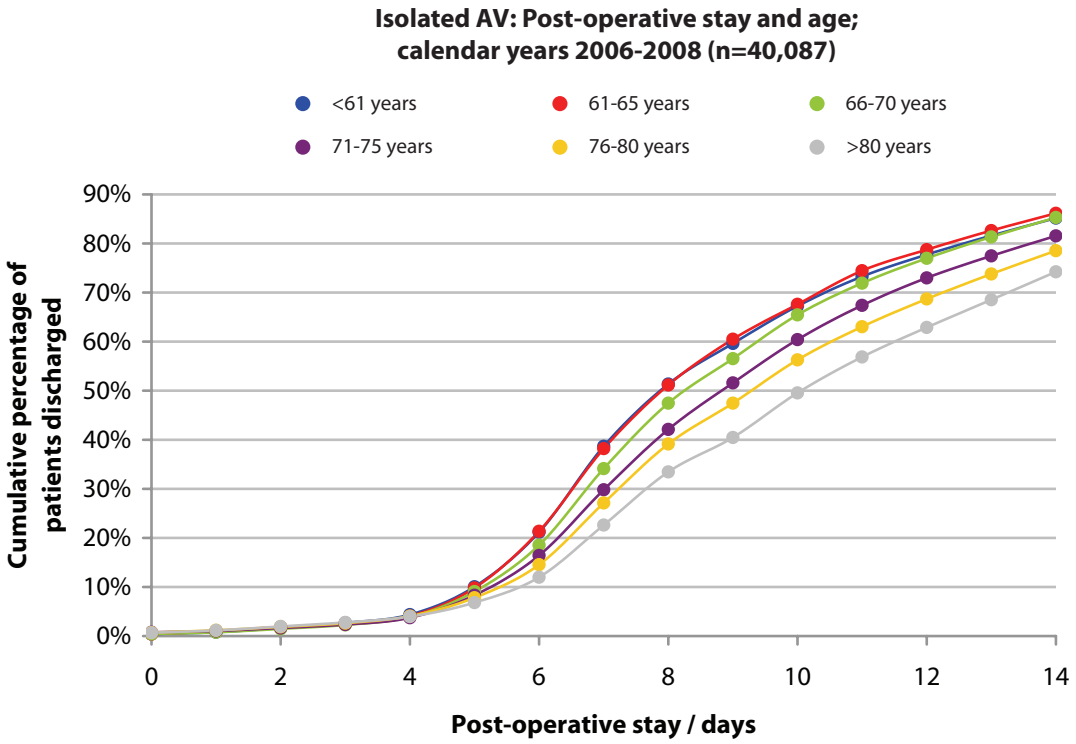


Age and post-operative stay

The patient's age at the time of surgery is an important factor that affects their post-operative length-of-stay following AV surgery. Concomitant CABG surgery adds little additional stay. Patients over the age of 80 years stay, on average, around 3 days longer than those under 61.

Post-operative stay after isolated aortic valve surgery broken down by age group; calendar years 2006-2008

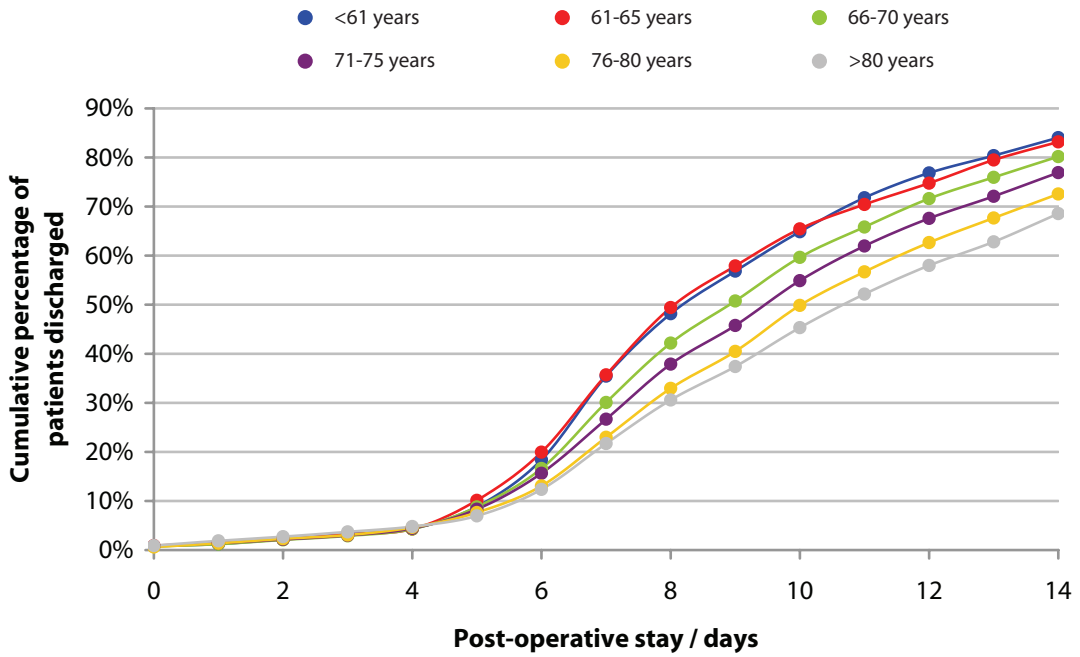
		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Age at surgery / years	<61	10,596	8.0	10.7	0.09
	61-65	4,186	8.0	11.1	0.20
	66-70	6,440	9.0	11.1	0.14
	71-75	7,571	9.0	12.0	0.14
	76-80	6,905	10.0	12.6	0.15
	>80	4,389	11.0	13.2	0.16
	Unspecified	24	9.5	10.3	0.90
	All	**40,111**	**9.0**	**11.7**	**0.06**



Post-operative stay after combined aortic valve & CABG surgery broken down by age group; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Age at surgery / years	<61	2,294	9.0	11.0	0.18
	61-65	2,171	9.0	11.1	0.22
	66-70	4,496	9.0	12.2	0.16
	71-75	6,036	10.0	13.0	0.16
	76-80	5,977	11.0	14.1	0.18
	>80	3,735	11.0	14.7	0.23
	Unspecified	22	9.0	10.2	1.41
	All	**24,731**	**10.0**	**13.0**	**0.08**

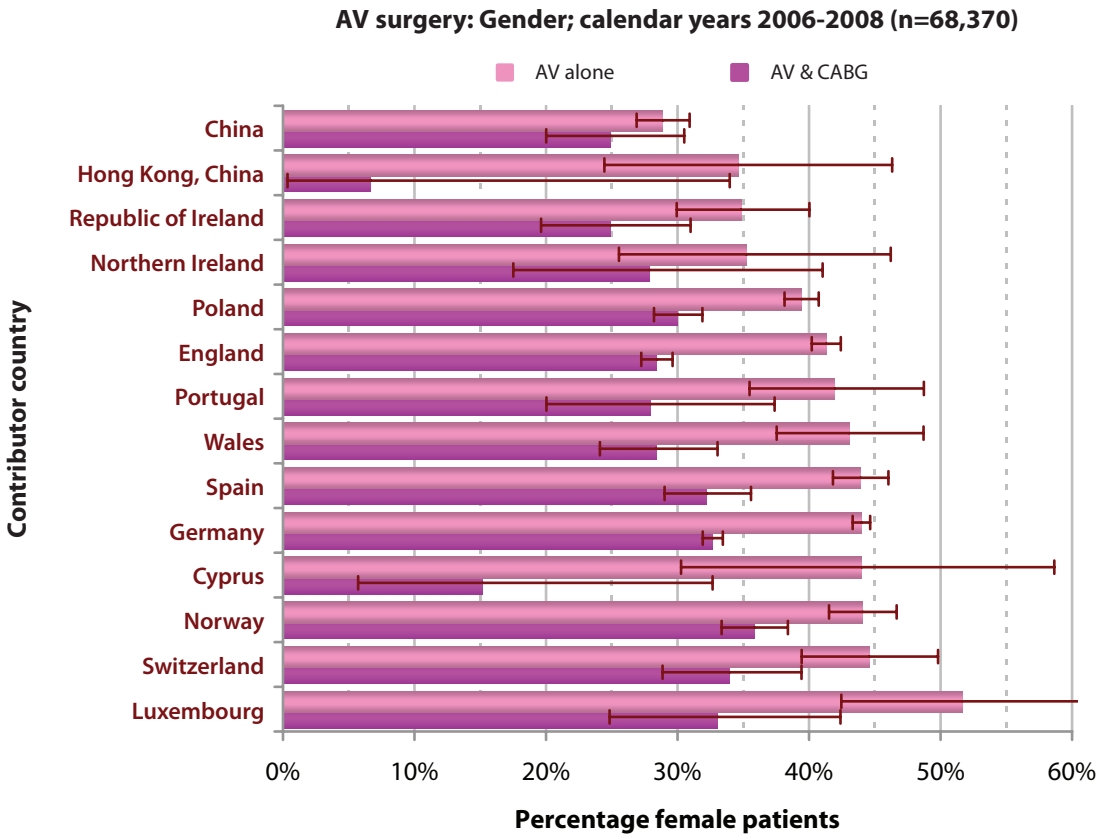
AV & CABG: Post-operative stay and age; calendar years 2006-2008 (n=24,709)



Gender

Gender distributions

The overall proportion of female patients undergoing isolated AV and combined AV & CABG surgery are 42.1% and 31.4% respectively. This ranges across the contributing countries from 28.9% up to 51.0% for isolated AV surgery and 24.9% to 33.1% for combined AV & CABG surgery.



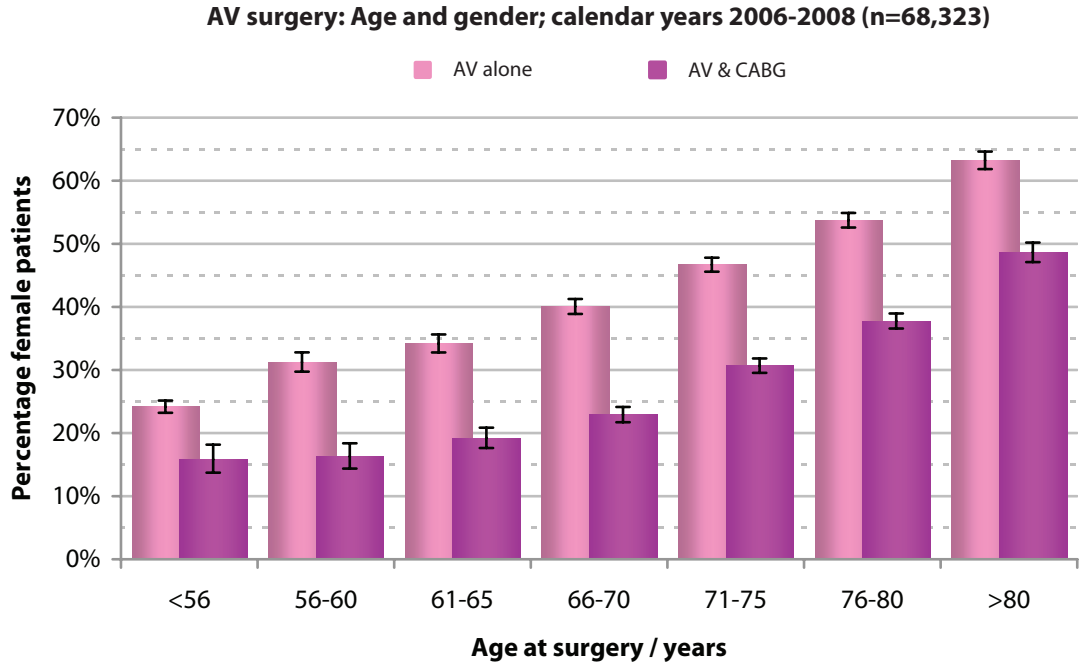
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Age and gender

As might be expected, the proportion of female patients increases with increasing age, from less than 25% for those under 56 years, up to >60% for those over 80, for isolated AV surgery.

Age and gender distributions for patients undergoing aortic valve surgery; calendar years 2006-2008

		Procedure group and gender					
		Isolated AV			AV & CABG		
		Male	Female	Unspecified	Male	Female	Unspecified
Age at surgery / years	<56	5,694	1,815	0	915	172	0
	56-60	2,474	1,124	0	1,131	220	0
	61-65	2,856	1,484	0	1,899	451	0
	66-70	3,998	2,672	0	3,628	1,078	0
	71-75	4,199	3,677	0	4,413	1,953	0
	76-80	3,371	3,916	0	4,019	2,438	0
	>80	1,715	2,951	0	2,085	1,975	0
	Unspecified	8	17	0	15	7	0
	All	**24,315**	**17,656**	**0**	**18,105**	**8,294**	**0**

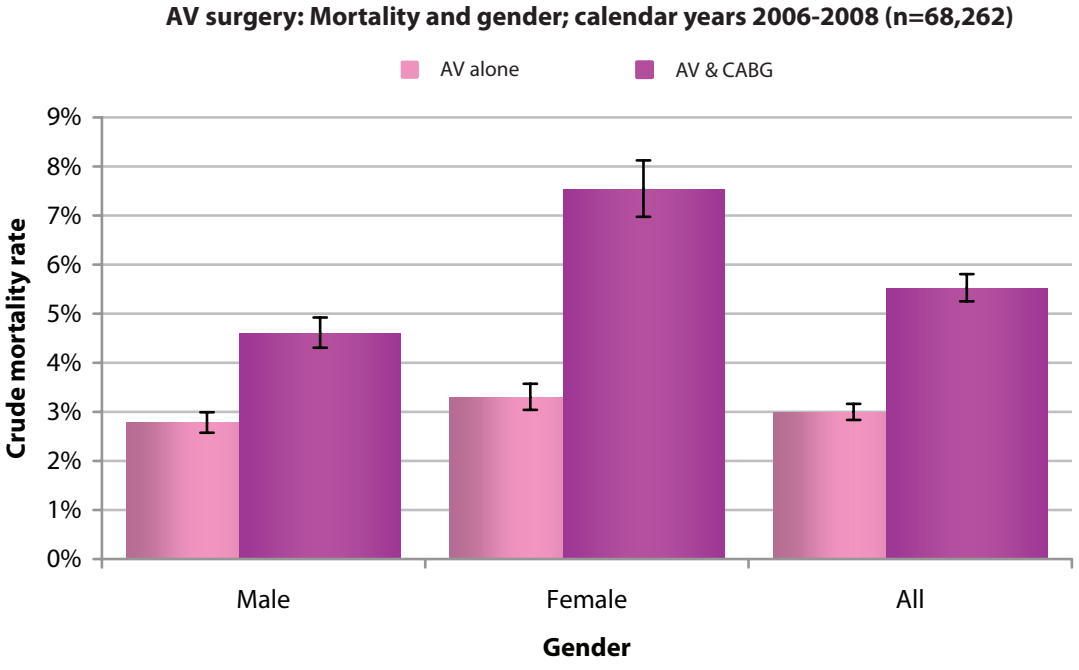


Gender and mortality

Gender is an important risk factor for operative mortality for both isolated AV surgery and combined AV & CABG surgery (p=0.002 & p<0.001 respectively).

Mortality at the time of discharge after aortic valve surgery broken down by gender; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Gender	Isolated AV	Male	23,614	674	27	2.8%	(2.6-3.0%)
		Female	17,048	581	27	3.3%	(3.0-3.6%)
		Unspecified	0	0	0		
	AV & CABG	Male	17,238	832	35	4.6%	(4.3-4.9%)
		Female	7,652	623	19	7.5%	(7.0-8.1%)
		Unspecified	0	0	0		

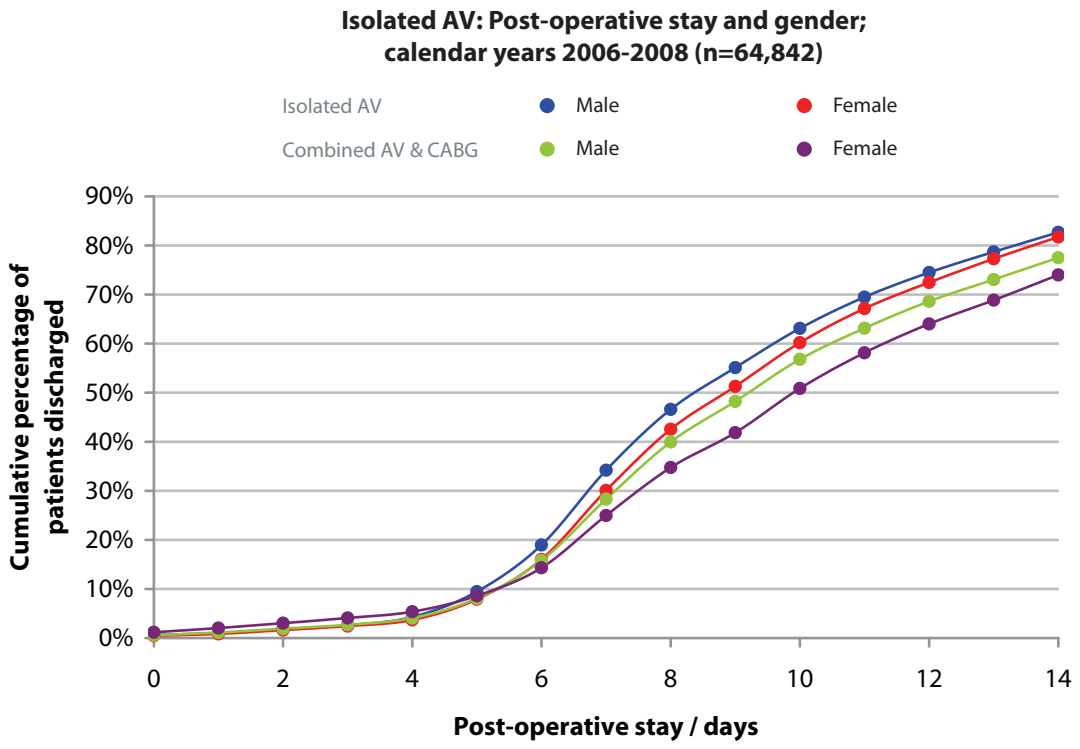


Gender and post-operative stay

Patterns of post-operative stay are significantly different for men and women (χ^2 p<0.001 for both isolated AV and combined AV & CABG).

Post-operative stay after aortic valve surgery broken down by gender; calendar years 2006-2008

			Post-operative stay		
			Count	Average / days	Standard error
Gender	Isolated AV	Male	23,247	11.6	0.08
		Female	16,864	11.8	0.08
		Unspecified	0	NA	NA
		All	**40,111**	**11.7**	**0.06**
	AV & CABG	Male	17,025	12.8	0.09
		Female	7,706	13.6	0.15
		Unspecified	0	NA	NA
		All	**24,731**	**13.0**	**0.08**

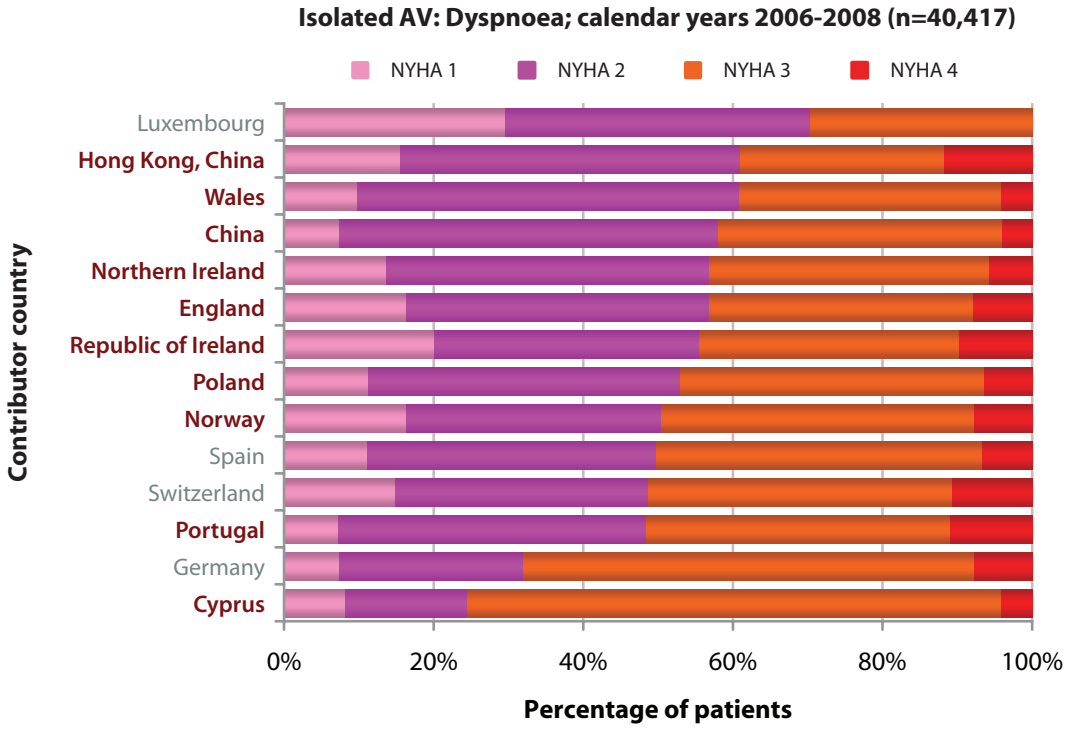


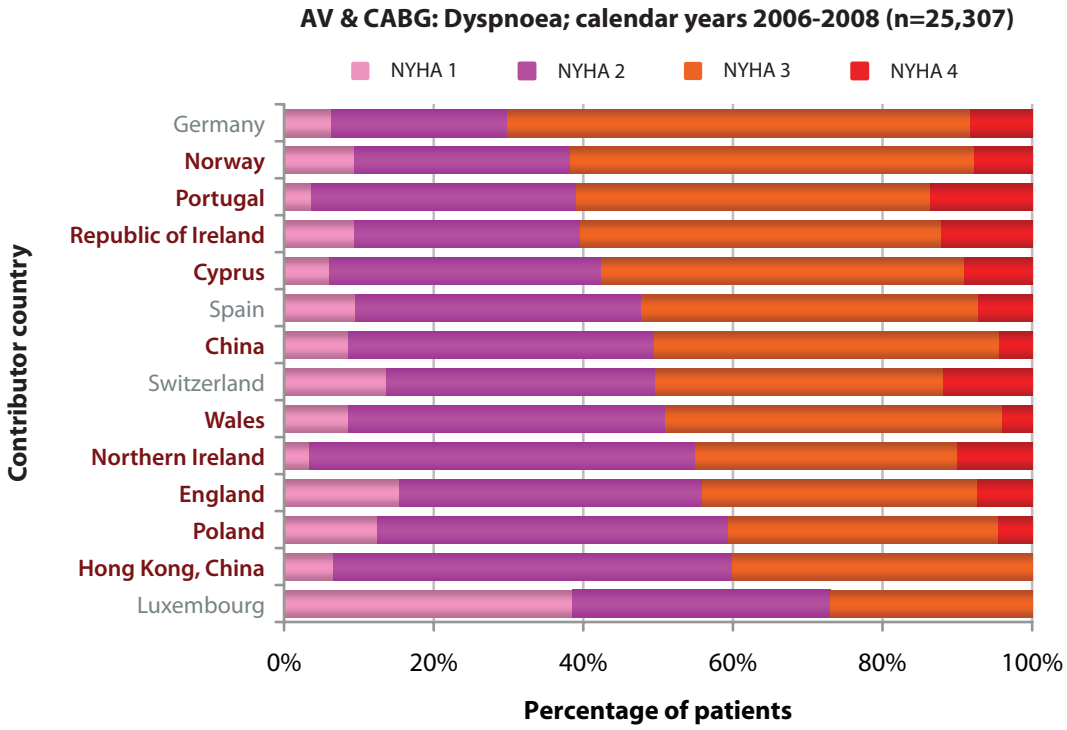
Dyspnoea

Dyspnoea distributions

Patients with asymptomatic aortic stenosis or regurgitation can be a problematic group to treat, with surgery recommended (backed by varying levels of evidence) for some groups of patients depending on the presence of a number of other characteristics, including the level of left ventricular dysfunction and response to exercise testing [1].

