International Journal of Cardiology 170 (2013) 81–87

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

An evaluation of composite indicators of hospital acute myocardial infarction care: A study of 136,392 patients from the Myocardial Ischaemia National Audit Project ☆

A.D. Simms [a,b,c,*,1], P.D. Batin [d,1], C.F. Weston [e,1], K.A.A. Fox [f,1], A. Timmis [g,1], W.R. Long [a,1], A.S. Hall [a,h,1], C.P. Gale [a,c,1]

[a] Centre for Epidemiology and Biostatistics, University of Leeds, Leeds, UK
[b] York and Hull Medical School, University of York, York, UK
[c] Department of Cardiology, York Teaching Hospital NHS Foundation Trust, York, UK
[d] Department of Cardiology, Pinderfields General Hospital, Mid Yorkshire NHS Trust, Wakefield, UK
[e] College of Medicine, Swansea University, Swansea, UK
[f] Centre for Cardiovascular Science, University of Edinburgh, Edinburgh, UK
[g] Institute Cardiovascular Science, UCL, London, UK
[h] Department of Cardiology, Leeds Teaching Hospitals NHS Trust, Leeds, UK

ARTICLE INFO

Article history:
Received 27 February 2013
Received in revised form 3 September 2013
Accepted 7 October 2013
Available online 14 October 2013

Keywords:
Acute myocardial infarction
Quality of care
Composite performance indicators
Mortality

ABSTRACT

Background: Hospital acute myocardial infarction (AMI) care is increasingly evaluated using composite quality scores. We investigated the influence of three aggregation methods for an AMI indicator on mortality and hospital rank.

Methods and results: We studied 136,392 patients discharged alive from 199 hospitals with AMI recorded in the Myocardial Ischaemia National Audit Project, between 01/01/2008 and 31/12/2009. A composite of prescription of aspirin, thienopyridine inhibitor, β-blocker, angiotensin converting enzyme inhibitor, HMG CoA reductase enzyme inhibitor and enrolment in cardiac rehabilitation at discharge was aggregated as opportunity based (OBCS), weighted opportunity-based (WOBCS) and all-or-nothing (ANCS) scores. We quantified adjusted 30-day, 6-month and 1-year mortality rates and hospital performance rank. Median (IQR) scores were OBCS: 95.0% (3.5), WOBCS: 94.7% (0.8) and ANCS: 80.9% (11.8). The three methods affected the proportion of hospitals outside 99.8% credible limits of the national median (OBCS: 52.2%, WOBCS: 64.3% and ANCS: 37.7%) and hospital rank. Each 1% increase in composite score was significantly associated with a 1 to 3% and a 4% reduction in 6-month and 1-year mortality, respectively. However, the ANCS had fewer cases and no significant association with 30-day mortality.

Conclusions: A hospital composite score, incorporating 6 aspects of AMI care, was significantly inversely associated with mortality. However, composite aggregation method influenced hospital rank, number of cases available for analysis and size of the association with all-cause mortality, with the ANCS performing least well. The use and choice of composite scores in hospital AMI quality improvement requires careful evaluation.

1. Introduction

Composite quality scores are increasingly used by regulators and healthcare professionals to evaluate hospital care. Such scores combine two or more components of care, to produce a single measure of performance [1]. By encompassing multiple aspects of care, they overcome the inherent problem of considering a large number of single indicators rendering more manageable the evaluation of a complex treatment pathway, which are often recommended in ACS guidelines of care [2–4].

An association of these measures with outcomes of care provides a strong argument for their use, in that, it implies that better care leads to better outcomes. In the United Kingdom (UK), recent Governmental policy has shifted the assessment of hospital quality of care to focus

☆ Details of funding: MINAP is funded by the Health Quality Improvement Partnership (HQIP). CPG is funded by the National Institute for Health Research as a Clinician Scientist and Honorary Consultant Cardiologist. This study was supported by funding from the British Heart Foundation PG/07/057/23215.

* Corresponding author at: Research Fellow and Clinical Lecturer in Cardiology, Centre for Epidemiology and Biostatistics, Level 8, Worsley Building, University of Leeds, Clarendon Way, West Yorkshire, Leeds, LS2 9JT, UK. Tel.: +44 113 343 8874; fax: +44 113 343 4877.

