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# The development of a postoperative morbidity score to assess total morbidity burden after cardiac surgery

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## Abstract

**Objective:** To develop a tool for identifying and quantifying morbidity following cardiac surgery (cardiac postoperative morbidity score [C-POMS]).

**Study Design and Setting:** Morbidity was prospectively assessed in 450 cardiac surgery patients on postoperative days 1, 3, 5, 8, and 15 using POMS criteria (nine postoperative morbidity domains in general surgical patients) and cardiac-specific variables (from expert panel). Other morbidities were noted as free text and included if prevalence was more than 5%, missingness less than 5%, and mean expert-rated severity-importance index score more than 8. Construct validity was assessed by expert panel review, Cronbach's alpha (internal consistency), and linear regression (predictive ability of C-POMS for length of stay [LOS]).

**Results:** A 13-domain model was derived. Internal consistency ($>0.7$) on D3−D15 permits use as a summative score of total morbidity burden. Mean C-POMS scores were 3.4 (D3), 2.6 (D5), 3.4 (D8), and 3.8 (D15). Patient LOS was 4.6 days ($P = 0.012$), 5.3 days ($P = 0.001$), and 7.6 days ($P = 0.135$) longer in patients with C-POMS-defined morbidity on D3, D5, D8, and D15, respectively, than in those without. For every unit increase in C-POMS summary score, subsequent LOS increased by 1.7 (D3), 2.2 (D5), 4.5 (D8), and 6.2 (D15) days (all $P = 0.000$).

**Conclusion:** C-POMS is the first validated tool for identifying total morbidity burden after cardiac surgery. However, further external validation is warranted. 

*Keywords:* Postoperative morbidity; Cardiac surgery; Morbidity score; C-POMS, Surgical outcome; Cardiac morbidity

## 1. Introduction

Mortality is an important performance indicator in heart surgery [1] and is the most commonly cited outcome variable [2,3]. This is because mortality is clearly an undesirable outcome, which can be unequivocally defined [4,5] and easily measured [5−7]. However, postoperative death has become increasingly infrequent [3,8], currently approximately 1:70 in-patients die after isolated coronary artery bypass graft surgery [9]. This makes mortality an insensitive general outcome measure.

Postoperative morbidity, being more common than mortality, may be a more useful indicator of outcome, and also of changes in quality of care and variation in performance, if inherent limitations, such as subjectivity and imprecision [10] can be overcome. Reported morbidity rates range from 4.3% [11] to 36% [12], reflecting the lack of consistently used definitions. Some definitions include death (e.g., [4,11]), some focus on specific morbid events (e.g., [13−15]), whereas others use surrogate markers, such as increased intensive care unit (ICU) use (e.g., [16,17]) or postoperative length of stay (LOS) [12,18,19]), which can be influenced by factors other than morbidity. Furthermore, none of the existing measures of morbidity are validated to be used as scores, complication rates have been shown not to correlate well with mortality rate [20,21] and surrogate markers do not account for the nonmedical causes of prolonged hospital stay [3,22]. Additionally, these markers provide no indication of the type or frequency of conditions contributing to the prolonged LOS, limiting its usefulness in relation to risk

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**What is new?**

**Key finding**
This new and simple tool provides a summative score for total morbidity burden after cardiac surgery.

**What this adds to what is known?**
We are unaware of any other tools that are able to identify and quantify postoperative total morbidity burden in patients undergoing cardiac surgery.

**What is the implication?**
The cardiac postoperative morbidity score (C-POMS) identifies considerable postoperative morbidity in these patients and may find application in modeling causation, preoperative risk assessment, and in identifying preventative and therapeutic targets.

assessment and optimization of care to reduce the frequency of postoperative morbid conditions. As a result, there are no tools currently being used in the United Kingdom for postoperative morbidity risk assessment.

The postoperative morbidity survey (POMS), which was developed [23] and validated [3] in general surgical patients, is the only published, explicit tool for postoperative morbidity assessment. In the absence of a standardized and uniformly applied definition of morbidity outcome following cardiac surgery, we sought to develop a tool specifically for the identification and quantification of postoperative morbidity following cardiac surgery (C-POMS).

## 2. Methods

Appropriate local ethics committee approval was received and the study complied with the ethical standards set forth in the Declaration of Helsinki of 1975.

### 2.1. Participants

Patients undergoing any form of adult cardiac surgery (excluding cardiac surgery for a congenital heart condition or a cardiomyopathy due to complicated and potentially nongeneralizable comorbidities) between January 2005 and November 2007 at the Heart Hospital, University College London Hospitals NHS Trust, United Kingdom and who gave written informed consent were eligible for inclusion. Excluded were those aged younger than 18 years, unable to give informed consent, undergoing emergency surgery, who died within 5 days of surgery, and were enrolled in clinical intervention trials. There were 4 phases of recruitment owing to researcher availability: Phase I and Phase II were conducted between January 10, 2005 and February 9, 2005, and March 7 2005 and April 28, 2005, respectively. Phase III was conducted between October 3, 2005 and December 3, 2005, whereas Phase IV was completed between July 2, 2007 and November 15, 2007.

### 2.2. Model development

The McMaster Framework [24,25] for constructing and assessing health indices for discriminative instruments, appropriate when no gold standard is available, was used. This comprises item selection, item scaling, item reduction, and determination of reliability and validity processes.

#### 2.2.1. Item selection

Item selection was determined by a protocol development group (PDG) comprising 15 representatives from cardiac, nursing, surgery, intensive care, and anesthesia, together with 1 representative from the original POMS study [23]. The PDG determined that all POMS variables (Table 1), (which involves noting of the presence or absence of nine morbidity domains on postoperative days 3 (D3), 5 (D5), 8 (D8,) and 15 (D15), if the patient remains an in-patient in the operating hospital) and specific cardiac surgery-related variables should be included. Such items included ambulation assistance (wheelchair, Zimmer frame, walking sticks, and so on)

**Table 1.** Postoperative morbidity survey [20]

| Morbidity type | Criteria |
|---|---|
| Pulmonary | The patient has developed a new requirement for oxygen or respiratory support |
| Infectious | Currently on antibiotics and/or has had a temperature of $>38^{\circ}C$ in the last 24 h |
| Renal | Presence of oliguria $<500$ mL/24 h, increased serum creatinine ($>30\%$ from preoperative level); urinary catheter in situ for nonsurgical reason |
| Gastrointestinal | Unable to tolerate an enteral diet for any reason including nausea, vomiting, and abdominal distension |
| Cardiovascular | Diagnostic tests or therapy within the last 24 h for any of the following: (1) new MI or ischemia, (2) hypotension (requiring fluid therapy $>200$mL/h or pharmacological therapy, (3) atrial or ventricular arrhythmias, (4) cardiogenic pulmonary edema and thrombotic event (requiring anticoagulation). |
| Neurological | New focal neurological deficit, confusion, delirium, or coma |
| Hematological | Requirement for any of the following within the last 24 h: packed erythrocytes, platelets, fresh-frozen plasma, or cryoprecipitate |
| Wound | Wound dehiscence requiring surgical exploration or drainage of pus from the operation wound with or without isolation of organisms |
| Pain | New postoperative pain significant enough to require parenteral opioids or regional analgesia |

*Abbreviation*: MI, myocardial infarction.