The data in the EACTS database shows marked differences in the proportion of patients undergoing surgery with both NYHA class 1 and more advanced (NYHA class 3 and 4) symptoms. Those with more advanced symptoms have both higher operative mortality and worse longer-term survival.



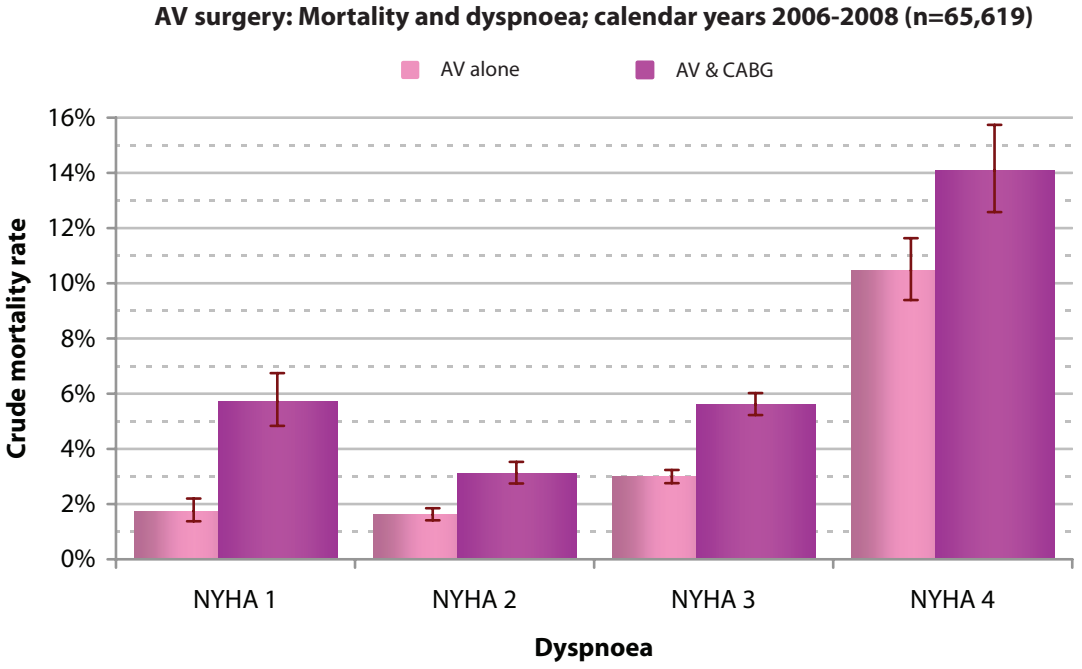


Dyspnoea and mortality

Symptom status shows a strong association with mortality for both isolated AV and combined AV & CABG surgery.

Mortality at the time of discharge after aortic valve surgery broken down by NYHA grade; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
NYHA grade	Isolated AV	NYHA 1	4,114	73	6	1.7%	(1.4-2.2%)
		NYHA 2	13,026	214	20	1.6%	(1.4-1.8%)
		NYHA 3	19,387	597	22	3.0%	(2.8-3.2%)
		NYHA 4	2,645	309	4	10.5%	(9.4-11.6%)
		Unspecified	1,490	62	2		
	AV & CABG	NYHA 1	2,243	136	1	5.7%	(4.8-6.7%)
		NYHA 2	7,590	244	17	3.1%	(2.7-3.5%)
		NYHA 3	12,381	736	30	5.6%	(5.2-6.0%)
		NYHA 4	1,653	271	5	14.1%	(12.6-15.7%)
		Unspecified	1,023	68	1		



1 Bonow RO, Carabello BA, Chatterjee K, de Leon AC, Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM and Shanewise JS. 2008 Focused Update Incorporated Into the ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease. *Journal of American College of Cardiology*. 2008; **52:**1-142, doi:10.1016/j.jacc.2008.05.007

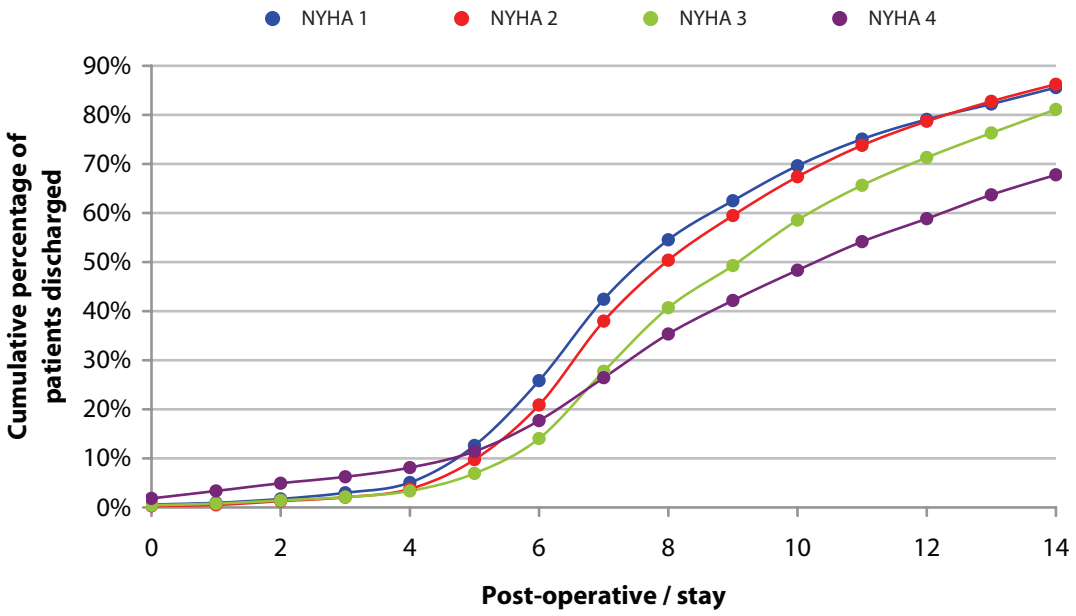
Dyspnoea and post-operative stay

Patients with severe NYHA class 4 symptoms stay, on average, 4 days longer following isolated AV surgery and also 4 days longer following combined AV & CABG surgery, as opposed to those with class 1 symptoms

Post-operative stay after isolated aortic valve surgery broken down by NYHA grade; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Dyspnoea	NYHA 1	3,922	8.0	10.6	0.15
	NYHA 2	12,662	8.0	10.8	0.10
	NYHA 3	19,294	10.0	12.0	0.08
	NYHA 4	2,821	11.0	14.7	0.28
	Unspecified	1,412	9.0	11.6	0.31
	All	**40,111**	**9.0**	**11.7**	**0.06**

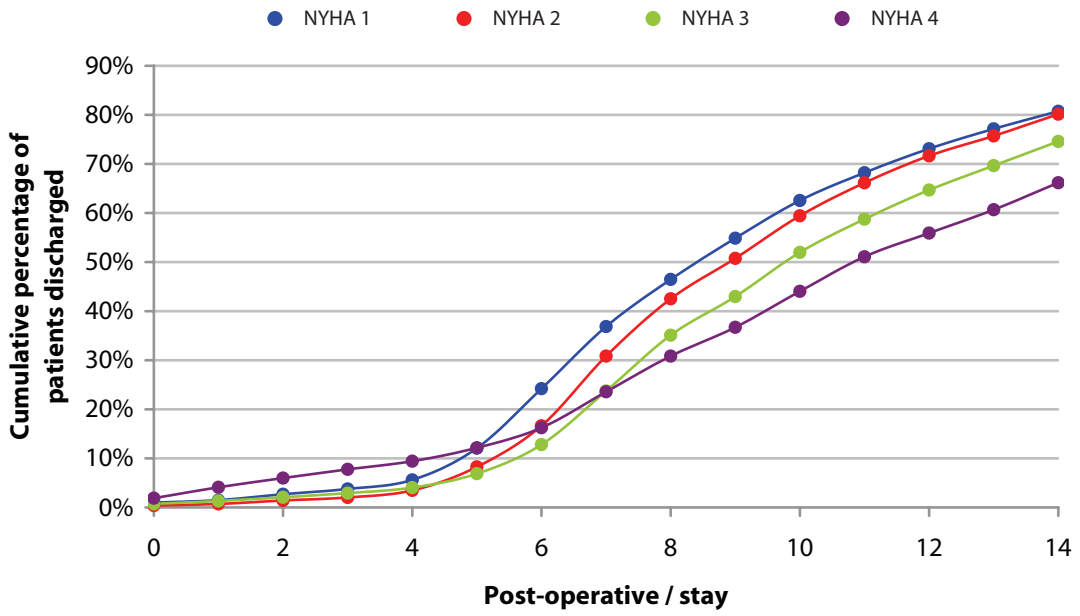
Isolated AV: Post-operative stay and dyspnoea; calendar years 2006-2008 (n=38,699)



Post-operative stay after combined aortic valve & CABG surgery broken down by NYHA grade; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Dyspnoea	NYHA 1	2,227	9.0	11.8	0.23
	NYHA 2	7,342	9.0	11.9	0.12
	NYHA 3	12,336	10.0	13.5	0.11
	NYHA 4	1,803	11.0	16.0	0.42
	Unspecified	1,023	9.0	11.8	0.29
	All	**24,731**	**10.0**	**13.0**	**0.08**

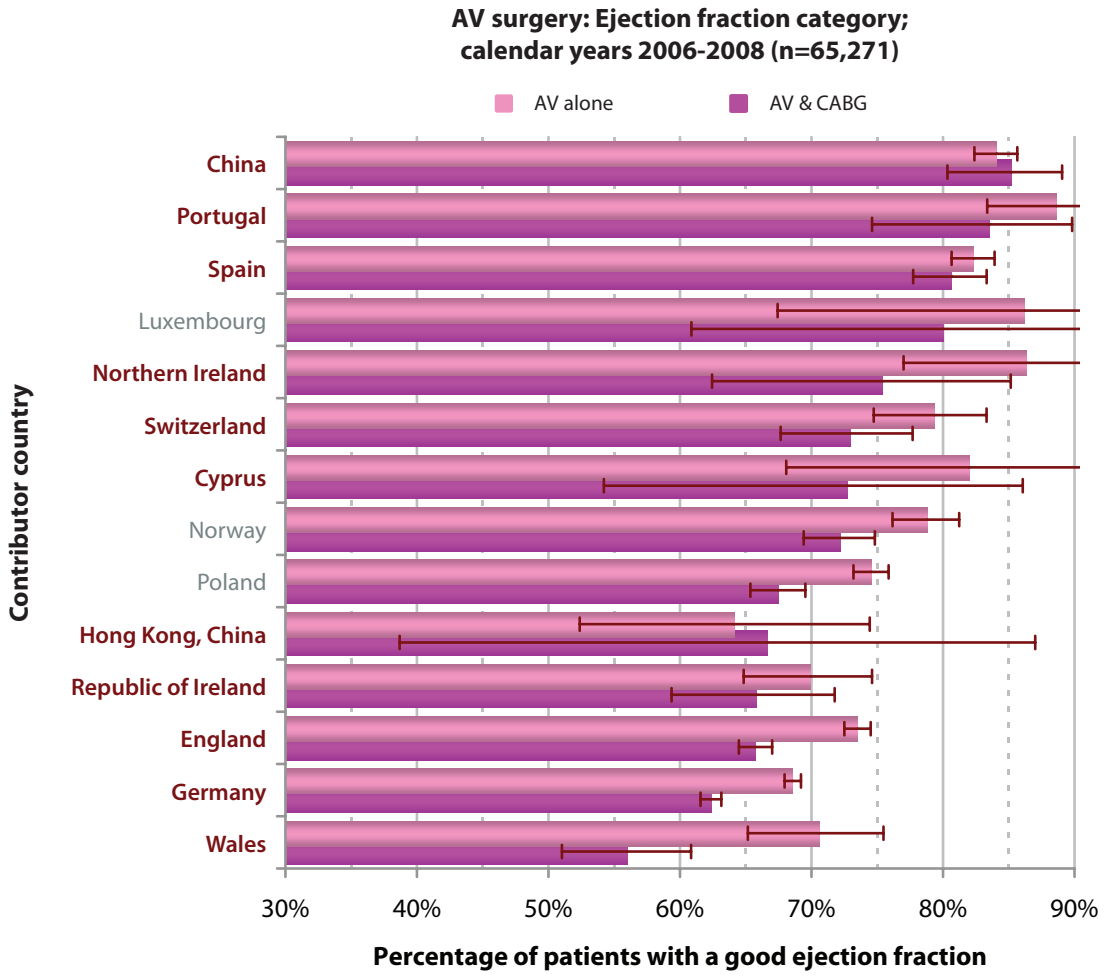
AV & CABG: Post-operative stay and dyspnoea; calendar years 2006-2008 (n=23,708)



Ejection fraction

Ejection fraction distributions

Ejection fraction is an important risk factor for patients with aortic valve disease: in order to derive optimum benefit from surgery, AV surgery should be undertaken when the ejection remains at a normal level. There are quite marked differences between countries in the proportion of patients undergoing surgery with good left ventricular function, from 64.1% up to 88.6%. The variation in those with normal left ventricular function is even more marked for combined AV & CABG surgery.



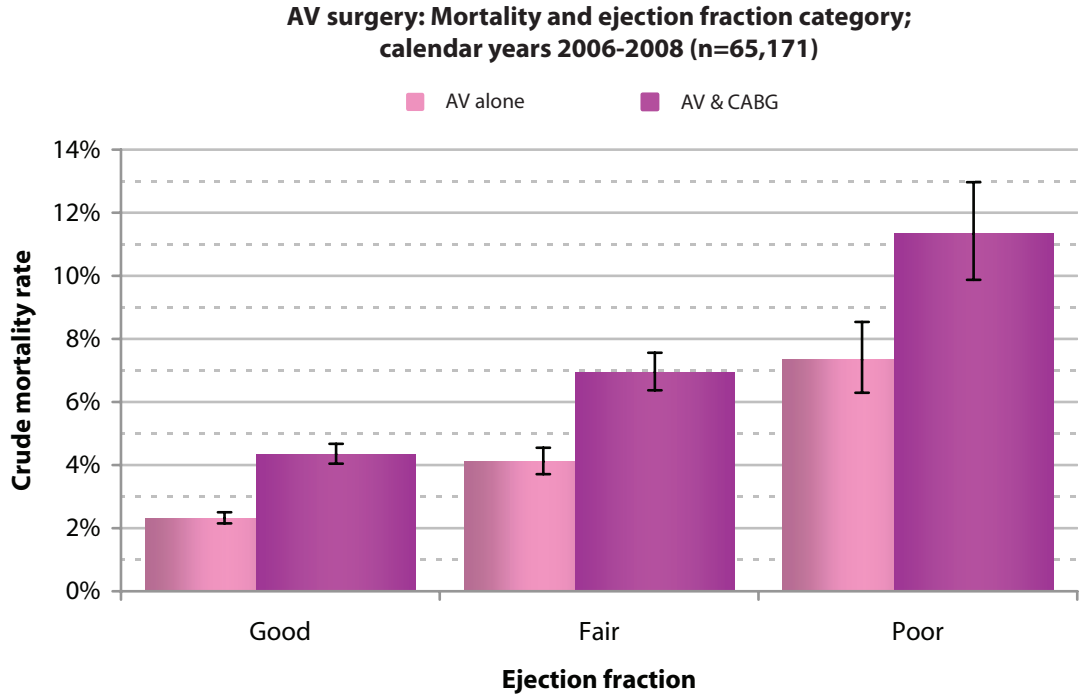
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Ejection fraction and mortality

There is a strong association between ejection fraction category and mortality, which applies to both isolated AV and combined AV & CABG surgery. Given the marked differences in reported ejection fraction categories between countries shown above, mortality comparisons should not be made between countries without adjusting for these variations.

Mortality at the time of discharge after aortic valve surgery broken down by ejection fraction category; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Ejection fraction category	Isolated AV	Good (>49%)	28,103	688	38	2.3%	(2.2-2.5%)
		Fair (30-49%)	8,540	366	7	4.1%	(3.7-4.5%)
		Poor (<30%)	2,008	159	3	7.3%	(6.3-8.5%)
		Unspecified	2,011	62	6		
	AV & CABG	Good (>49%)	15,733	715	37	4.3%	(4.0-4.7%)
		Fair (30-49%)	6,702	500	10	6.9%	(6.4-7.6%)
		Poor (<30%)	1,487	190	5	11.3%	(9.9-13.0%)
		Unspecified	968	50	2		

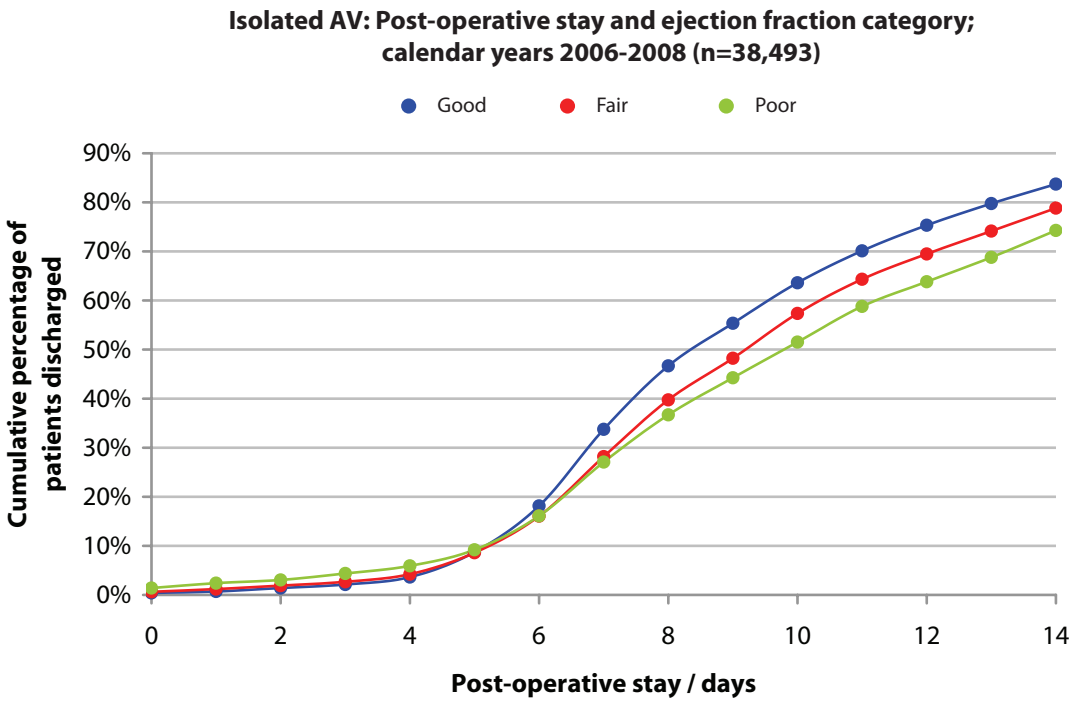


Ejection fraction and post-operative stay

Again, there are marked differences in post-operative length-of-stay depending on the patient's ejection fraction: those with poor left ventricular function stay, on average, 2 days longer following AV surgery and 3 days longer after combined AV & CABG surgery.