E-mail address: simmsy@doctors.org.uk (A.D. Simms).

[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

0167-5273/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ijcard.2013.10.027

on outcomes of care and as such, composite indicators of AMI care are required to strongly relate to outcomes [5]. The use of composite indicators of care in the UK for evaluation of hospital AMI care is in its infancy and as yet does not feature in hospital evaluation. However, other countries, including the USA (Centre for Medicare and Medicaid [6]) and France [7], have more experience of such indicators in the evaluation of hospital performance and are frequently used to determine financial reimbursement.

On the other hand, although used to decide hospital payment, AMI composite indicators have shown a heterogeneous association with mortality [8–13]. Whilst composite quality scores can be derived through various means – including opportunity-based, weighting, and all-or-nothing scoring – it has been suggested that these methods are highly correlated and the precise method used does not influence comparative performance (expressed through hospital ranking) [11]. Yet, others have shown that the composite aggregation was important in determining hospital performance rank and subsequently made such inferences less stable [14,15].

In this study we evaluated a composite quality score derived by three aggregation methods endorsed in published guidelines for the selection and creation of performance measures for the quantification of the quality of cardiovascular care [16]. We investigated the association of each score with 30-day, 6-month and 1-year mortality, and studied their impact on hospital performance ranking using data from 136,392 patients within the Myocardial Ischaemia National Audit Project (MINAP), a national registry of patients hospitalised with an acute coronary syndrome (ACS). We aimed to identify a valid metric by which hospital AMI performance might be measured.

2. Methods

2.1. Study design

The analyses were performed on data from a multicentre national database of over 1 million acute coronary syndromes in England and Wales, the Myocardial Ischaemia National Audit Project (MINAP) [17]. MINAP data are collected prospectively at each acute hospital using a secure electronic system that ensures electronic encryption and on-line transfer to a central database managed by the Central Cardiac Audit Database within the National Institute for Cardiovascular Outcomes Research (NICOR) at University College, London [17]. MINAP is overseen by a multi-professional steering group representing the stakeholders hosted by NICOR [18]. As such, this study includes data collected on behalf of the British Cardiovascular Society, under the auspices of NICOR, in which patient identity is protected. Each patient entry offers details of the 'patient journey', including the method and timing of admission, in-patient investigations, treatment, and date of all-cause death (from linkage to the Medical Research Information System, part of the National Health Service (NHS) Information Centre, using a unique NHS number). Data quality is enhanced through routine on-line error checking and a mandatory annual data validation exercise [17].

2.2. Ethics

The National Institute for Cardiovascular Research (NICOR) which includes the Myocardial Ischaemia National Audit Project (MINAP) (Ref: NIGB: ECC 1-06 (d)/2011) has support under section 251 of the National Health Service (NHS) Act 2006. Ethical approval was therefore not required under NHS research governance arrangements for the project.

2.3. Composite score — selection

We selected a hospital composite quality score for care of patients with AMI at discharge from hospital. The score consisted of 6 evidence-based processes of care: the prescription of aspirin, thienopyridine inhibitor, β-blocker, angiotensin converting enzyme inhibitor (ACEi), HMG CoA reductase enzyme inhibitor (statin) and enrolment onto a cardiac rehabilitation programme at the time of discharge [2,16,19,20].

2.4. Composite score — creation

The composite score was aggregated in three separate ways at the hospital level and included: an equally weighted opportunity based composite score (OBCS), a weighted opportunity based composite score (WOBCS) and an all-or-nothing composite score (ANCS) [1]. The OBCS reflects the number of care opportunities fulfilled at each hospital (numerator) divided by the number of opportunities to provide care (denominator) [1]. Excluded from both numerator and denominator were particular interventions that were contra-indicated, not applicable, not indicated in, or declined by, individual patients. Therefore the OBCS utilises all possible components of the previously defined 'bundle' of interventions, and expresses each intervention as equally important — allowing hospitals to score highly for near excellent performance.