Post-operative stay after isolated aortic valve surgery broken down by ejection fraction category; calendar years 2006-2008

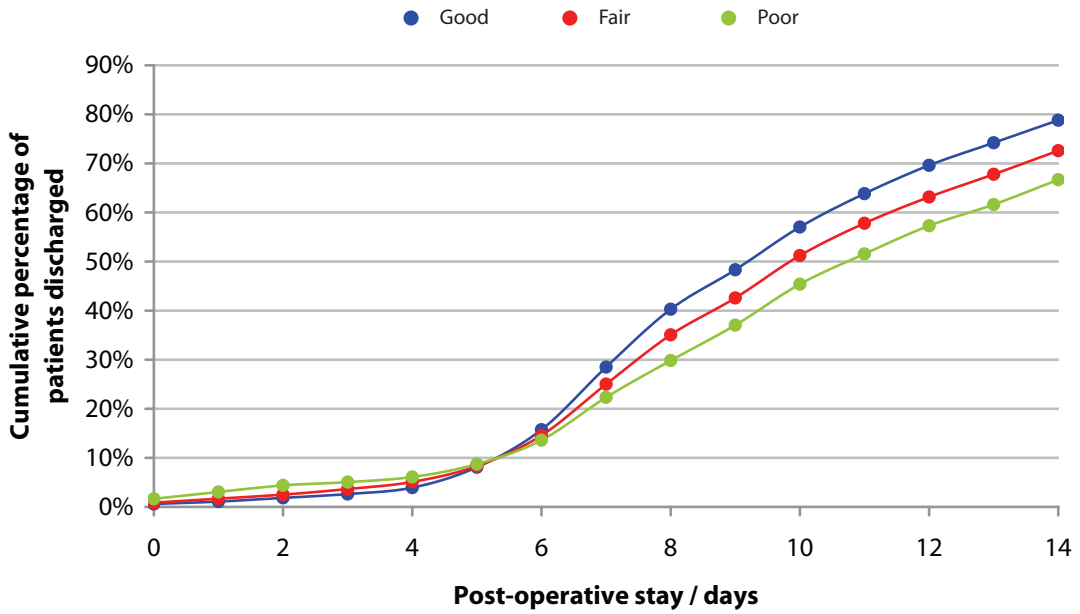
		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Ejection fraction category	Good (>49%)	27,713	9.0	11.3	0.06
	Fair (30-49%)	8,649	10.0	12.5	0.13
	Poor (<30%)	2,131	10.0	13.5	0.31
	Unspecified	1,618	8.0	10.6	0.27
	All	**40,111**	**9.0**	**11.7**	**0.06**



Post-operative stay after combined aortic valve & CABG surgery broken down by ejection fraction category; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Ejection fraction category	Good (>49%)	15,559	10.0	12.4	0.09
	Fair (30-49%)	6,876	10.0	14.0	0.17
	Poor (<30%)	1,639	11.0	15.2	0.33
	Unspecified	657	9.0	10.9	0.37
	All	**24,731**	**10.0**	**13.0**	**0.08**

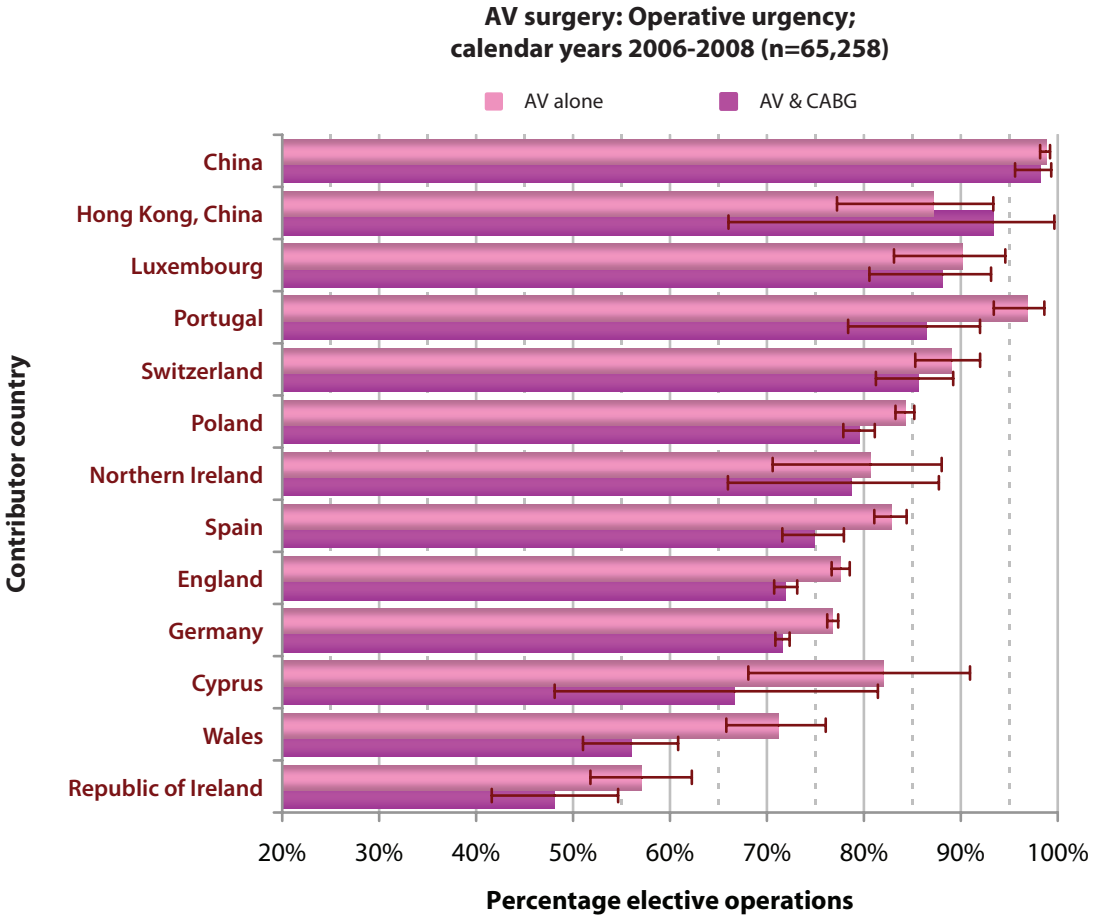
AV & CABG: Post-operative stay and ejection fraction category; calendar years 2006-2008 (n=24,074)



Operative urgency

Operative urgency distributions

Elective patients are those who are admitted from home for their surgery. The reported proportion of patients undergoing isolated AV surgery as elective cases varies between countries from less than 50% up to nearly 100%.



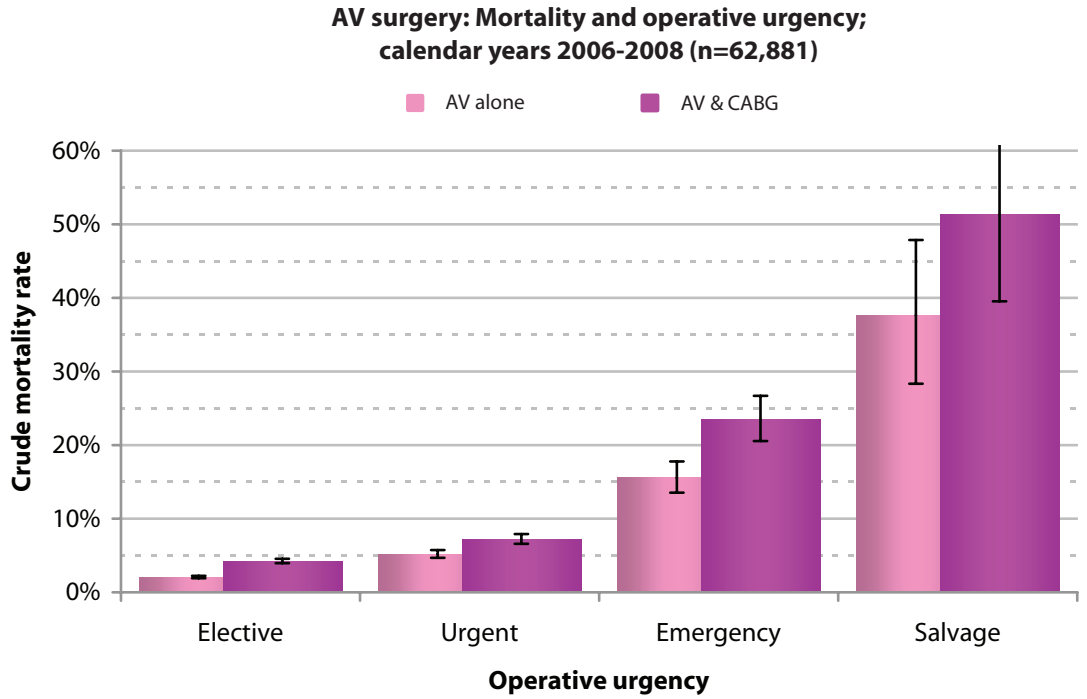
n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Operative urgency and mortality

Operative urgency is strongly associated with mortality. The volume of salvage surgery is small and these patients have a very high mortality rate.

Mortality at the time of discharge after aortic valve surgery broken down by operative urgency; countries that submitted mortality data, excluding China [1]; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Operative urgency	Isolated AV	Elective	29,418	622	47	2.1%	(1.9-2.2%)
		Urgent	6,631	363	6	5.2%	(4.7-5.7%)
		Emergency	989	182	1	15.5%	(13.5-17.8%)
		Salvage	63	38	0	37.6%	(28.3-47.9%)
		Unspecified	1,596	23	0		
	AV & CABG	Elective	17,045	756	41	4.2%	(4.0-4.6%)
		Urgent	5,509	429	13	7.2%	(6.6-7.9%)
		Emergency	583	179	0	23.5%	(20.6-26.7%)
		Salvage	36	38	0	51.4%	(39.5-63.0%)
		Unspecified	1,457	36	0		



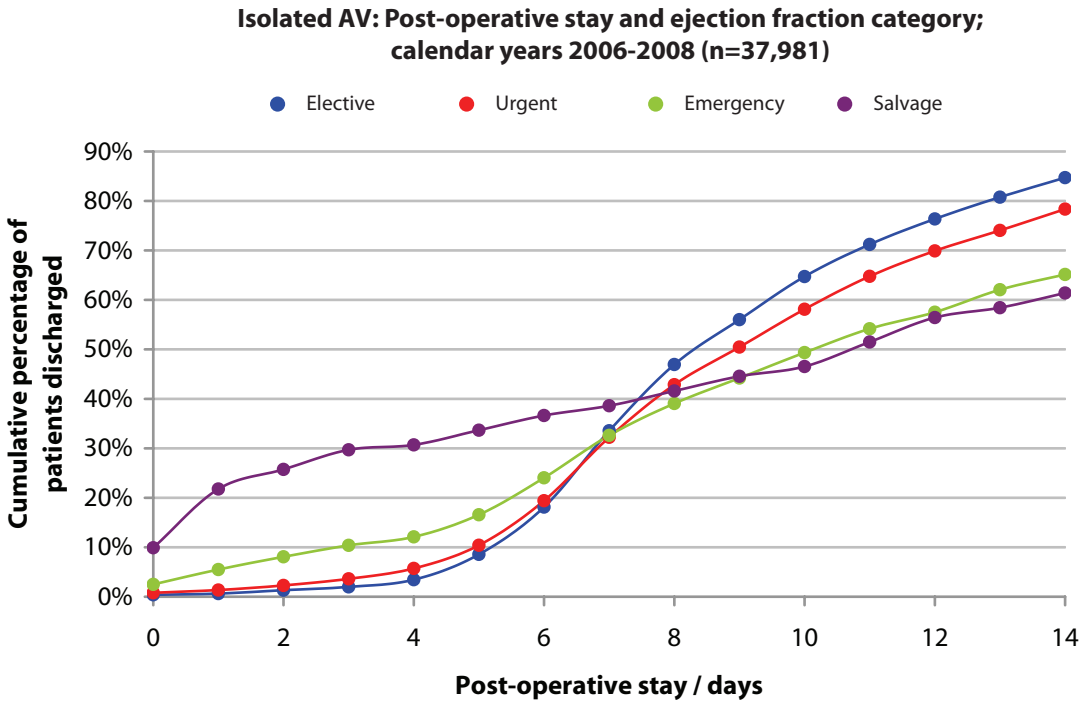
1 The data from China were excluded from these analyses as their data were classified as *Elective*, *Urgent/emergency* and *Salvage*. Their inclusion would have meant that the *Urgent* and *Emergency* classes would have had to have been merged, and much of the power of this story would have been lost. The Chinese *Elective* and *Salvage* data were excluded in order to avoid and skewing of the results for these two sub-divisions of the urgency data field due to any putative Country-effect.

Operative urgency and post-operative stay

Again, length-of-stay is greater after non-elective surgery.

Post-operative stay after isolated aortic valve surgery broken down by operative urgency, excluding data from China [1]; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Operative urgency	Elective	29,771	9.0	11.2	0.06
	Urgent	6,944	9.0	12.6	0.14
	Emergency	1,165	11.0	15.3	0.54
	Salvage	101	11.0	15.3	1.64
	Unspecified	139	9.0	12.1	1.22
	All	**38,120**	**9.0**	**11.6**	**0.06**

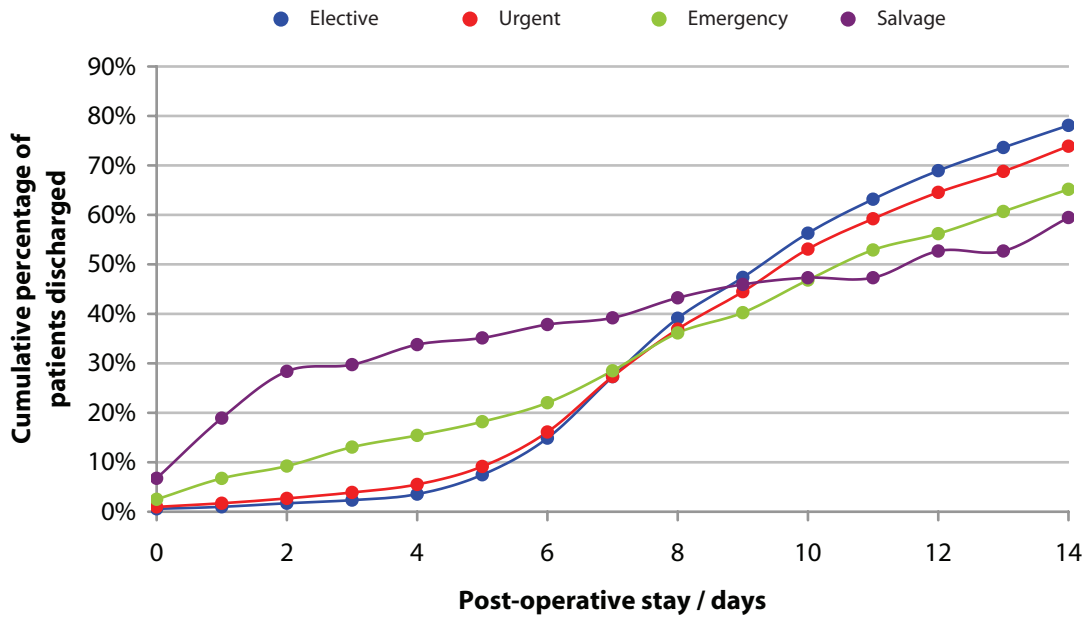


1 The data from China were excluded from these analyses as their data were classified as *Elective*, *Urgent / emergency* and *Salvage*. Their inclusion would have meant that the *Urgent* and *Emergency* classes would have had to have been merged, and much of the power of this story would have been lost. The Chinese *Elective* and *Salvage* data were excluded in order to avoid and skewing of the results for these two sub-divisions of the urgency data field due to any putative Country-effect.

Post-operative stay after combined aortic valve & CABG surgery broken down by operative urgency, excluding data from China; calendar years 2006-2008

		Post-operative stay			
		Count	Median / days	Average / days	Standard error
Operative urgency	Elective	17,667	10.0	12.7	0.09
	Urgent	5,897	10.0	13.7	0.17
	Emergency	758	11.0	14.4	0.50
	Salvage	74	12.0	14.1	1.56
	Unspecified	59	10.0	13.6	1.62
	All	**24,455**	**10.0**	**13.0**	**0.08**

AV & CABG: Post-operative stay and ejection fraction category; calendar years 2006-2008 (n=24,396)



Other risk factors for isolated aortic valve surgery

Distributions, mortality and post-operative stay for other risk factors; calendar years 2006-2008

			Counts by zone	
			Northern	Central
Risk factor	Body Mass Index	<20.0	41	1,176
		20.0-24.9	350	9,741
		25.0-29.9	378	14,637
		30.0-34.9	140	7,256
		>34.9	54	2,709
		Unspecified	505	470
	Angina	CCS 0	0	16,219
		CCS 1	0	4,911
		CCS 2	0	6,715
		CCS 3	0	3,789
		CCS 4	0	521
		Unspecified	1,468	3,834
	Diabetes	No	1,324	28,803
		Yes	144	7,002
		Unspecified	0	184
	Smoking history	Never smoked	0	6,970
		Ex-smoker	0	6,127
		Current smoker	0	1,107
		Unspecified	1,468	21,785
	Extra-cardiac arteriopathy	No	0	31,335
		Yes	0	4,311
		Unspecified	1,468	343
	Renal disease	No	0	14,134
		Yes	0	154
		Unspecified	1,468	21,701
	Hypertension	No	0	6,073
		Yes	0	8,390
		Unspecified	1,468	21,526
	Left main stem disease	No	1,287	33,146
		Yes	13	324
		Unspecified	168	2,519
	Previous cardiac surgery	No	0	32,237
		Yes	0	3,187
		Unspecified	1,468	565

Counts by zone			Mortality rate	Post-operative stay
Southern	Asia	All	% (count; 95 % CI)	av. days (count; SE)
40	364	**1,621**	5.6% (1,618; 4.6-6.9%)	12.7 (1,566; 0.28)
522	1,167	**11,780**	3.2% (11,759; 2.9-3.5%)	11.8 (11,338; 0.11)
1,037	490	**16,542**	2.7% (16,530; 2.4-2.9%)	11.3 (16,023; 0.09)
548	46	**7,990**	2.6% (7,978; 2.3-3.0%)	11.6 (7,771; 0.12)
200	3	**2,966**	3.3% (2,961; 2.7-4.1%)	12.5 (2,879; 0.24)
97	0	**1,072**		
541	1,992	**18,752**	2.7% (18,725; 2.5-3.0%)	11.5 (18,618; 0.07)
139	21	**5,071**	2.5% (5,062; 2.1-3.0%)	11.2 (5,016; 0.14)
335	38	**7,088**	2.9% (7,077; 2.5-3.3%)	11.1 (7,016; 0.12)
212	13	**4,014**	4.0% (4,010; 3.4-4.7%)	12.3 (3,990; 0.19)
40	5	**566**	8.3% (565; 6.2-11.0%)	13.9 (560; 0.61)
1,177	1	**6,480**		
1,788	1,978	**33,893**	2.6% (33,846; 2.5-2.8%)	11.4 (32,261; 0.06)
587	91	**7,824**	4.4% (7,820; 3.9-4.8%)	12.9 (7,616; 0.15)
69	1	**254**		
1,518	43	**8,531**	2.4% (8,504; 2.1-2.8%)	11.0 (8,353; 0.15)
638	27	**6,792**	2.9% (6,771; 2.6-3.4%)	11.0 (6,634; 0.16)
202	7	**1,316**	1.9% (1,314; 1.3-2.8%)	11.0 (1,292; 0.46)
86	1,993	**25,332**		
2,109	76	**33,520**	2.8% (33,476; 2.6-3.0%)	11.4 (33,183; 0.06)
242	2	**4,555**	5.5% (4,547; 4.8-6.2%)	14.2 (4,525; 0.17)
93	1,992	**3,896**		
2,187	2,053	**18,374**	2.3% (18,322; 2.1-2.5%)	11.1 (18,006; 0.10)
4	15	**173**	11.6% (173; 7.4-17.5%)	14.4 (169; 1.32)
253	2	**23,424**		
806	1,542	**8,421**	1.8% (8,400; 1.6-2.1%)	11.1 (8,268; 0.15)
1,589	527	**10,506**	2.9% (10,475; 2.6-3.3%)	11.3 (10,282; 0.13)
49	1	**23,044**		
1,877	2,058	**38,368**	3.0% (38,331; 2.8-3.2%)	11.5 (36,844; 0.05)
17	3	**357**	7.8% (357; 5.4-11.3%)	14.0 (341; 0.87)
550	9	**3,246**		
2,204	2,025	**36,466**	2.5% (36,417; 2.4-2.7%)	11.4 (36,126; 0.06)
180	45	**3,412**	8.7% (3,409; 7.8-9.8%)	13.9 (3,381; 0.25)
60	0	**2,093**		

Other risk factors for combined aortic valve & CABG surgery

Distributions, mortality and post-operative stay for other risk factors; calendar years 2006-2008

			Counts by zone	
			Northern	Central
Risk factor	Body Mass Index	<20.0	47	557
		20.0-24.9	358	5,796
		25.0-29.9	413	10,448
		30.0-34.9	162	5,082
		>34.9	40	1,521
		Unspecified	406	329
	Angina	CCS 0	0	4,972
		CCS 1	0	2,283
		CCS 2	0	7,363
		CCS 3	0	6,840
		CCS 4	0	1,194
		Unspecified	1,426	1,081
	Diabetes	No	1,198	16,696
		Yes	228	6,918
		Unspecified	0	119
	Smoking history	Never smoked	0	3,432
		Ex-smoker	0	4,930
		Current smoker	0	613
		Unspecified	1,426	14,758
	Extra-cardiac arteriopathy	No	0	18,543
		Yes	0	4,778
		Unspecified	1,426	412
	Renal failure	No	0	8,930
		Yes	0	109
		Unspecified	1,426	14,694
	Hypertension	No	0	2,536
		Yes	0	6,604
		Unspecified	1,426	14,593
	Left main stem disease	No	1,073	19,398
		Yes	188	3,057
		Unspecified	165	1,278
	Previous cardiac surgery	No	0	22,168
		Yes	0	1,197
		Unspecified	1,426	368

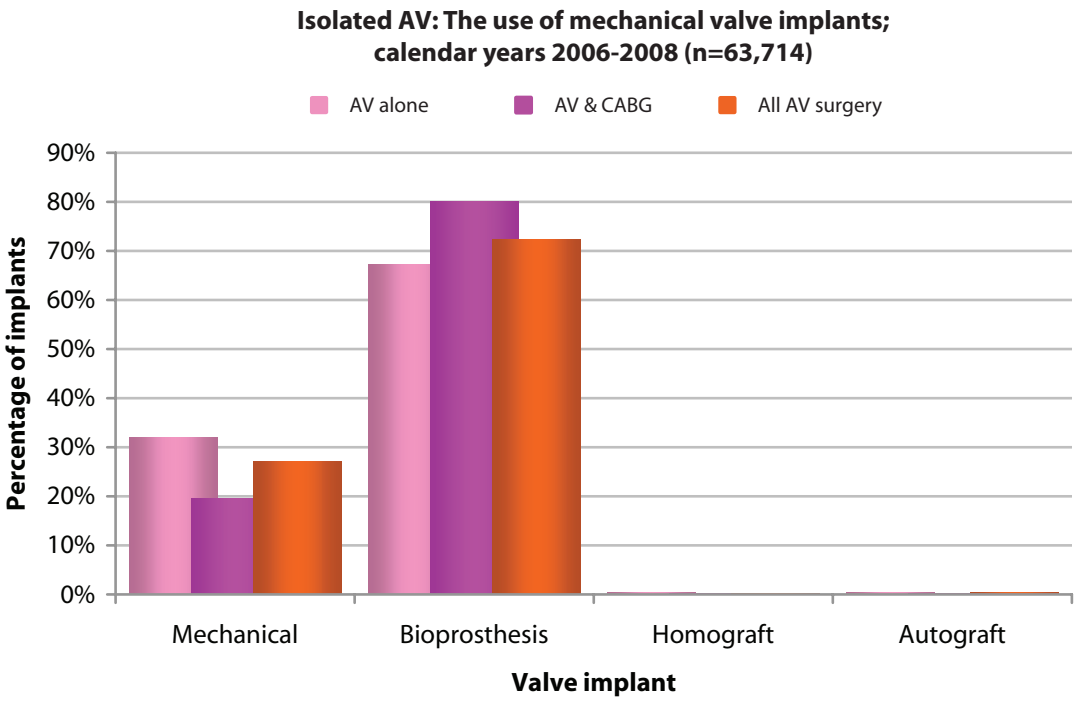
Counts by zone			Mortality rate	Post-operative stay
Southern	Asia	All	% (count; 95 % CI)	av. days (count; SE)
14	31	**649**	9.1% (646; 7.1-11.7%)	14.4 (596; 0.56)
192	149	**6,495**	6.4% (6,481; 5.8-7.0%)	13.0 (6,078; 0.15)
434	101	**11,396**	4.9% (11,378; 4.5-5.3%)	12.7 (10,888; 0.11)
224	11	**5,479**	5.1% (5,468; 4.5-5.7%)	13.2 (5,271; 0.18)
49	0	**1,610**	5.9% (1,605; 4.8-7.2%)	14.2 (1,555 0.36)
35	0	**770**		
135	166	**5,273**	5.8% (5,260; 5.2-6.5%)	13.1 (5,232; 0.18)
61	20	**2,364**	3.9% (2,360; 3.1-4.7%)	12.5 (2,332; 0.27)
221	73	**7,657**	4.4% (7,368; 3.9-4.9%)	12.4 (7,580; 0.12)
202	26	**7,068**	6.3% (7,053; 5.8-6.9%)	13.6 (7,019; 0.15)
72	7	**1,273**	12.4% (1,271; 10.7-14.4%)	14.9 (1,258; 0.39)
257	0	**2,764**		
571	244	**18,709**	4.9% (18,668; 4.6-5.3%)	12.5 (17,339; 0.09)
347	48	**7,541**	6.8% (7,530; 6.3-7.4%)	14.1 (7,267; 0.16)
30	0	**149**		
515	3	**3,950**	5.2% (3,931; 4.6-6.0%)	12.4 (3,856; 0.21)
341	12	**5,283**	5.0% (5,253; 4.4-5.6%)	12.7 (5,165; 0.19)
63	0	**676**	4.7% (675; 3.3-6.7%)	12.7 (664; 0.70)
29	277	**16,490**		
641	15	**19,199**	5.3% (19,155; 5.0-5.6%)	12.7 (19,014;0.08)
276	0	**5,054**	7.2% (5,045; 6.5-8.0%)	14.2 (5,009; 0.20)
31	277	**2,146**		
834	285	**10,049**	4.9% (9,998; 4.5-5.3%)	12.5 (9,822; 0.14)
2	7	**118**	12.9% (116; 7.7-20.7%)	16.3 (114; 1.41)
112	0	**16,232**		
222	110	**2,868**	5.1% (2,859; 4.4-6.0%)	12.0 (2,805; 0.24)
712	182	**7,498**	5.0% (7,454; 4.5-5.5%)	12.8 (7,330; 0.17)
14	0	**16,033**		
682	260	**21,413**	5.2% (21,365; 5.0-5.6%)	12.9 (20,178; 0.08)
124	32	**3,401**	7.6% (3,396; 6.8-8.6%)	13.5 (3,188; 0.21)
142	0	**1,585**		
905	290	**23,363**	5.3% (23,313; 5.0-5.6%)	13.0 (23,140; 0.08)
23	2	**1,222**	14.0% (1,221; 12.1-16.1%)	14.0 (1,216; 0.36)
20	0	**1,814**		

Valve implants

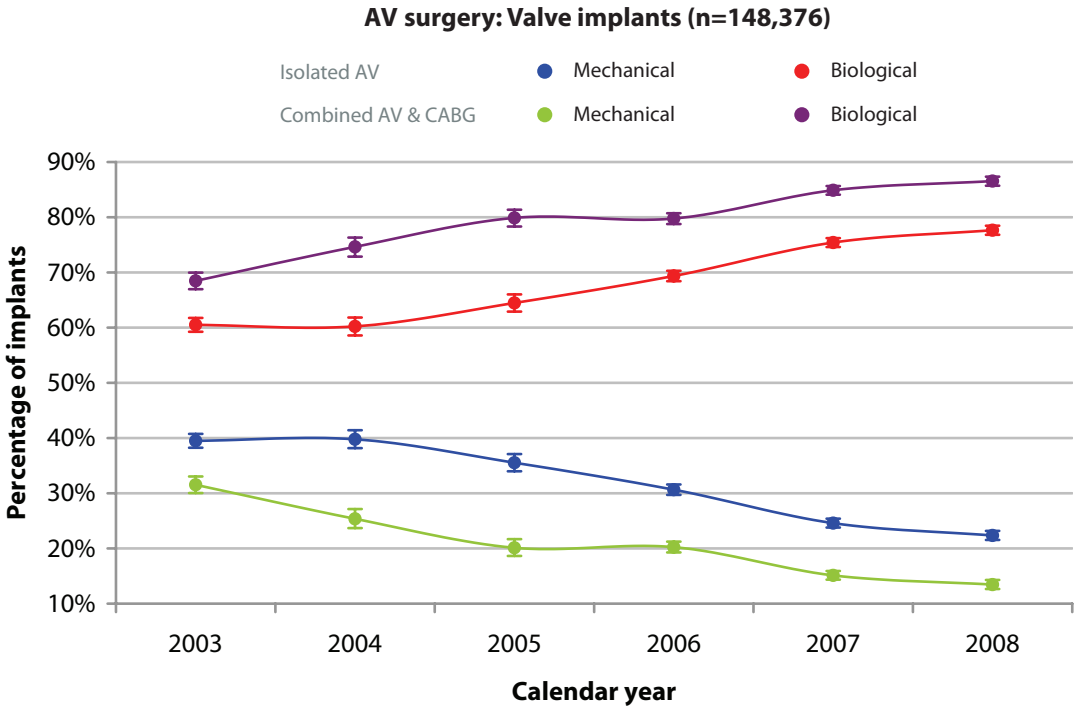
Overall, about one-third of valves implanted during isolated AV & one-fifth of valves implanted during combined AV & CABG surgery are mechanical valves. The vast majority of the remainder are bioprostheses.

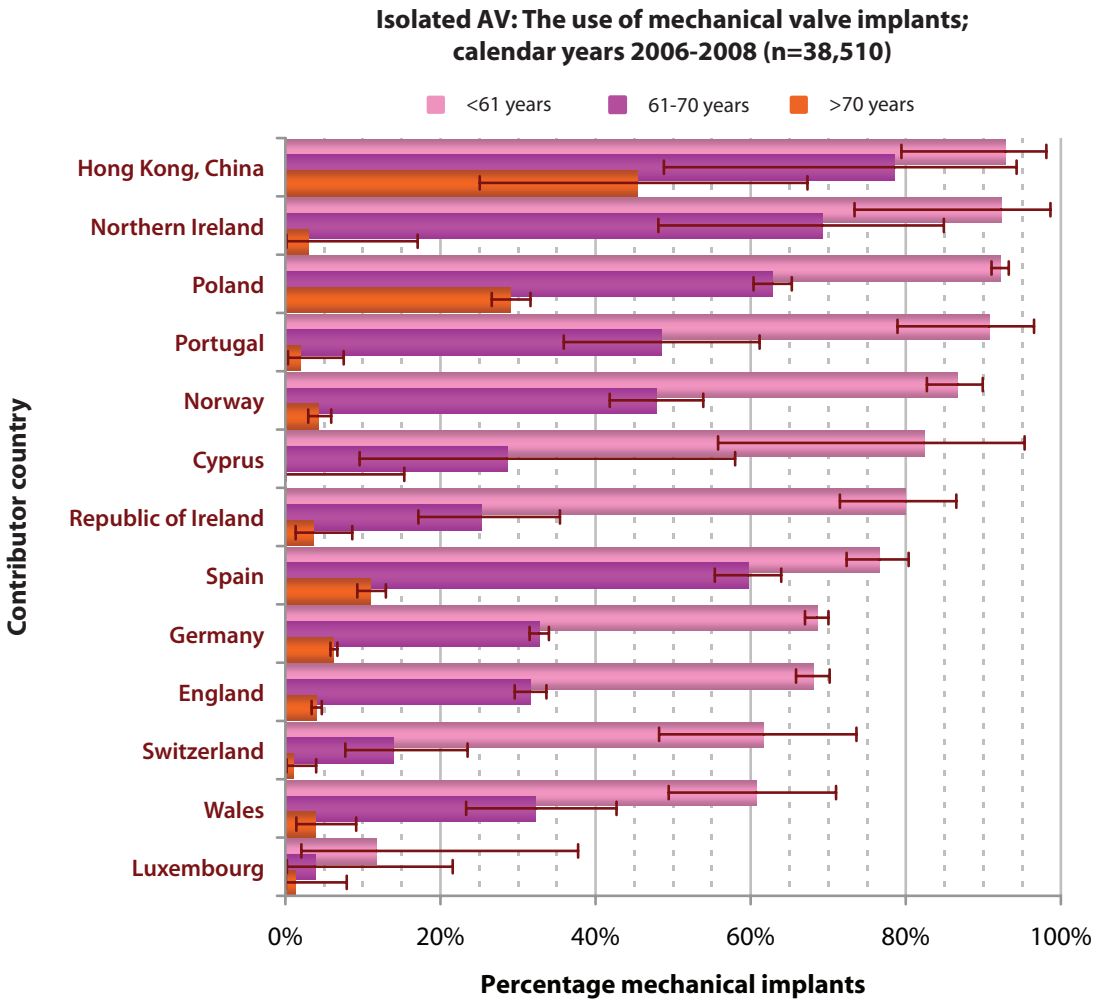
Implanted prosthesis distributions for aortic valve surgery; calendar years 2006-2008

		Procedure		
		Isolated AV	AV & CABG	**All**
Implant type	Mechanical	12,305	4,941	**17,246**
	Bioprosthesis	25,935	20,161	**46,096**
	Homograft	136	29	**165**
	Autograft	159	48	**207**
	Unspecified	3,436	1,220	**4,656**
	All	**41,971**	**26,399**	**68,370**

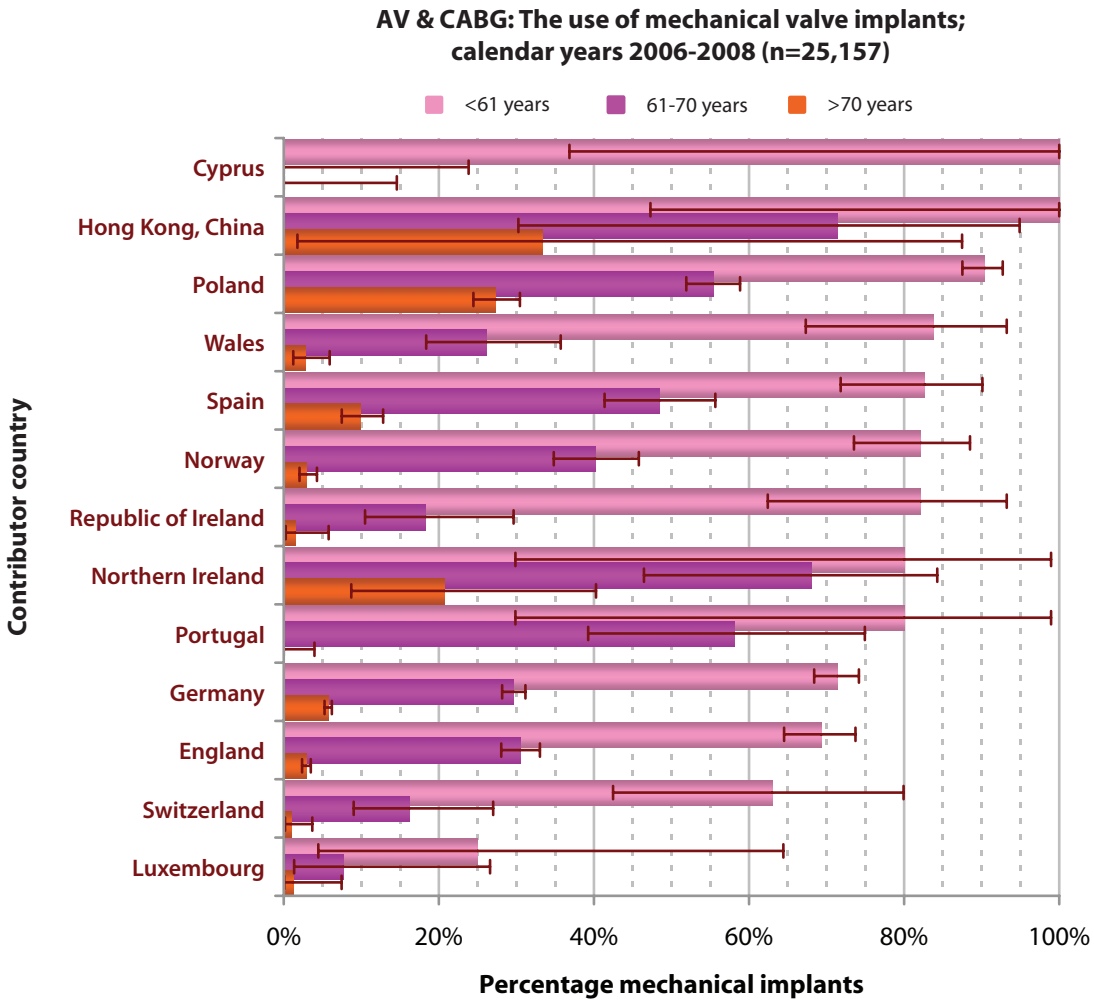


There has been an increase in the proportion of valves that are biological, at the expense of mechanical valves, over time. This applies both to isolated AV and combined AV & CABG surgery.



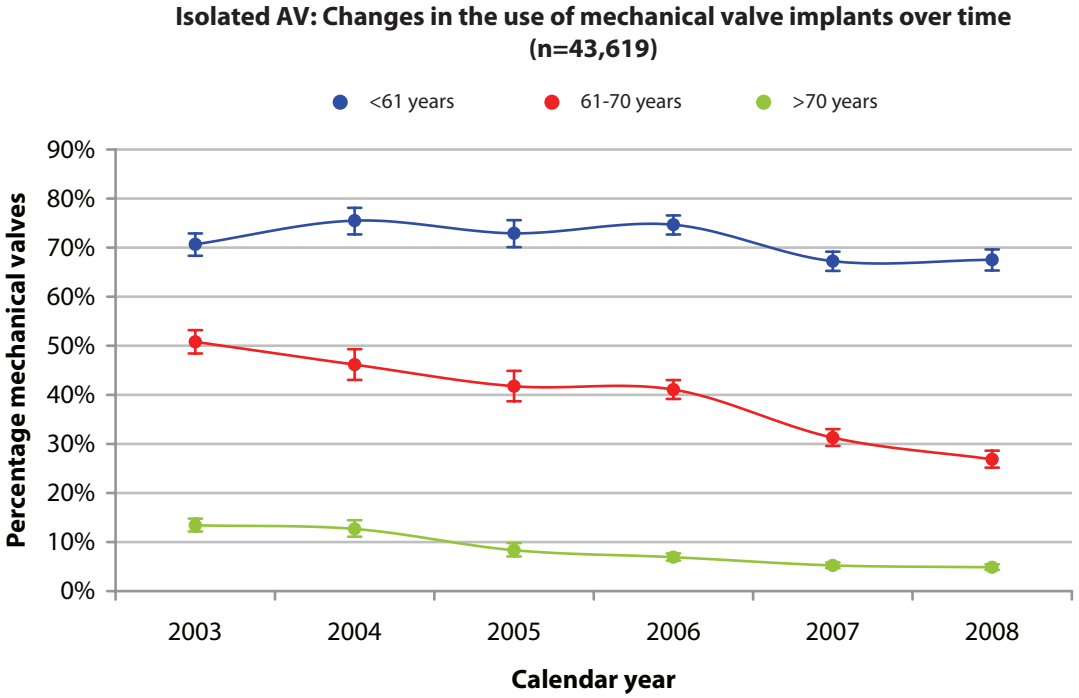


n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.



n.b. The countries highlighted in **brick red** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

The data show that there has been a marked decrease in the proportion of patients undergoing mechanical valve implantation for those over the age of 60 years (χ^2 trend through time $p<0.001$ for all age-groups under analysis, for both isolated AV and combined AV & CABG surgery). This decision-making process is most likely based on data that show better longevity for the modern generation of biological valves [1, 2, 3, 4].



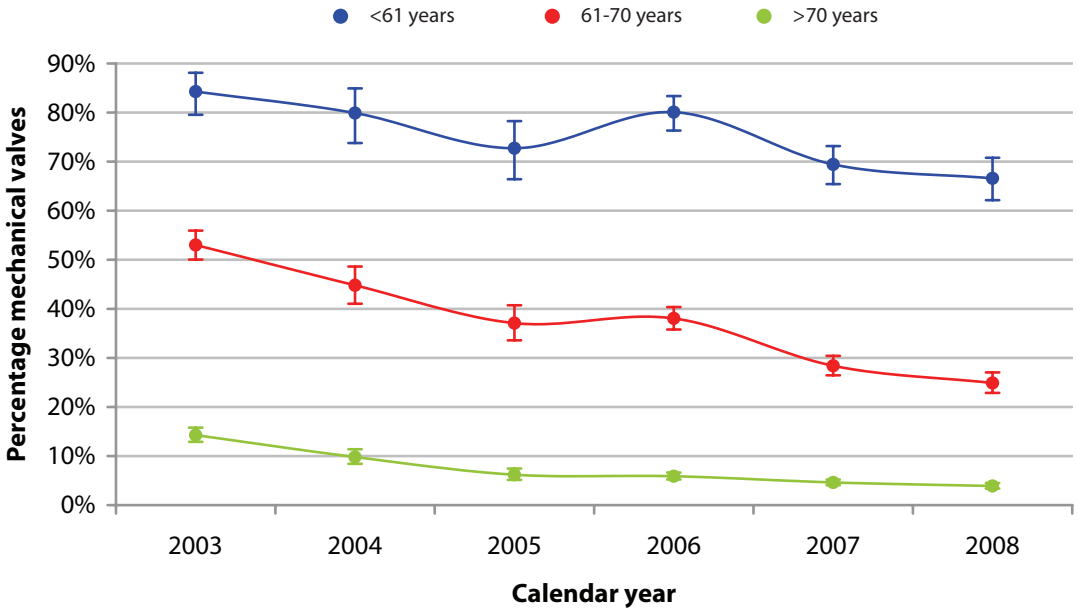
1 Pelletier LC, Carrier M, Leclerk Y, Dyrda I. The Carpentier-Edwards pericardial bioprosthesis; clinical experience with 600 patients. *Ann Thorac Surg.* 1995; **60:** S297-S302

2 Banbury MK, Cosgrove DM, White JA, Blackstone EH, Frater RW, Okies JE. Age and valve size effect on the long-term durability of the Carpentier-Edwards aortic pericardial bioprosthesis. *Ann Thorac Surg.* 2001; **72:** 753-757.

3 Aupart MR, Mirza A, Meurisse YA, Sirinelli AL, Neville PH, Marchand MA. Perimount pericardial bioprosthesis for aortic calcified stenosis; 18-year experience with 1133 patients. *J Heart valve Dis.* 2006; **15(6):** 768-75.

4 Rizzoli G, Mirone S, Lus P, Polesel E, Bottio T, Salvador L, Zussa C, Gerosa G, Valfre C. Fifteen-year results with the Hancock II valve: a multicentre experience. *J Thorac Cardiovasc Surg.* 2006; **13(3):** 602-9.

AV & CABG: Changes in the use of mechanical valve implants over time (n=30,523)

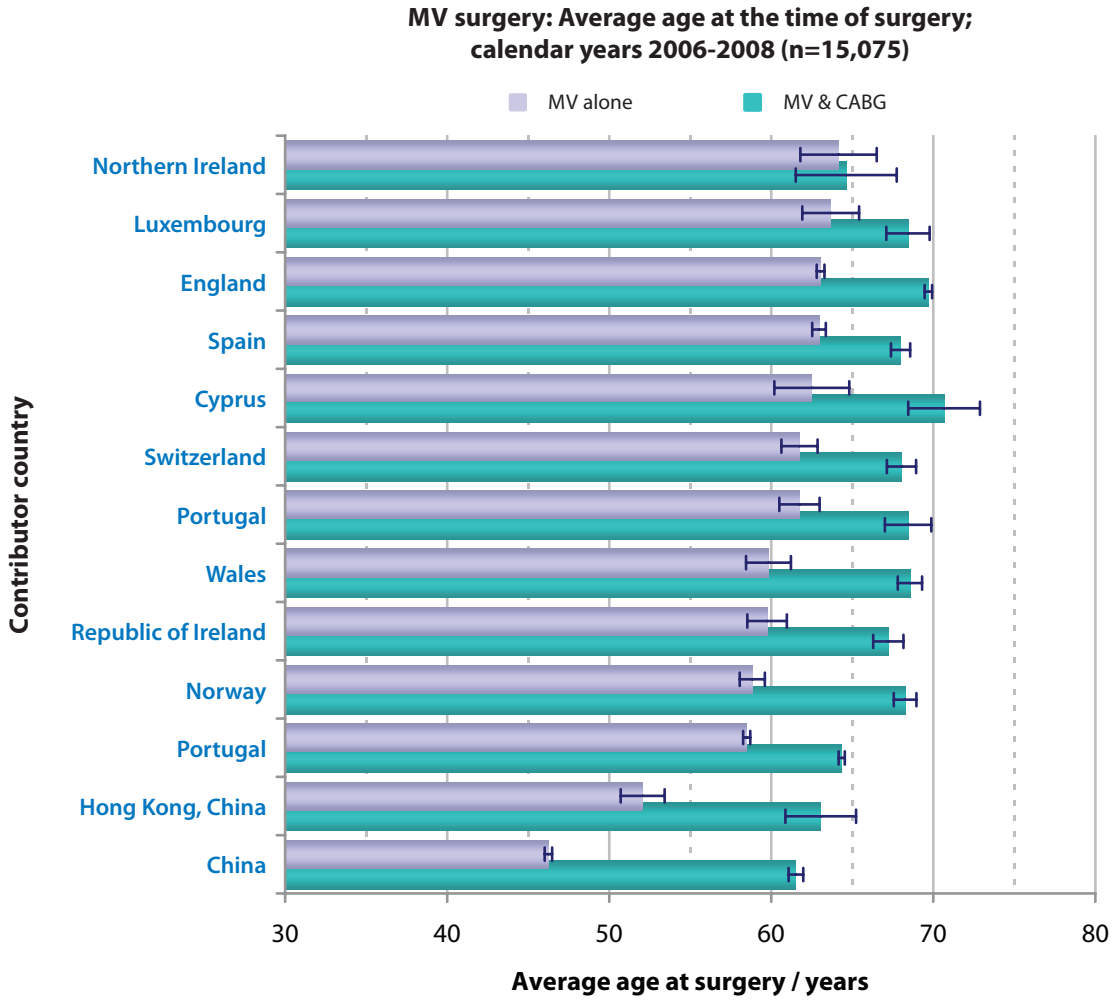


Mitral valve surgery

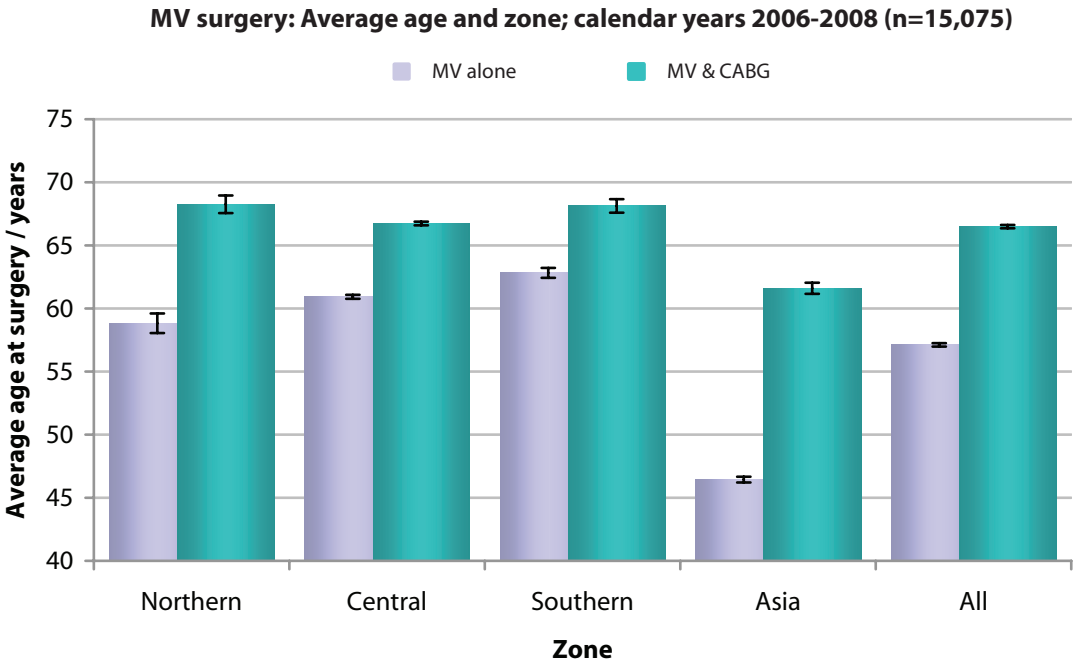
Age at surgery

Age distributions

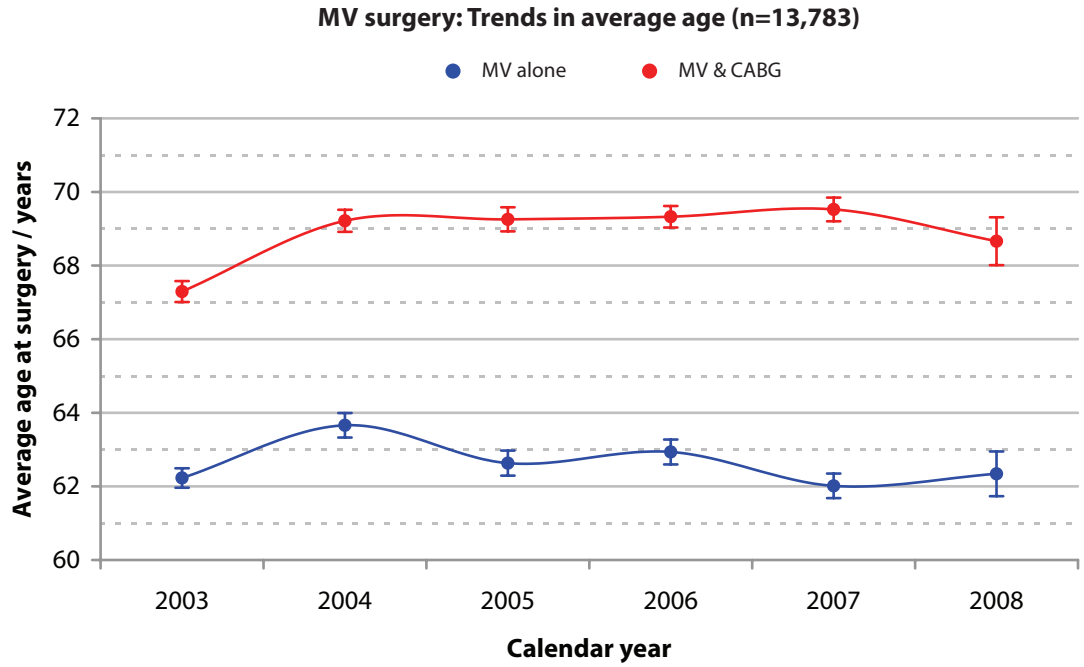
Patients from Asia have a lower average age for mitral surgery than those from other countries submitting to the database.



n.b. The countries highlighted in **blue** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.