The WOBCS differs from the OBCS in that each component intervention is weighted according to a perceived 'gold standard' [1], in this case the strength of the association of the intervention with 6-month mortality. Weighting was achieved by multiplying each component of the score for each patient by the reciprocal of its odds ratio (OR) for mortality. To calculate the OR, patient-level 6-month mortality was regressed on each component of the score whilst adjusting for the impact of the remaining five components using a multivariable binomial model with a log link [21]. In essence, those interventions (or individual performance indicators) with the greatest independent effect on 6-month mortality were given a greater weighting. Only components with a significant inverse association with mortality were weighted, otherwise the component was multiplied by a factor of 1. In defining the WOBCS, we were able to compare hospital's performance when awarded for providing those care interventions most associated with mortality to when all care interventions were equally weighted [1]. The use of mortality as a "gold standard" to weight indicator components by appears logical and intuitive. More debated was the use of 6-months outcome data as opposed to either 30-day or 1-year. We felt that the overall mortality effect of secondary preventative treatments was most likely to be most significant at 6-months, whilst at 30-day some therapies could be argued not to have had enough time to effect outcomes and at 1-year other influences, such as, medication adherence and primary care involvement may impact on outcomes.

The ANCS is the proportion of patients who received all the elements of the composite quality score for which they were eligible and excludes any patient ineligible for one or more composite components [1]. The ANCS therefore expresses excellent performance [22].

2.5. Cohort description

The cohort comprised 136,392 episodes of patients with AMI discharged from 199 acute hospitals in England and Wales between 1st January 2008 and 31st December 2009. The diagnosis of AMI was made by local clinicians using their judgement of presenting history, clinical examination and the results of in-patient investigations. Although the recording of therapies used in the composite is instigated in hospital, it is usually only at discharge from hospital that all opportunities are realised — we therefore only considered survivors at the time of discharge to help mitigate biases associated with in-hospital deaths.

2.6. Study statistics

Patients were categorised into 5 groups according to their age at admission to hospital — 18 to <55 years, 55 to 64, 65 to 74, 75 to 84 years, and >84 years of age, respectively. For each patient we estimated the risk of death at 6-months using the National Institute for Health and Clinical Excellence (NICE) described mini-GRACE risk score [23]. The mini-GRACE risk score is calculated from 6 variables and the corresponding reported coefficients from the GRACE risk score: age, admission systolic blood pressure and heart rate, electrocardiographic ST-segment deviation, cardiac arrest and elevated cardiac troponin concentration. According to the mini-GRACE risk score, each patient was then categorised into low, medium or high risk, corresponding to <3%, 3 to 6% and >6% predicted 6-month mortality, respectively [19]. Hospitals were ranked into quartiles for volume (Qn1 to Qn4) according to the total numbers of patients hospitalised at their centre who were diagnosed with AMI.

The composite quality scores derived from each patient discharged from a particular hospital were aggregated and assigned to that hospital. Hospital performance was described by its median score and interquartile range (IQR). Pearson's correlation coefficient with Bonferroni adjustment for multiple testing was used to quantify the linear dependency between the composite scores. Sensitivity analyses were undertaken comparing hospital scores for each aggregation method by year, gender, age group, risk category and hospital volume quartile. Hospitals were categorised by quartiles of performance according to their median score for each of the three aggregation methods (Qp1 to Qp4). Hospital median composite scores were compared visually to a national median score using funnel plots [24,25]. Credible limits around the national median performance were derived using a binomial distribution assumption and set at 99.8%. The variation in the reporting of hospital performance attributable to the aggregation method was described by changes in the hospital rank and the hospital quartile rank. It was more likely that hospital rank will change by composite aggregate score, whereas change in hospital quartile rank would suggest greater discordance between aggregation methods.

For each aggregation method, the strength of the statistical association between hospital composite quality score and 30-day, 6-month and 1-year post admission mortality was quantified using a multilevel logistic regression model. The models were built with a hierarchy of patients clustered in each hospital (random intercepts), so allowing for correlations between patient outcomes. We adjusted for case-mix using the mini-GRACE risk variables [23]. Analyses were considered by completed cases because previous multiple imputation of missing MINAP data has not been shown to substantially influence the precision of estimates [26]. For all tests, P values <0.05 were considered statistically significant. All analyses were conducted using Stata IC version 11.2 (Stat Corp LP, Texas, USA).