There has been little change in the average age of patients coming to mitral surgery over time.



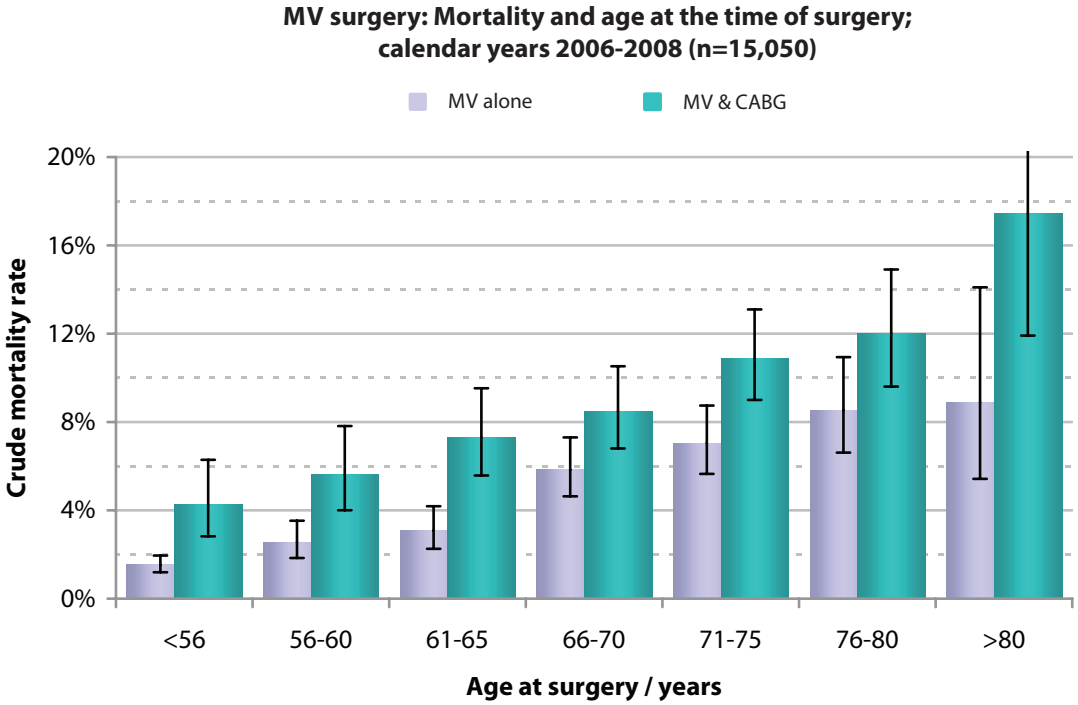
Age and mortality

As with both coronary artery surgery and aortic valve surgery, increasing age is associated with higher mortality. Combined mitral valve & CABG surgery has a higher mortality than isolated valve surgery. This is almost certainly due to different pathologies in the combined MV & CABG surgery group (more patients with ischaemic aetiology) as well as the mortality associated with the more complex and prolonged combined procedure.

Mortality at the time of discharge after mitral valve surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Age at surgery / years	Isolated MV	**All patients**	**10,124**	**376**	**17**	**3.6%**	**(3.2-4.0%)**
		<56	4,308	67	2	1.5%	(1.2-2.0%)
		56-60	1,448	38	3	2.6%	(1.8-3.5%)
		61-65	1,319	42	4	3.1%	(2.3-4.2%)
		66-70	1,195	74	2	5.8%	(4.6-7.3%)
		71-75	1,042	79	1	7.0%	(5.7-8.7%)
		76-80	632	59	3	8.5%	(6.6-10.9%)
		>80	174	17	2	8.9%	(5.4-14.1%)
		Unspecified	6	0	0		
	MV & CABG	**All patients**	**4,168**	**393**	**8**	**8.6%**	**(7.8-9.5%)**
		<56	564	25	0	4.2%	(2.8-6.3%)
		56-60	587	35	0	5.6%	(4.0-7.8%)
		61-65	671	53	2	7.3%	(5.6-9.5%)
		66-70	841	78	2	8.5%	(6.8-10.5%)
		71-75	835	102	1	10.9%	(9.0-13.1%)
		76-80	542	74	2	12.0%	(9.6-14.9%)
		>80	123	26	1	17.4%	(11.9-24.7%)
		Unspecified	5	0	0		

As with both coronary artery surgery and aortic valve surgery, there is strong association between increasing age and increased mortality. The mortality for patients over the age of 80 undergoing combined MV & CABG surgery is strikingly high at 17.4%.

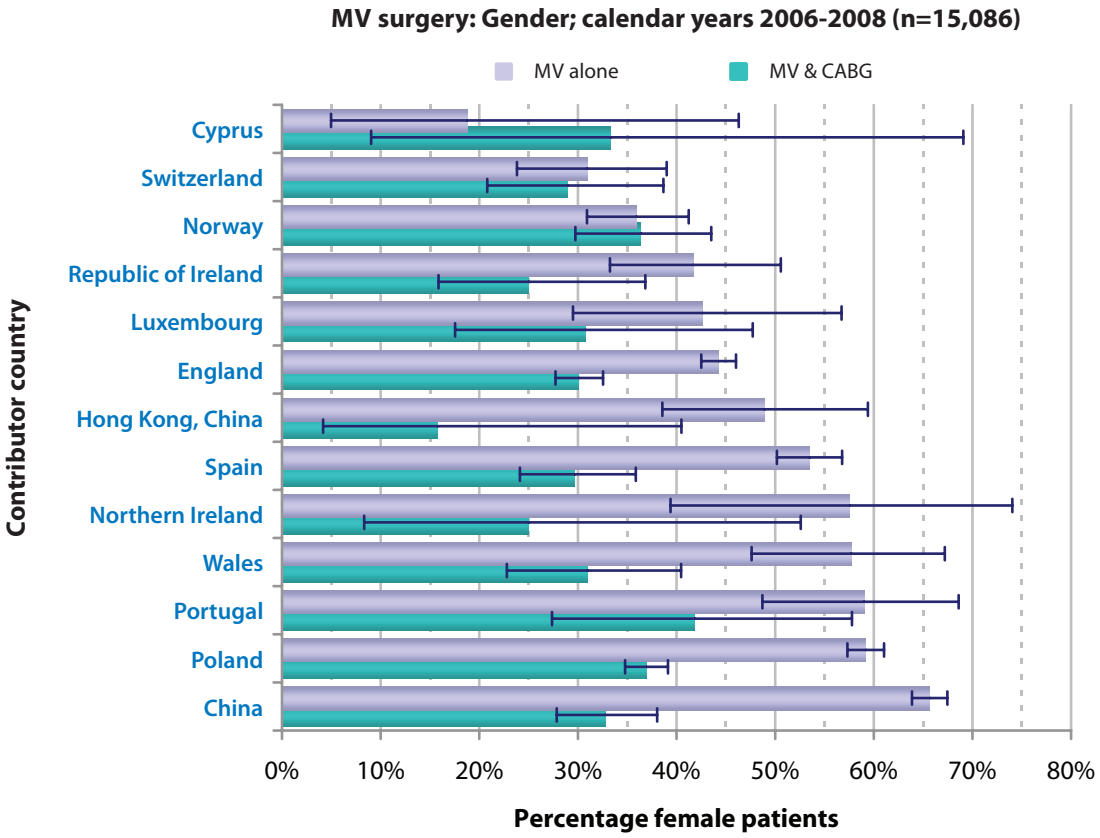


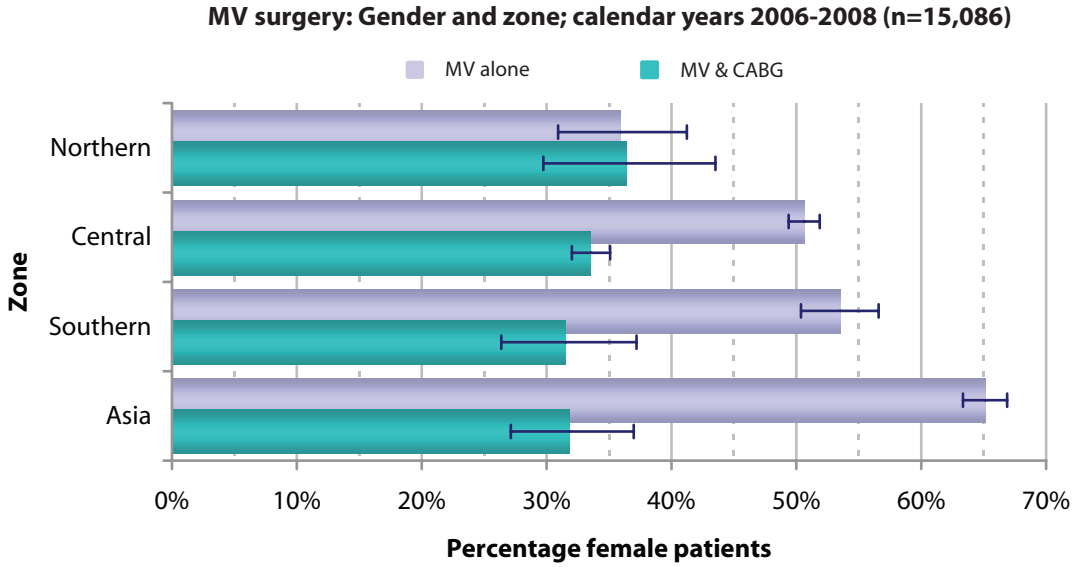
Gender

Gender distributions

Overall 48.0% of patients presenting for MV surgery are women compared to 22.0% for CABG surgery and 38.0% for AV surgery (p<0.001 for both comparisons). There is a difference in gender incidence between mitral surgery and combined mitral & CABG surgery, due to the differing incidence of the aetiologies in the two groups (with a higher incidence of ischaemic mitral disease, and the association of ischaemic heart disease with male gender).

There is a large variation across countries, ranging from less than 20% female patients undergoing isolated mitral surgery up to 66%. These are profound variations.



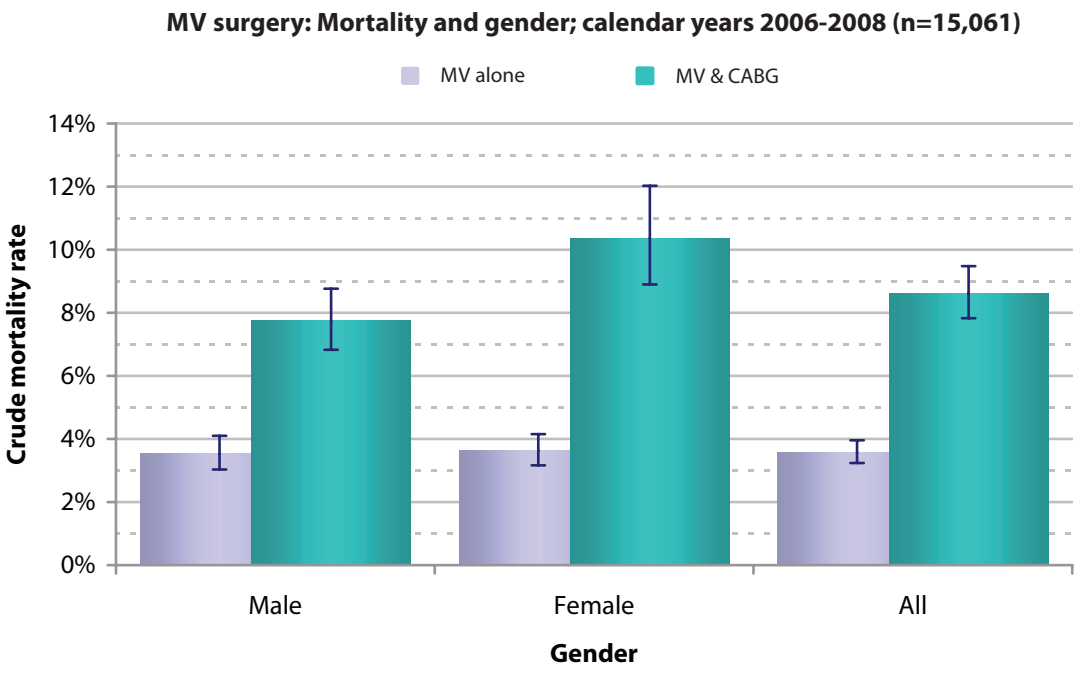


Gender and mortality

Unlike isolated coronary artery and AV surgery, female gender is not associated with a higher mortality following isolated MV surgery. There is a differential mortality following combined MV & CABG surgery.

Mortality at the time of discharge after mitral valve surgery broken down by gender; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Gender	Isolated MV	Male	4,622	169	11	3.5%	(3.0-4.1%)
		Female	5,502	207	6	3.6%	(3.2-4.2%)
		Unspecified	0	0	0		
	MV & CABG	Male	2,801	235	7	7.7%	(6.8-8.8%)
		Female	1,367	158	1	10.4%	(8.9-12.0%)
		Unspecified	0	0	0		

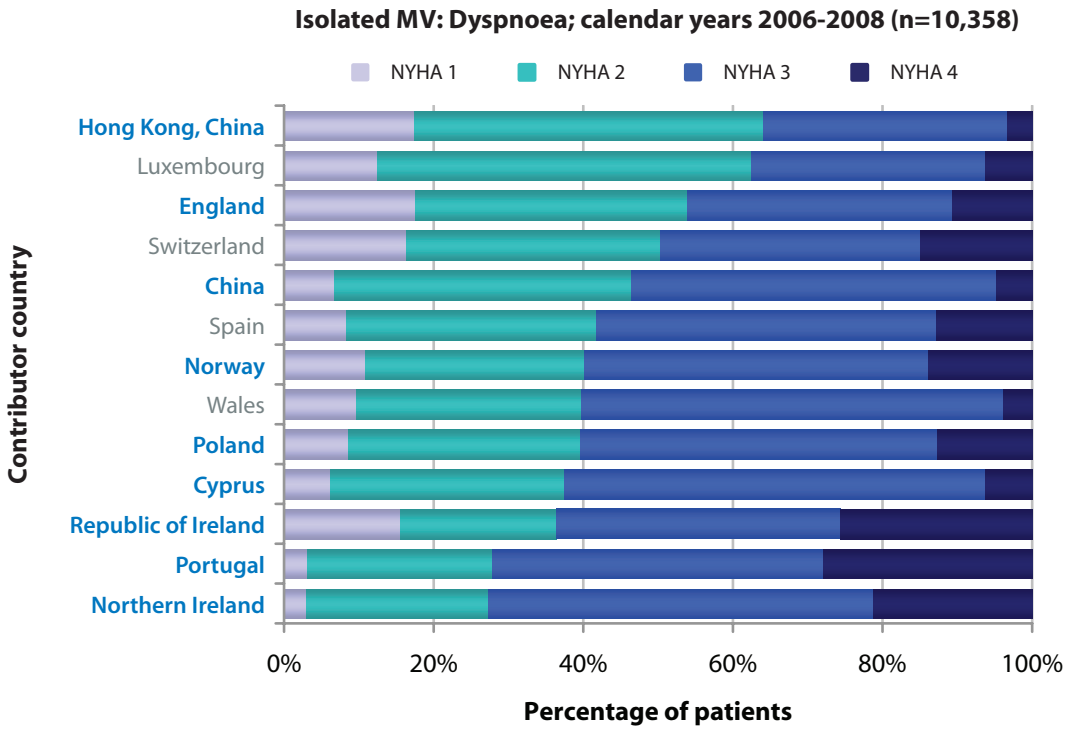


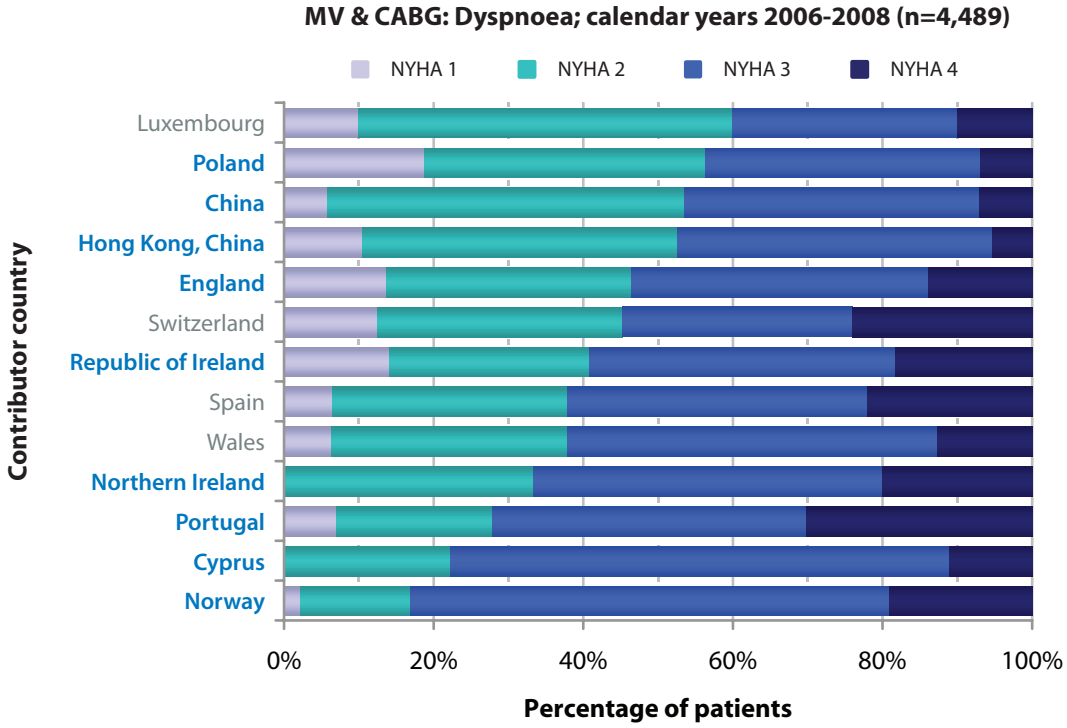
Dyspnoea

Dyspnoea distributions

Patients undergo surgery for mitral valve disease for a variety of indications, but there has been a major change for patients with degenerative mitral valve disease towards earlier surgery, and mitral repair is now indicated for asymptomatic patients with severe regurgitation and left ventricular dysfunction or dilatation; some centres undertake surgery purely on the basis of the magnitude of mitral regurgitation [1].

The data presented below, which are based on all patients undergoing either mitral valve repair or replacement, irrespective of aetiology, shows that NYHA class 1 patients form a small proportion of MV surgery overall (12.0%) ranging from 0.0% up to 18.8% between countries. The proportion who have class 4 symptoms, who would not expect to derive optimum benefit from surgery, form 10.5% overall ranging from 3.3% to 30.2%.



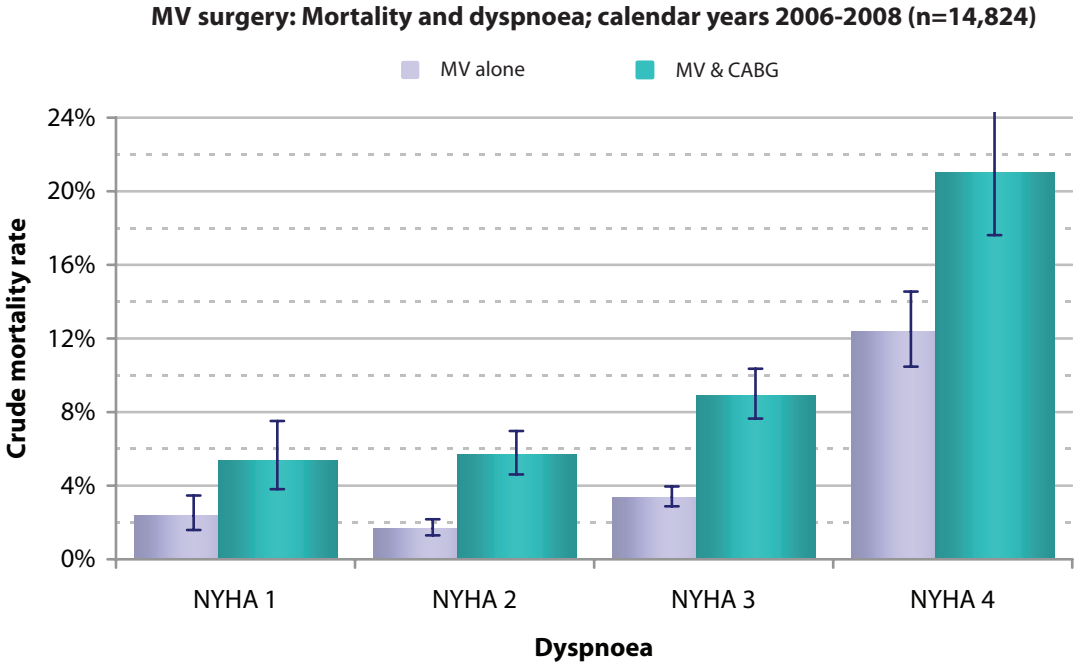


Dyspnoea and mortality

Patients with the most severe symptoms have a high mortality of 12.4% after isolated MV surgery and 21.0% after combined MV & CABG surgery.

Mortality at the time of discharge after mitral valve surgery broken down by NYHA grade; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
NYHA grade	Isolated MV	NYHA 1	1,116	27	0	2.4%	(1.6-3.5%)
		NYHA 2	3,561	61	5	1.7%	(1.3-2.2%)
		NYHA 3	4,374	153	9	3.4%	(2.9-4.0%)
		NYHA 4	921	130	1	12.4%	(10.5-14.5%)
		Unspecified	152	5	2		
	MV & CABG	NYHA 1	598	34	0	5.4%	(3.8-7.5%)
		NYHA 2	1,478	89	3	5.7%	(4.6-7.0%)
		NYHA 3	1,615	158	4	8.9%	(7.6-10.4%)
		NYHA 4	402	107	1	21.0%	(17.6-24.9%)
		Unspecified	75	5	0		

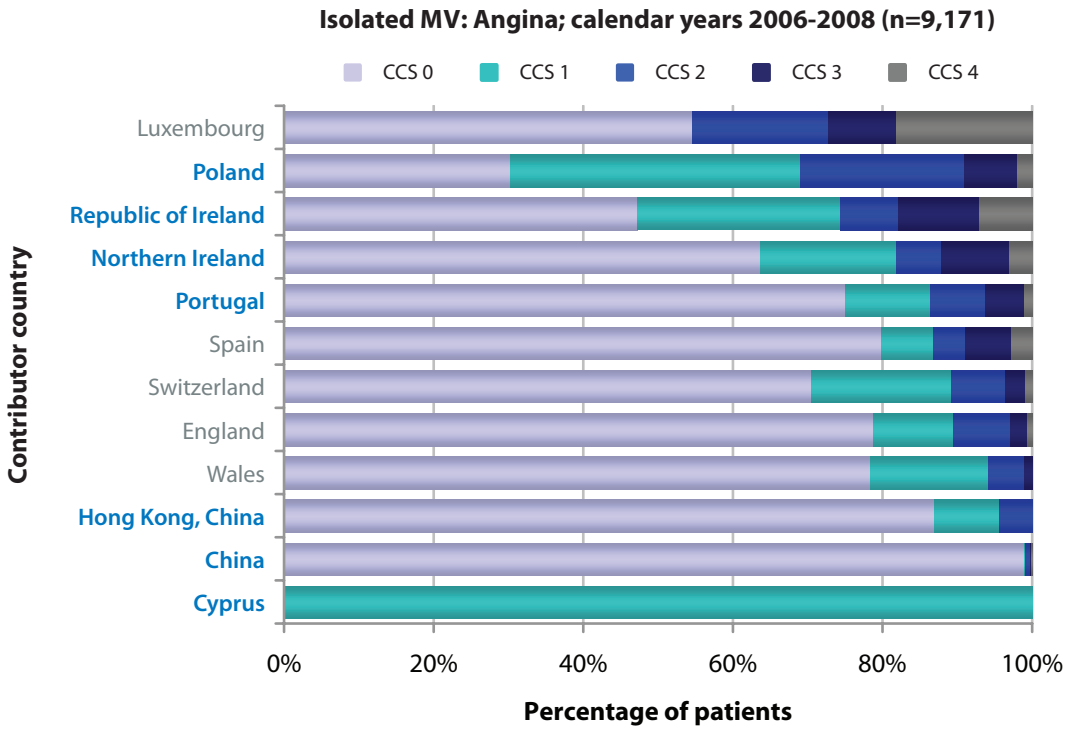


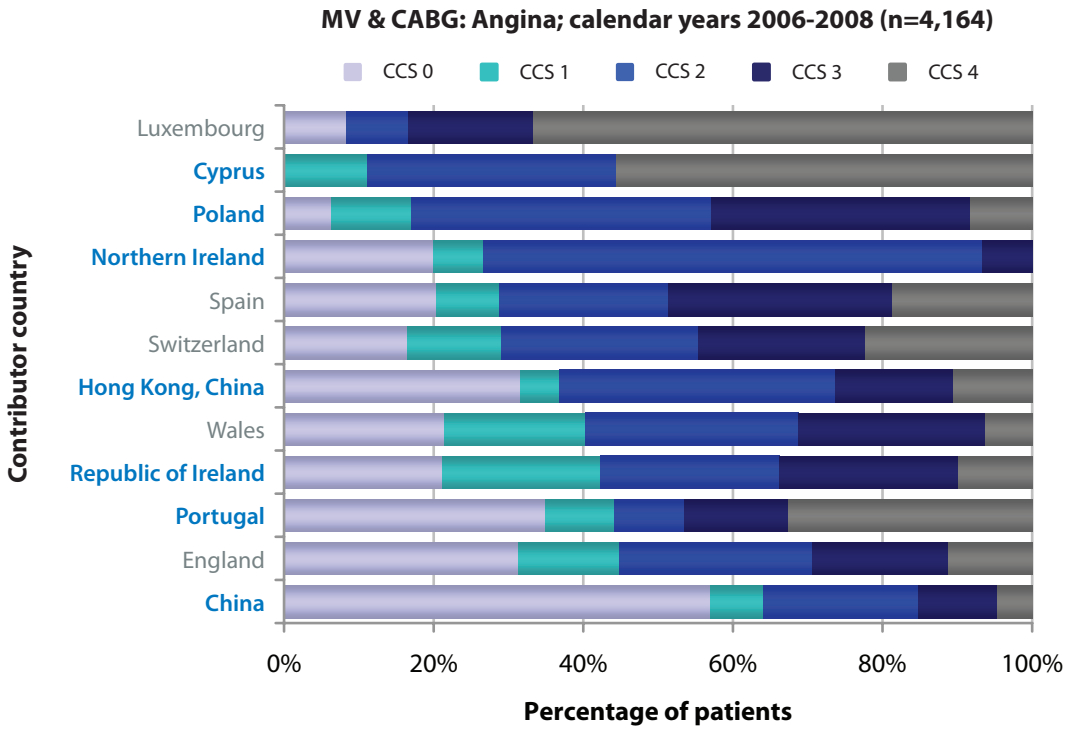
1 Bonow RO, Carabello BA, Chatterjee K, de Leon AC, Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM and Shanewise JS. 2008 Focused Update Incorporated Into the ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease. *Journal of American College of Cardiology*. 2008; **52:**1-142, doi:10.1016/j.jacc.2008.05.007

Angina

Angina distributions

The majority of patients for isolated MV surgery do not have angina. There is, however, a surprising proportion reporting angina in some countries, which may, possibly, be due to issues with data quality. Angina is obviously far more common for patients undergoing combined MV & CABG surgery.





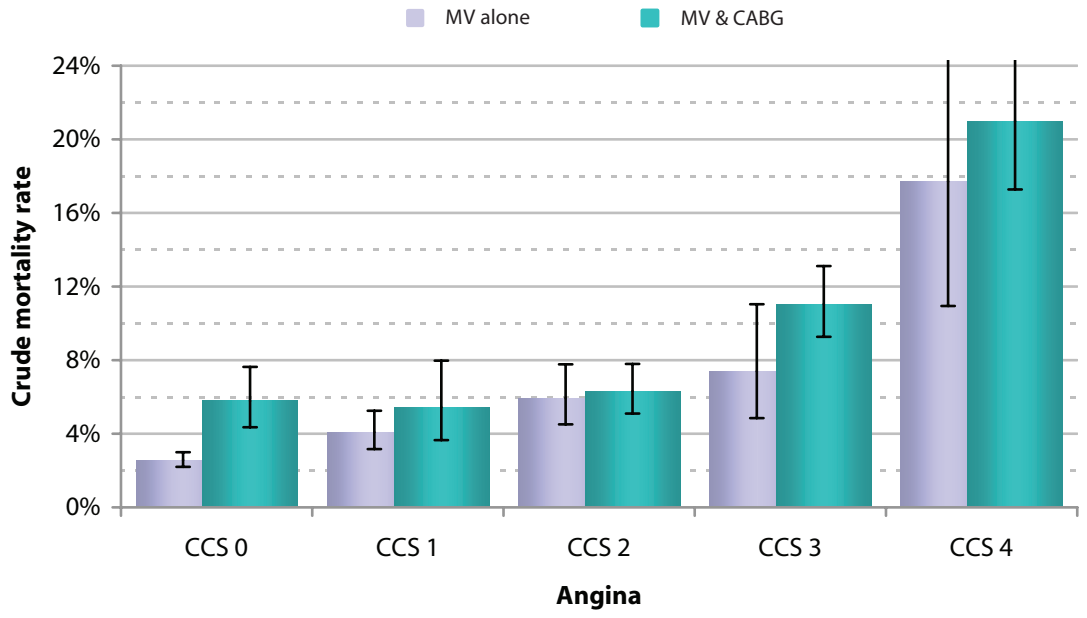
Angina and mortality

Increasing angina status is associated with increasing mortality for both isolated MV and combined MV & CABG surgery. The mortality rates for patients with class 4 symptoms are strikingly high at 17.7% and 21.0% respectively.

Mortality at the time of discharge after mitral valve surgery broken down by CCS class; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
CCS Class	Isolated MV	CCS 1	6,216	164	12	2.6%	(2.2-3.0%)
		CCS 2	1,432	61	4	4.1%	(3.2-5.3%)
		CCS 2	823	52	0	5.9%	(4.5-7.8%)
		CCS 3	288	23	0	7.4%	(4.8-11.0%)
		CCS 4	79	17	0	17.7%	(10.9-27.1%)
		Unspecified	1,286	59	1		
	MV & CABG	CCS 1	798	49	3	5.8%	(4.4-7.6%)
		CCS 2	452	26	1	5.4%	(3.7-8.0%)
		CCS 2	1,246	84	2	6.3%	(5.1-7.8%)
		CCS 3	958	119	2	11.0%	(9.3-13.1%)
		CCS 4	335	89	0	21.0%	(17.3-25.2%)
		Unspecified	379	26	0		

MV surgery: Mortality and angina; calendar years 2006-2008 (n=13,311)

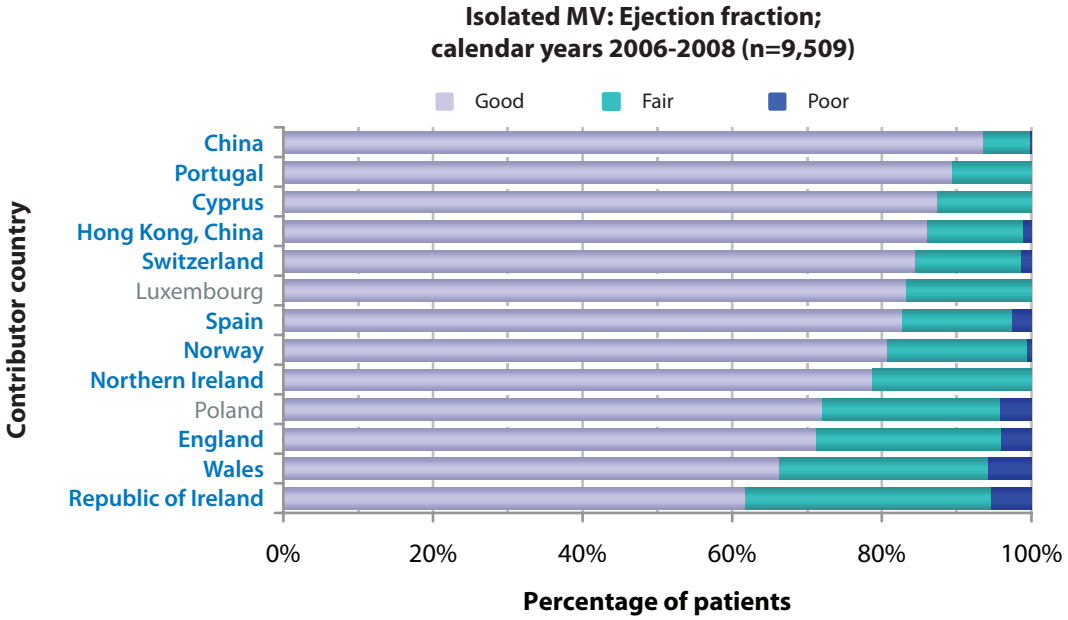


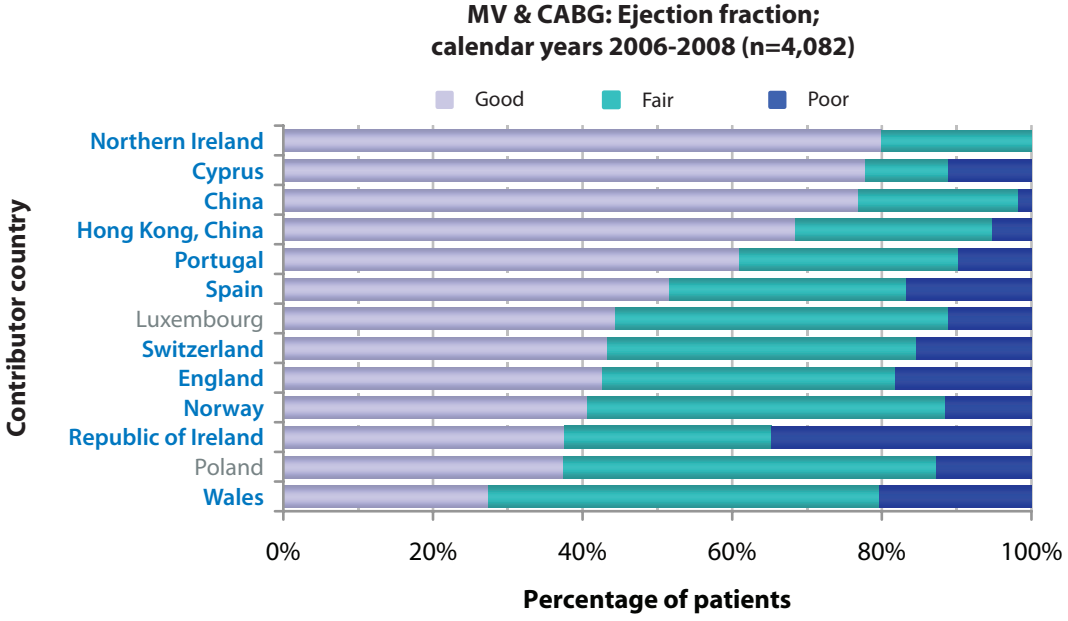
Ejection fraction

Ejection fraction distributions

Ejection fraction is classified in the database as good, moderate or poor, & the calculation is based on the ejection fraction value. This can become confused in patients with mitral regurgitation; patients with quite abnormal left ventricular ejection fraction in the presence of severe mitral regurgitation may still have an ejection fraction >50% and so be classified as having *normal* left ventricular function. The comparative data between countries show quite marked differences, with a high incidence of good left ventricular function in the Asian contributions, which may represent a higher proportion of patients with mitral stenosis from rheumatic valve disease, which is usually associated with preserved left ventricular function.

Only a small proportion of patients presenting for isolated mitral surgery have poor left ventricular function, but the proportion for combined MV & CABG surgery is much higher reflecting the association between ischaemic heart disease and left ventricular impairment.



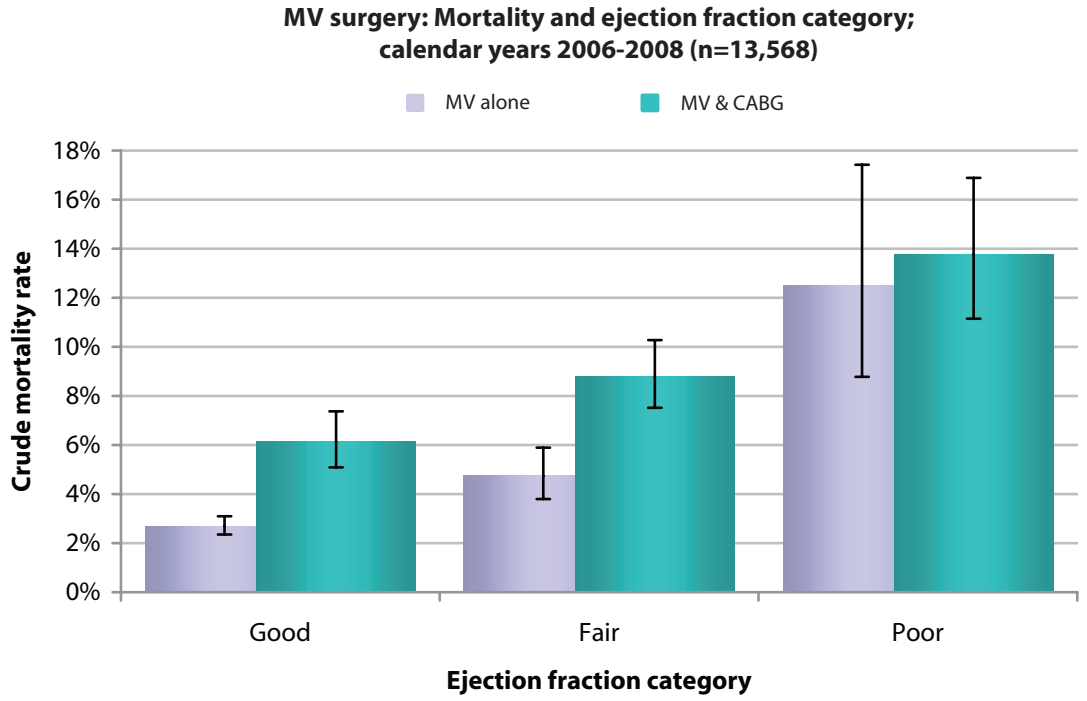


Ejection fraction and mortality

Progressive impairment of left ventricular function is associated with a marked increase in operative mortality for both isolated MV surgery and combined MV & CABG surgery.

Mortality at the time of discharge after mitral valve surgery broken down by ejection fraction category; countries that submitted mortality data; calendar years 2006-2008

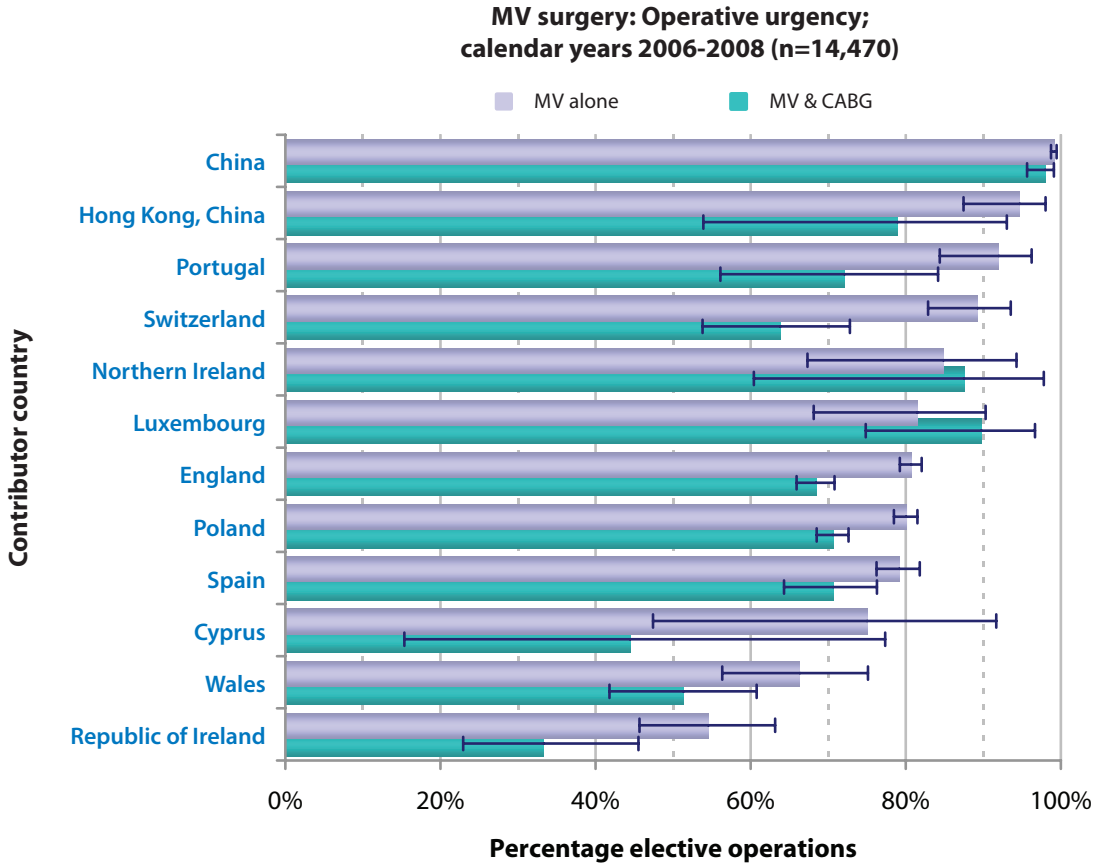
			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Ejection fraction category	Isolated MV	Good	7,354	204	11	2.7%	(2.4-3.1%)
		Fair	1,608	80	4	4.7%	(3.8-5.9%)
		Poor	217	31	0	12.5%	(8.8-17.4%)
		Unspecified	945	61	2		
	MV & CABG	Good	1,683	110	4	6.1%	(5.1-7.4%)
		Fair	1,544	149	4	8.8%	(7.5-10.3%)
		Poor	507	81	0	13.8%	(11.1-16.9%)
		Unspecified	434	53	0		



Operative urgency

Operative urgency distributions

There is, again, marked variation in operative urgency between countries, with a particularly high incidence of elective surgery in the patients from Asia and very low rates in the Republic of Ireland.



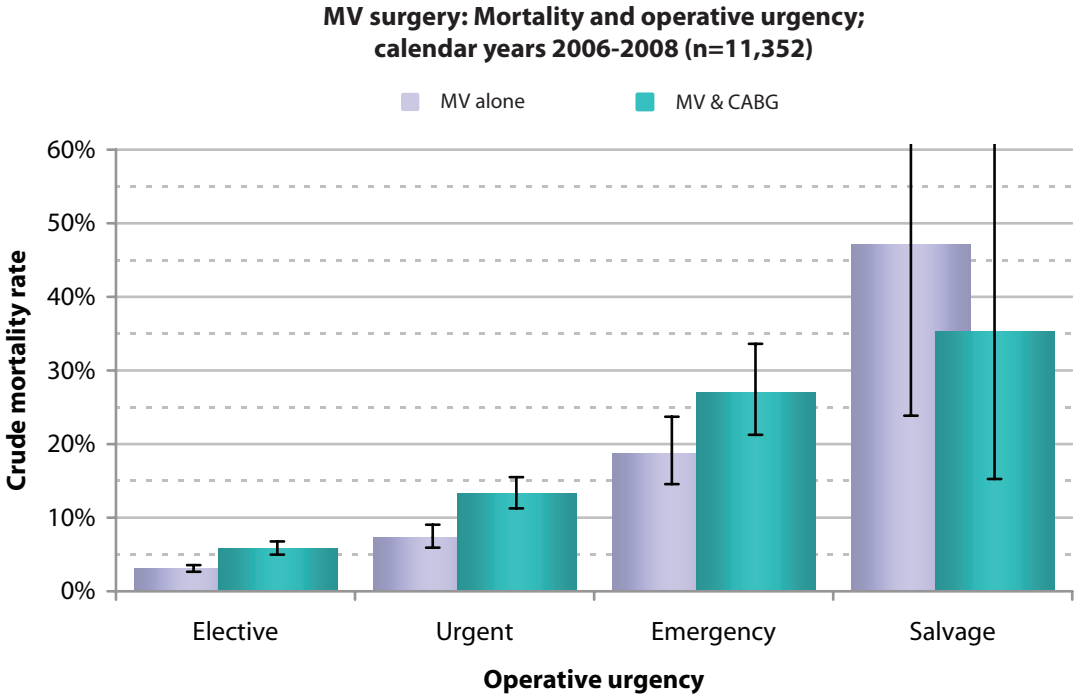
n.b. The countries highlighted in **blue** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Operative urgency and mortality

Operative urgency is strongly associated with increasing mortality.

Mortality at the time of discharge after mitral valve surgery broken down by operative urgency; countries that submitted mortality data, excluding China; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Operative urgency	Isolated AV	Elective	5,704	181	13	3.1%	(2.7-3.6%)
		Urgent	1,060	84	4	7.3%	(5.9-9.0%)
		Emergency	243	56	0	18.7%	(14.6-23.7%)
		Salvage	9	8	0	47.1%	(23.9-71.5%)
		Unspecified	392	12	0		
	AV & CABG	Elective	2,592	160	6	5.8%	(5.0-6.8%)
		Urgent	891	136	2	13.2%	(11.3-15.5%)
		Emergency	154	57	0	27.0%	(21.3-33.6%)
		Salvage	11	6	0	35.3%	(15.3-61.4%)
		Unspecified	200	12	0		



Other risk factors for isolated mitral valve surgery

The following tables give, for completeness, the incidence of the various risk factors not reported in detail above.

Distributions, mortality and post-operative stay for other major risk factors not reported in detail; calendar years 2006-2008

			Counts by zone	
			Northern	Central
Risk factor	Body Mass Index	<20.0	17	446
		20.0-24.9	81	2,312
		25.0-29.9	67	2,312
		30.0-34.9	15	905
		>34.9	8	233
		Unspecified	160	99
	Diabetes	No	332	5,645
		Yes	16	640
		Unspecified	0	22
	Smoking history	Never smoked	0	3,416
		Ex-smoker	0	2,318
		Current smoker	0	465
		Unspecified	348	108
	Extra-cardiac arteriopathy	No	0	5,941
		Yes	0	343
		Unspecified	348	23
	Renal failure	No	0	6,113
		Yes	0	87
		Unspecified	348	107
	Hypertension	No	0	3,348
		Yes	0	2,940
		Unspecified	348	19
	Left main stem disease	No	286	5,373
		Yes	2	42
		Unspecified	60	892
	Previous cardiac surgery	No	0	5,369
		Yes	0	737
		Unspecified	348	201

Counts by zone			Mortality rate	Post-operative stay
Southern	Asia	All	% (count; 95 % CI)	av. days (count; SE)
36	816	**1,315**	2.7% (1,312; 1.9-3.7%)	13.4 (1,288; 0.25)
327	1,460	**4,180**	3.4% (4,174; 2.9-4.0%)	12.8 (4,024; 0.19)
445	503	**3,327**	3.9% (3,321; 3.2-4.6%)	11.8 (3,195; 0.24)
129	60	**1,109**	4.4% (1,107; 3.3-5.9%)	11.9 (1,078; 0.37)
39	6	**286**	2.8% (286; 1.3-5.6%)	12.9 (276; 0.60)
41	0	**300**		
796	2,752	**9,525**	3.0% (9,510; 2.7-3.4%)	12.2 (9,037; 0.12)
171	92	**919**	9.3% (918; 7.5-11.4%)	14.2 (888; 0.62)
50	1	**73**		
663	60	**4,139**	4.0% (4,131; 3.5-4.7%)	11.7 (4,032; 0.21)
234	29	**2,581**	5.2% (2,575; 4.4-6.2%)	11.9 (2,537; 0.29)
83	5	**553**	4.5% (553; 3.0-6.7%)	12.4 (542; 0.65)
37	0	**493**		
932	92	**6,965**	4.1% (6,949; 3.6-4.6%)	11.8 (6,815; 0.16)
66	2	**411**	11.4% (411; 8.6-15.0%)	13.0 (396; 0.84)
19	2,751	**3,141**		
912	2,827	**9,852**	3.3% (9,836; 3.0-3.7%)	12.3 (9,686; 0.12)
3	17	**107**	21.5% (107; 14.4-30.7%)	18.4 (106; 3.51)
102	1	**558**		
503	2,539	**6,390**	2.5% (6,376; 2.1-2.9%)	12.5 (6,302; 0.15)
488	306	**3,734**	5.5% (3,732; 4.8-6.3%)	12.3 (3,649; 0.21)
26	0	**393**		
753	2,822	**9,234**	3.5% (9,223; 3.2-3.9%)	12.4 (8,839; 0.12)
6	6	**56**	5.4% (56; 1.4-15.8%)	14.7 (53; 2.87)
258	17	**1,227**		
751	2,710	**8,830**	2.7% (8,817; 2.4-3.1%)	12.0 (8,696; 0.12)
224	133	**1,094**	10.5% (1,090; 8.7-12.5%)	15.6 (1,062; 0.54)
42	2	**593**		

Other risk factors for combined mitral valve & CABG surgery

The following tables give, for completeness, the incidence of the various risk factors not reported in detail above.

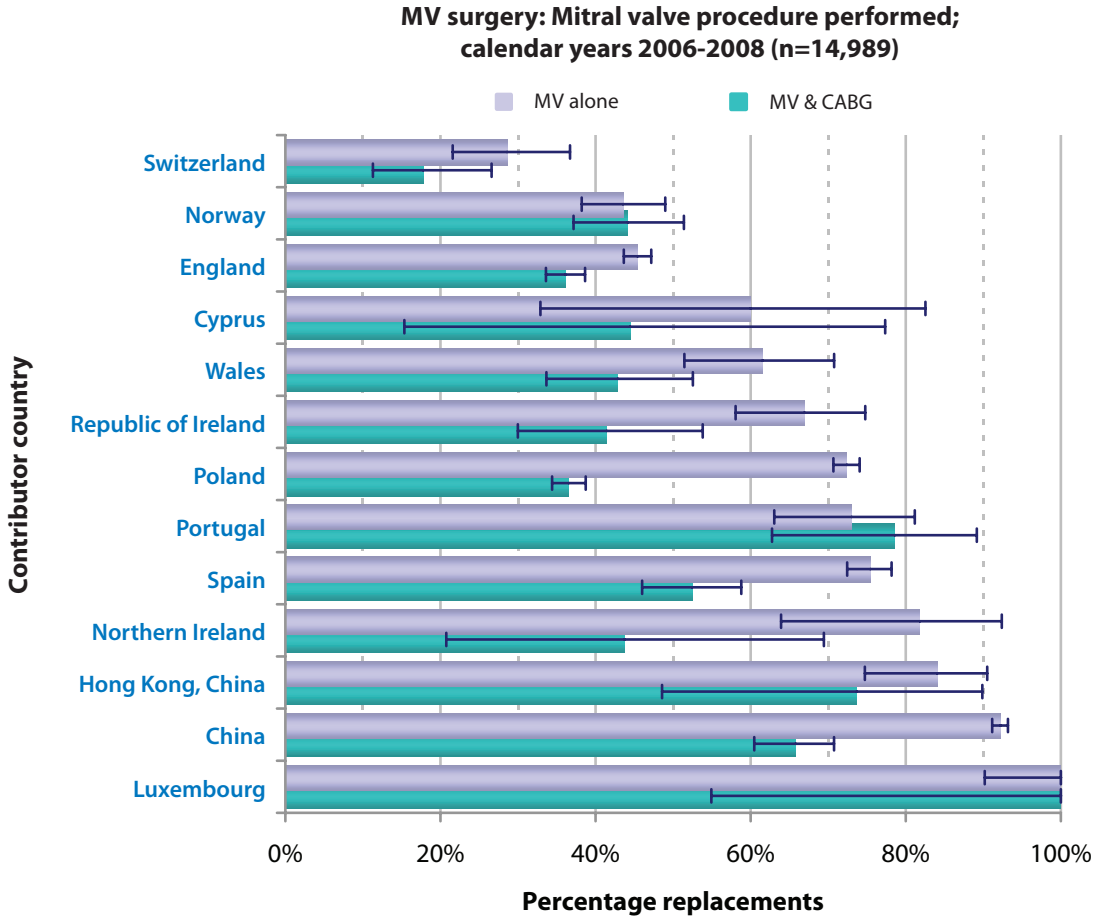
Distributions, mortality and post-operative stay for other major risk factors not reported in detail; calendar years 2006-2008

			Counts by zone	
			Northern	Central
Risk factor	Body Mass Index	<20.0	4	104
		20.0-24.9	45	1,127
		25.0-29.9	49	1,616
		30.0-34.9	14	645
		>34.9	1	138
		Unspecified	85	82
	Diabetes	No	172	2,839
		Yes	26	864
		Unspecified	0	9
	Smoking history	Never smoked	0	1,345
		Ex-smoker	0	1,954
		Current smoker	0	351
		Unspecified	198	62
	Extra-cardiac arteriopathy	No	0	3,142
		Yes	0	558
		Unspecified	198	12
	Renal failure	No	0	3,589
		Yes	0	71
		Unspecified	198	52
	Hypertension	No	0	1,175
		Yes	0	2,530
		Unspecified	198	7
	Left main stem disease	No	141	2,899
		Yes	22	558
		Unspecified	35	255
	Previous cardiac surgery	No	0	3,547
		Yes	0	111
		Unspecified	198	54

Counts by zone			Mortality rate	Post-operative stay
Southern	Asia	All	% (count; 95 % CI)	av. days (count; SE)
8	36	**152**	13.8% (152; 8.9-20.6%)	14.3 (144; 1.03)
85	193	**1,450**	10.4% (1,448; 8.9-12.1%)	13.5 (1,378; 0.34)
123	121	**1,909**	6.5% (1,905; 5.5-7.7%)	13.7 (1,829; 0.39)
52	10	**721**	9.6% (719; 7.6-12.0%)	14.0 (694; 0.63)
20	1	**160**	6.9% (160; 3.7-12.3%)	18.3 (155; 1.84)
10	0	**177**		
183	276	**3,470**	7.4% (3,463; 6.6-8.4%)	13.0 (3,232; 0.23)
110	85	**1,085**	12.3% (1,084; 10.4-14.4%)	16.6 (1,036; 0.65)
5	0	**14**		
145	8	**1,498**	8.8% (1,495; 7.5-10.4%)	14.1 (1,459; 0.47)
107	8	**2,069**	8.8% (2,064; 7.6-10.1%)	13.2 (2,035; 0.30)
38	3	**392**	9.7% (392; 7.0-13.2%)	13.7 (383; 0.81)
8	0	**268**		
205	19	**3,366**	8.4% (3,359; 7.5-9.4%)	13.2 (3,291; 0.25)
86	0	**644**	12.3% (643; 9.9-15.1%)	15.0 (632; 0.70)
7	342	**559**		
253	357	**4,199**	8.4% (4,191; 7.6-9.3%)	13.6 (4,111; 0.23)
0	4	**75**	22.7% (75; 14.1-34.1%)	15.5 (74; 1.86)
45	0	**295**		
83	163	**1,421**	6.2% (1,420; 5.0-7.6%)	13.6 (1,390; 0.38)
210	198	**2,938**	10.0% (2,931; 8.9-11.2%)	14.0 (2880; 0.30)
5	0	**210**		
215	319	**3,574**	7.9% (3,566; 7.1-8.9%)	13.7 (3,377; 0.26)
46	42	**668**	13.0% (668; 10.6-15.9%)	14.5 (629; 0.63)
37	0	**327**		
276	351	**4,174**	8.4% (4,167; 7.5-9.2%)	13.8 (4,087; 0.24)
15	10	**136**	16.3% (135; 10.7-23.9%)	16.1 (132; 1.19)
7	0	**259**		

Mitral valve operations

There are marked variations in the proportion of patients who have mitral valve replacements rather than repairs between countries. This will be a function of the relative rate of surgery for stenosis rather than regurgitation, the proportion of rheumatic and other valve pathologies, and the availability of local mitral repair expertise.

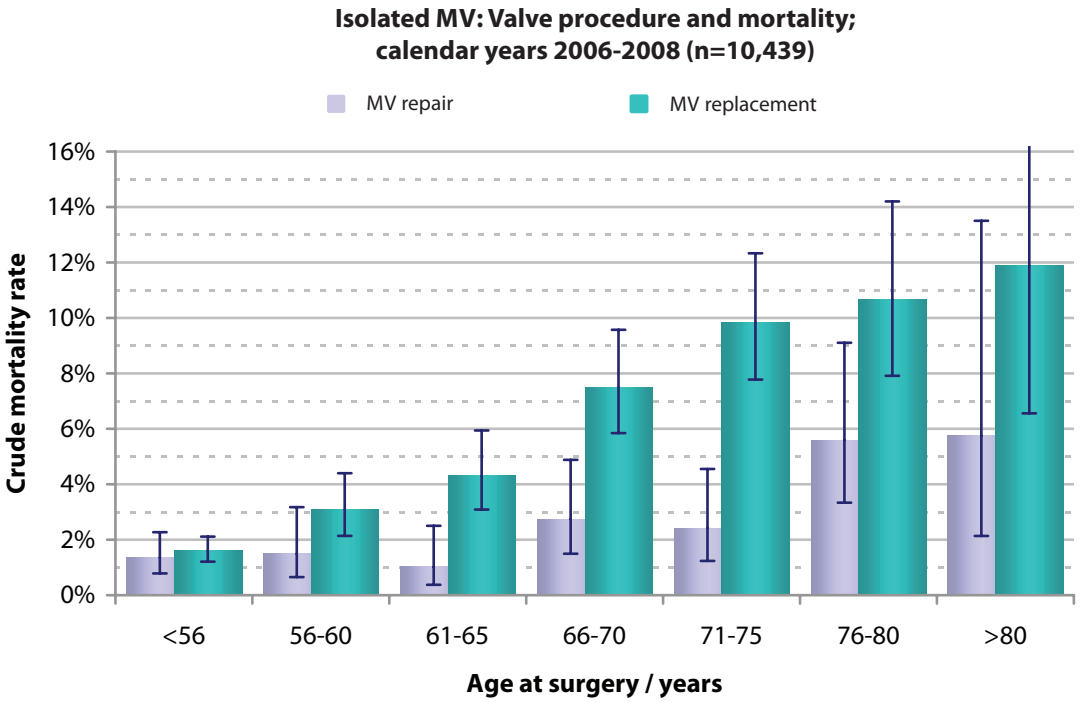


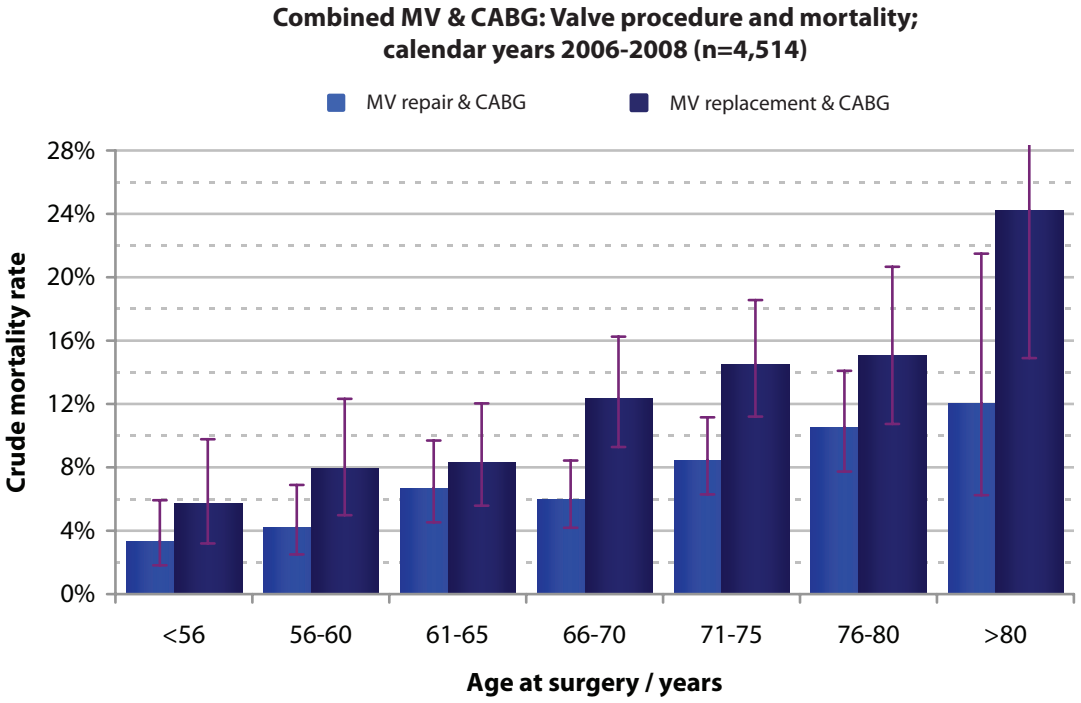
n.b. The countries highlighted in **blue** ink have >90% completion for the variable under scrutiny; countries labelled in grey text submitted some data for the variable, but have ≤90% completion.

Valve procedure and mortality

The overall mortality for mitral repair was 2.1% and for replacement was 4.3%. The overall mortality for combined mitral repair & CABG surgery was 6.8% and for replacement & CABG was 11.4%. These differences are statistically significant ($p<0.001$ for both comparisons). Differences in risk factors for the two groups are shown on pages 224-225.

The differential mortality for repair *versus* replacement for different age groups are shown in the chart below. The mortality difference between repair and replacement increases with increasing age.





Mortality at the time of discharge after mitral valve **repair** surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Age at surgery / years	Isolated MV	<56	1,096	15	1	1.4%	(0.8-2.3%)
		56-60	464	7	1	1.5%	(0.7-3.2%)
		61-65	486	5	2	1.0%	(0.4-2.5%)
		66-70	425	12	2	2.7%	(1.5-4.9%)
		71-75	403	10	1	2.4%	(1.2-4.6%)
		76-80	270	16	2	5.6%	(3.3-9.1%)
		>80	82	5	0	5.7%	(2.1-13.5%)
		Unspecified	5	0	0		
	MV & CABG	<56	347	12	0	3.3%	(1.8-5.9%)
		56-60	364	16	0	4.2%	(2.5-6.9%)
		61-65	377	27	1	6.7%	(4.5-9.7%)
		66-70	503	32	2	6.0%	(4.2-8.4%)
		71-75	500	46	1	8.4%	(6.3-11.2%)
		76-80	349	41	1	10.5%	(7.7-14.1%)
		>80	73	10	1	12.0%	(6.2-21.5%)
		Unspecified	2	0	0		

Mortality at the time of discharge after mitral valve **replacement** surgery broken down by age group; countries that submitted mortality data; calendar years 2006-2008

			Patient outcome at discharge				
			Alive	Died	Unspecified	Mortality rate (95% CI)	
Age at surgery / years	Isolated MV	<56	3,193	52	1	1.6%	(1.2-2.1%)
		56-60	975	31	2	3.1%	(2.1-4.4%)
		61-65	823	37	2	4.3%	(3.1-5.9%)
		66-70	764	62	0	7.5%	(5.8-9.6%)
		71-75	633	69	0	9.8%	(7.8-12.3%)
		76-80	360	43	1	10.7%	(7.9-14.2%)
		>80	89	12	2	11.9%	(6.6-20.2%)
		Unspecified	1	0	0		
	MV & CABG	<56	215	13	0	5.7%	(3.2-9.8%)
		56-60	220	19	0	7.9%	(5.0-12.3%)
		61-65	288	26	1	8.3%	(5.6-12.0%)
		66-70	326	46	0	12.4%	(9.3-16.2%)
		71-75	324	55	0	14.5%	(11.2-18.6%)
		76-80	186	33	1	15.1%	(10.7-20.7%)
		>80	50	16	0	24.2%	(14.9-36.6%)
		Unspecified	3	0	0		

Isolated mitral valve surgery: risk factor comparison for repair *versus* replacement

Distributions, calendar years 2006-2008

			MV procedure			
			Repair		Replacement	
Risk factor	Age	Average	59.6		56.0	
		Standard error	0.24		0.17	
		Known age	3,305		7,151	
		Unspecified age	5		1	
	Gender	Male	2,099	(63.4%)	2,667	(37.3%)
		Female	1,211	(36.6%)	4,485	(62.7%)
		Unspecified	0		0	
	Dyspnoea	NYHA 1-2	1,891	(39.8%)	2,861	(40.5%)
		NYHA 3-4	2,861	(60.2%)	4,198	(59.5%)
		Unspecified	93		93	
	Ejection fraction	Good	2,287	(75.8%)	5,259	(81.4%)
		Fair	607	(20.1%)	1,079	(16.7%)
		Poor	124	(4.1%)	123	(1.9%)
		Unspecified	292		691	
	Operative urgency	Elective	2,651	(85.6%)	5,936	(85.2%)
		Non-elective	446	(14.4%)	1,033	(14.8%)
		Unspecified	213		183	
	Previous cardiac surgery	No	2,877	(94.4%)	5,918	(86.6%)
		Yes	170	(5.6%)	913	(13.4%)
		Unspecified	263		321	

Combined MV & CABG surgery: risk factor comparison for repair *versus* replacement

Distributions, calendar years 2006-2008

			MV & CABG procedure			
			Repair		Replacement	
Risk factor	Age	Average	66.5		66.4	
		Standard error	0.17		0.21	
		Known age	2,703		1,819	
		Unspecified age	2		3	
	Gender	Male	1,924	(71.1%)	1,090	(59.8%)
		Female	781	(28.9%)	732	(40.2%)
		Unspecified	0		0	
	Dyspnoea	NYHA 1-2	1,459	(54.4%)	733	(40.9%)
		NYHA 3-4	1,222	(45.6%)	1,059	(59.1%)
		Unspecified	24		30	
	Ejection fraction	Good	913	(37.0%)	875	(54.7%)
		Fair	1,116	(45.2%)	577	(36.1%)
		Poor	438	(17.8%)	148	(9.3%)
		Unspecified	238		222	
	Operative urgency	Elective	1,796	(69.4%)	1,263	(73.0%)
		Non-elective	791	(30.6%)	466	(27.0%)
		Unspecified	118		93	
	Previous cardiac surgery	No	2,520	(98.3%)	1,614	(94.6%)
		Yes	43	(1.7%)	92	(5.4%)
		Unspecified	142		116	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Appendices

Submission of data

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Scope of this appendix

This appendix outlines the basic requirements for data submission from hospitals or from national registries for successful import into the EACTS Central Adult Cardiac Surgical Registry. It covers:

1. Minimum requirements for file-formats
2. Minimum requirements for each row of data
3. Minimum requirements for supporting documentation

File formats

Individual anonymised patient records are required, not aggregate data analyses.

In many cases the data must be viewed and manipulated in third-party software prior to import. This allows for detailed examination of the data so that the final import database is the best fit to the database structure of the central registry. It also allows some pre-import manipulation of the data to create the cleanest final import possible. The data also have to be transmuted into a file-format that is suitable for import a tab-delimited text file.

The most common acceptable source data formats; include:

- Microsoft Access™
- Microsoft Excel™
- Tab-delimited text files

However, any file that can be demonstrated to be compatible with standard Microsoft packages would also be acceptable. Comma-delimited files are not generally acceptable as the comma is used to sub-delimit fields where more than one response option may be selected. Comma-delimited files may be accepted as long as there are no multiple-response fields with comma delimiters or sub-delimiters other than commas.

Where there is more than one table of source data to be imported, it is essential that the tables of data required in the final import product are identified, and that the inter-relationships between these tables are recorded explicitly, including the indices that are used to link between the tables. This requirement applies most frequently to Access™ databases, but also applies to other file formats where data from multiple files are to be migrated into the EACTS central registry database.

Minimum requirements for each row of data

The minimum requirements for data submitted to the EACTS database are:

- The first row in each data file or table must contain headers
- Each row of data in each file or table must include a unique patient identifier [1]
- Each row of data in each file must include a key-date such as an index (admission, operation, *etc.* For the EACTS database the key-date is the date-of-operation) [2]
- Numbers containing decimals should be presented with a decimal point (.) signifying the decimal position and without comma thousand separators *e.g.*, 10000.245
- Dates should be presented in long date format, dd / mm / yyyy.
- Date-time fields should be presented in dd / mm / yyyy hh:mm format using the 24-hour clock.
- Where a data item may contain multiple responses each of those responses must be separated by a comma only.
- It is important that soft carriage-returns are removed from the data before delivery to the EACTS Registry. These control characters cause configuration problems when the data are transferred into the file format that acts as the substrate for the import process as the carriage return is reserved as a row (record) delimiter.

Requirements for supporting documentation

A full data dictionary is required, particularly where abbreviations or encoding systems have been used. This dictionary should include supporting information on the relationship between the individual data-items and patient's progress *i.e.*, are the data pre-operative, post-operative *etc.*

Where data are maintained in a language other than United Kingdom English, a full translation of all the headers and data items must also be provided. It is important to have full explanations for all headers:

- The meaning of the header
- The type of data [3]

Where data-items are coded (0, 1; Y, N; *etc.*) a comprehensive set of data definitions should be supplied with, and at the same time as, the data to be imported [4].

1 If the data-file lacks an unique identifier such as a Hospital number or a Department number, then there must be sufficient patient-specific data to be able to generate an unique identifier. An indication of the nature of the unique identifier is very important *i.e.*, is the identifier a hospital number, a national number or a database row ID. The minimum data fields would be the patient's Surname, Forename, Date-of-birth and Gender. In such cases, if an examination of the data demonstrates that there are a number of duplications then this methodology and the whole data submission will be rejected. The unique patient identifier may be absent in individual data-files from a multiple file suite as long as there is a database key that allows the patient-records to be linked back to an unique identifier in one of the data-files.

2 Any row of data that lacks a key date will not appear in the final import. Null values in this field will be treated as missing and, as such, removed at the time of import.

3 Type of data should include the clinical sense of the data (pre-operative, operative, post-operative, *etc.*), the scope of the data (mutually exclusive data, multiple choice data, date data, free text *etc.*).

4 Any data point that contains data options not included in the accompanying data definition documentation will be treated as an error and, as such, removed at the time of import.

The *EuroSCORE*

The ***EuroSCORE*** is a published system that generates a pre-operative prediction of post-operative mortality risk for cardiac surgery patients. It was published in 2003 using data provided by a large number of hospitals from across Europe, employing logistic regression techniques; it is, therefore, particularly pertinent to the European cardiac surgery patient and the European cardio-thoracic surgeon. The table shows the risk factors used and their weightings as defined in the additive ***EuroSCORE***; the appropriate scores are simply added together to give a patient-specific approximation of the risk of death following cardiac surgery.

	Factor	Definition	Score
Patient-related factors	Age	Per 5 years or part thereof	1
	Gender	Female	1
	Chronic pulmonary disease	Long-term use of bronchodilators or steroids for lung disease	1
	Extra-cardiac arteriopathy	Any one or more of the following: claudication, carotid occlusion or >50% stenosis, previous or planned intervention on the abdominal aorta, limb arteries or carotids	2
	Neurological dysfunction	Severely affecting ambulation or day-to-day functioning	2
	Previous cardiac surgery	Previous surgery requiring the opening of the pericardium	3
	Serum creatinine	>200 µmol l^{-1} pre-operatively	2
	Active endocarditis	Patient still under antibiotic treatment for endocarditis at the time of surgery	3
	Critical pre-operative state	Any one or more of the following: ventricular tachycardia, or fibrillation or aborted sudden death, pre-operative cardiac massage, pre-operative ventilation before arrival in the anaesthetic room, pre-operative inotropic support, intra-aortic balloon counterpulsation or pre-operative acute renal failure (anuria or oliguria <10 ml $hour^{-1}$)	3
Cardiac-related factors	Unstable angina	Rest angina requiring intra-venous nitrates until arrival in the anaesthetic room	2
	Left ventricular dysfunction	Moderate function (30-50% LVEF)	1
		Poor function (<30% LVEF)	3
	Recent myocardial infarction	Within the last 90 days	2
	Pulmonary hypertension	Systolic PA pressure >60 mmHg	2
Operation-related factors	Emergency	Carried out on referral before the beginning of the next working day	2
	Other than isolated CABG	Major procedure other than or in addition to coronary artery surgery	2
	Surgery on the thoracic aorta	For disorder of ascending, arch or descending aorta	3
	Post infarct septal rupture		4

Another version, the logistic ***EuroSCORE***, is detailed on the ***EuroSCORE*** website at: www.euroscore.org. This model uses the same suite of risk factors, but assigns quite different weightings to each factor, and the final risk prediction is derived from these weightings using a more complex formula:

$$\text{Logistic EuroSCORE} = \frac{e^{(\beta_o + \sum b_i X_i)}}{1 + e^{(\beta_o + \sum b_i X_i)}}$$

where

- e is the base for natural logarithms and is approximately 2.7182 …
- β_o is the constant of the logistic regression equation: -4.789594
- β_i is the coefficient of the variable X_i in the logistic regression equation
- X_i is set to 1 if a categorical risk factor is present and 0 if it is absent. For the age risk factor, X_i=1 if the patient is aged <60 years old, and X_i increases by one point per year thereafter; for age 59 years or less X_i = 1, age 60 X_i = 2, age 61 X_i = 3, and so on.

There was some evidence that this logistic model can provide slightly more accurate results, especially for the high-risk patient.

The EACTS database form

The European Association for Cardio-Thoracic Surgery
Adult Cardiac Surgical Database
Version 1.0; page 1

Unique patient identifier	
Date-of-birth	dd / mm / yyyy
Gender	○ Male ○ Female ○ Unknown

Initial registry data

Hospitalisation

Country code	
Hospital code	
Date-of-admission	dd / mm / yyyy
Date-of-operation	dd / mm / yyyy
Date-of-discharge / Date-of-death	dd / mm / yyyy

Cardiac history

Angina (CCS class)	○ CCS 0 ○ CCS 1 ○ CCS 2 ○ CCS 3 ○ CCS 4
Dyspnoea (NYHA grade)	○ NYHA 1 ○ NYHA 2 ○ NYHA 3 ○ NYHA 4
Number of previous myocardial infarctions	○ None ○ One ○ Two or more ○ Unknown
Most recent myocardial infarction	○ No MI ○ < 6 hours before operation ○ 6-24 hours before operation ○ 1-7 days before operation ○ 8-21 days before operation ○ 22-90 days before operation ○ >90 days before operation
Congestive heart failure	○ No ○ Yes

Previous interventions

Previous PCI	○ No PCI ○ PCI <24 hours before surgery ○ PCI >24 hours before surgery; same admission ○ PCI >24 hours before surgery; previous admission
Date of last PCI	dd / mm / yyyy
Previous cardiac, vascular or thoracic surgery	○ None ☐ CABG ☐ Valve ☐ Other
Date of last cardiac surgery	dd / mm / yyyy

Designed by
Dendrite Clinical Systems

This form is laid out so that questions requiring a single response are identified by round radio buttons next to the options, whereas questions where more than one response may be selected are identified by square tick-boxes next to the options.

The European Association for Cardio-Thoracic Surgery
Adult Cardiac Surgical Database
Version 1.0; page 2

Unique patient identifier

Date-of-surgery dd / mm / yyyy

Pre-operative risk factors

Weight kg

Height cm

Smoking history
- ○ Never smoked
- ○ Ex-smoker (≥1 month)
- ○ Current smoker

Diabetes treatment
- ○ None
- ○ Diet
- ○ Oral alone
- ○ Insulin (with or without oral)

Hypertension
- ○ No hypertension
- ○ Hypertension [1]
- ○ Not known

Hypercholesterolaemia
- ○ No
- ○ Yes

Renal
- ○ None
- ☐ Functioning transplant
- ☐ Creatinine >200 µmol l^{-1}
- ☐ Dialysis - acute renal failure
- ☐ Dialysis - chronic renal failure

Last pre-operative creatinine µmol l^{-1}

Chronic lung disease
- ○ No
- ○ COPD / Emphysema
- ○ Asthma

Extra-cardiac arteriopathy
- ○ No
- ○ Peripheral vascular disease
- ○ Cerebro-vascular disease

Cerebrovascular disease type
- ○ Not applicable
- ☐ Coma
- ☐ CVA
- ☐ RIND
- ☐ TIA
- ☐ Non-invasive >75% stenosis on doppler
- ☐ Previous carotid surgery

Neurological dysfunction
- ○ No
- ○ Yes

Carotid bruits
- ○ No
- ○ Yes

Pre-operative heart rhythm
- ○ Sinus
- ○ VT / VF
- ○ Atrial fibrillation / flutter
- ○ Complete heart block
- ○ Other abnormal rhythm

1 Treated or BP >140/90 on > 1 occasion prior to admission

Designed by
Dendrite Clinical Systems

This form is laid out so that questions requiring a single response are identified by round radio buttons next to the options, whereas questions where more than one response may be selected are identified by square tick-boxes next to the options.

The European Association for Cardio-Thoracic Surgery
Adult Cardiac Surgical Database
Version 1.0; page 3

Unique patient identifier

Date-of-surgery dd / mm / yyyy

Pre-operative haemodynamics and catheterisation

Left- or right-heart catheterisation
- ○ Never
- ☐ This admission
- ☐ Previous admission

Date of last catheterisation dd / mm / yyyy

Number of diseased coronary vessels
- ○ No vessel with >50% diameter stenosis
- ○ One vessel with >50% diameter stenosis
- ○ Two vessels with >50% diameter stenosis
- ○ Three vessels with >50% diameter stenosis
- ○ Not investigated

Left main stem disease
- ○ No LMS disease / LMS disease ≤50% diameter stenosis
- ○ LMS disease >50% diameter stenosis
- ○ Not investigated

Ejection fraction category
- ○ Good (more than 49%)
- ○ Fair (30-49%)
- ○ Poor (<30%)
- ○ Not measured

Ejection fraction value %

PA systolic value if known

AV gradient value if known

LVEDP value if known

Mean PAWP / LA value if known

Pre-operative status and support

IV nitrates / heparin of any kind ○ No ○ Yes

IV inotropes ○ No ○ Yes

Ventilated ○ No ○ Yes

Cardiogenic shock ○ No ○ Yes

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The European Association for Cardio-Thoracic Surgery
Adult Cardiac Surgical Database
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Unique patient identifier

Date-of-surgery dd / mm / yyyy

Operation

Operative urgency

- ○ Elective [2]
- ○ Urgent [3]
- ○ Emergency [4]
- ○ Salvage [5]

Main reason for urgency

- ○ Anatomy
- ○ Acute evolving MI
- ○ Cardiogenic shock
- ○ Aortic dissection
- ○ Unstable or worsening angina / ongoing ischaemia
- ○ Pulmonary oedema
- ○ Valve dysfunction

Number of previous heart operations

- ○ None
- ○ One
- ○ Two
- ○ Three
- ○ Four
- ○ Five

Procedure group

- ○ CABG
- ○ Valve
- ○ CABG & valve
- ○ CABG & other
- ○ Valve & other
- ○ CABG & valve & other
- ○ Other

Other cardiac procedures

- ○ No
- ○ Yes

Other non-cardiac procedures

- ○ No
- ○ Yes

Coronary surgery

DCAs - arterial conduits [6]

DCAs - venous conduits

Artery / Arteries used as grafts

- ○ No arteries used
- ☐ Right IMA
- ☐ Left IMA
- ☐ Right radial
- ☐ Left radial
- ☐ Right GEPA
- ☐ Other artery

2 Routine admission from the waiting list; procedure can be deferred without risk

3 Not scheduled for routine admission from the waiting list; requiring surgery on the current admission; cannot be sent home without surgery

4 Unscheduled patientswith ongoing refractory compromise; there should be no delay in surgical intervention irrespective of the time of day

5 Patients requiring CPR *en route* to the operating theatre or prior to anaesthetic induction

6 Distal coronary anastomoses - arterial conduits

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Date-of-surgery: dd / mm / yyyy

Valve surgery

	Aortic valve	Mitral valve	Tricuspid valve	Pulmonary valve
Stenosis	○ No ○ Yes	○ No ○ Yes	○ No ○ Yes	○ No ○ Yes
Insufficiency	○ None ○ Trivial ○ Mild ○ Moderate ○ Severe	○ None ○ Trivial ○ Mild ○ Moderate ○ Severe	○ None ○ Trivial ○ Mild ○ Moderate ○ Severe	○ None ○ Trivial ○ Mild ○ Moderate ○ Severe
Explant type	○ Native valve ○ Mechanical ○ Biological ○ Homograft ○ Autograft ○ Ring	○ Native valve ○ Mechanical ○ Biological ○ Homograft ○ Autograft ○ Ring	○ Native valve ○ Mechanical ○ Biological ○ Homograft ○ Autograft ○ Ring	○ Native valve ○ Mechanical ○ Biological ○ Homograft ○ Autograft ○ Ring
Native valve pathology	code	code	code	code
Reason for repeat valve surgery	○ Not applicable ○ Thrombosis ○ Dehiscence ○ Embolism ○ Infection ○ Intrinsic failure ○ Haemolysis ○ Other reason	○ Not applicable ○ Thrombosis ○ Dehiscence ○ Embolism ○ Infection ○ Intrinsic failure ○ Haemolysis ○ Other reason	○ Not applicable ○ Thrombosis ○ Dehiscence ○ Embolism ○ Infection ○ Intrinsic failure ○ Haemolysis ○ Other reason	○ Not applicable ○ Thrombosis ○ Dehiscence ○ Embolism ○ Infection ○ Intrinsic failure ○ Haemolysis ○ Other reason
Valve procedure	○ Replacement ○ Repair	○ Replacement ○ Repair	○ Replacement ○ Repair	○ Replacement ○ Repair
Implant type	○ None ○ Mechanical ○ Biological ○ Homograft ○ Autograft	○ None ○ Mechanical ○ Biological ○ Homograft ○ Ring	○ None ○ Mechanical ○ Biological ○ Homograft ○ Ring	○ None ○ Mechanical ○ Biological ○ Homograft
Implant code	code	code	code	code
Valve / ring size	mm	mm	mm	mm

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Date-of-surgery dd / mm / yyyy

Other procedures

Other cardiac procedures detail

- ○ None
- ☐ Left ventricular aneurysm repair
- ☐ Ventricular septal defect repair
- ☐ Atrial septal defect repair
- ☐ Batista
- ☐ SVR
- ☐ Congenital
- ☐ Transmyocardial laser revascularisation
- ☐ Cardiac trauma
- ☐ Cardiac transplant
- ☐ Permanent pacemaker
- ☐ AICD
- ☐ Other

Other non-cardiac procedures detail

- ○ None
- ☐ Aorta
- ☐ Other thoracic
- ☐ Carotid endarterectomy
- ☐ Other vascular

Segments of the aorta

- ☐ Root
- ☐ Ascending
- ☐ Arch
- ☐ Descending
- ☐ Abdominal

Aortic procedure

- ☐ Interposition tube graft
- ☐ Tube graft and separate AVR
- ☐ Root replacement with composite valve graft and coronary reimplantation
- ☐ Root replacement with preservation of native valve and coronary reimplantation
- ☐ Homograft root replacement
- ☐ Ross procedure for aortic root pathology (not isolated AVR)
- ☐ Aortic patch graft
- ☐ Sinus of valsalva repair
- ☐ Reduction aortoplasty

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Perfusion and myocardial protection

Cardiopulmonary bypass
- ○ No
- ○ Yes - planned
- ○ Yes - conversion from off-pump

Predominant myocardial protection
- ○ Non-cardioplegic
- ○ Cardioplegia

Cardioplegia - solution
- ○ Not applicable
- ○ Blood
- ○ Crystalloid

Cardioplegia - temperature
- ○ Not applicable
- ☐ Warm
- ☐ Cold

Cardioplegia - infusion mode
- ○ Not applicable
- ☐ Antegrade
- ☐ Retrograde

Cardioplegia - timing
- ○ Not applicable
- ○ Continuous
- ○ Intermittent

Non-cardioplegia myocardial protection
- ○ Not applicable
- ○ Fibrillation with perfusion
- ○ Cross-clamp and beating heart
- ○ Aortic cross-clamp
- ○ Cross-clamp with direct coronary perfusion
- ○ Beating heart without cross-clamp

Intra-aortic balloon pump used
- ○ No
- ☐ Intra-operatively
- ☐ Pre-operatively
- ☐ Post-operatively

Reason for intra-aortic balloon pump use
- ○ Not applicable
- ○ CPB wean
- ○ Haemodynamic instability
- ○ Unstable angina
- ○ PTCA support
- ○ Prophylactic

Bypass time min

Cumulative cross-clamp time min

Total circulatory arrest time min

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Version 1.0; page 8

Unique patient identifier

Date-of-surgery dd / mm / yyyy

Post-operative complications

Re-operation

- ○ No re-operation required
- ☐ Re-operation for graft problems
- ☐ Re-operation for valve problems
- ☐ Re-operation for bleeding / tamponade
- ☐ Sternal resuturing for any reason
- ☐ Re-operation for other cardiac problems

New post-operative stroke

- ○ None
- ○ Transient
- ○ Permanent

New post-operative dialysis ○ No ○ Yes

Multi-system failure ○ No ○ Yes

Discharge details

Destination on discharge

- ○ Not applicable - patient deceased
- ○ Home
- ○ Convalescence / Nursing home
- ○ Another unit within the same hospital
- ○ Another hospital

Patient status at discharge ○ Alive ○ Deceased

Primary cause of death

- ○ Not applicable
- ○ Cardiac
- ○ Neurological
- ○ Renal
- ○ Vascular
- ○ Infection
- ○ Pulmonary
- ○ Valvular
- ○ Other

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Codes for valve data

Native valve pathology

0	Native valve not present
1	Congenital
2	Degenerative
3	Active infective endocarditis
4	Previous infective endocarditis
5	Rheumatic
6	Annuloaortic ectasia
7	Calcific degeneration
8	Ischaemic
9	Functional regurgitation
19	Other native valve pathology

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The EACTS database report 2010: towards global benchmarking

The European Association for Cardio-Thoracic Surgery (EACTS) exists to promote and support all aspects of care given to patients suffering from cardiothoracic surgical disease. E ACTS has established a database project in which data on risk factors and outcomes for patients can be collated and analysed to provide information for all stakeholders. In line with a membership policy of EACTS not constrained by geographical barriers, we have also encouraged submission of data from hospitals outside Europe.

This EACTS adult cardiac surgery database report is an analysis of over one million patients records, from 29 countries, and 366 hospitals, in Europe and China (including Hong Kong). The report includes analyses of patient characteristics, the type of surgery, operative risk factors and post-operative outcomes, including in-hospital mortality and length-of-stay. We have analysed the pooled data to show trends over time and compared the incidence of risk factors and outcomes between countries. We have set these analyses against data on populations, health status and economic statistics from the World Health Organisation.

This report represents one of the largest clinically driven international benchmarking report ever produced. It is testament to the professional societies representing cardiac surgery in these countries, along with the hospitals and surgeons involved, that data from so many patients have been collected in cardiac surgical registries.

The report demonstrates a widespread culture amongst cardiac surgeons of a willingness to become involved in active clinical benchmarking to improve the quality of care they deliver for patients. It also contains some fascinating findings, with major variation between countries in almost every risk factor and outcome analysed. Some key messages include:

- Major variation in the proportion of cardiac surgery that is coronary surgery between countries.
- A marked increase in the proportion of obese and diabetic patients coming to surgery.
- Large variations in the management of coronary artery bypass surgery patients as urgent or elective cases between countries.
- Large changes in the type of valve prostheses used for valve surgery over time, and major differences between countries.
- Big differences in predicted mortality between countries.
- Major differences in post-operative length of stay following surgery between countries, which seem to offer major opportunities for improvement and a decrease in resource utilisation.

We have provided in the report a framework for risk-adjusted benchmarking of mortality, and offered all countries a bespoke data completeness and mortality analysis to feedback issues of quality alongside this report.

EACTS
European Association For Cardio-Thoracic Surgery

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