

Meeting abstracts

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### Evaluation of a new real continuous cardiac output pulmonary artery catheter

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**Introduction:** None of the currently available pulmonary artery (PA) catheters allows instantaneous and continuous measurement of pulmonary blood flow. At best, the so-called continuous cardiac output (CO) catheters (and associated software) indicate continuously an averaged value of CO measured over several minutes. A new catheter has been introduced recently, and animal experiments have shown that it allows instantaneous detection of changes in pulmonary blood flow. In this catheter, blood flow is derived from the power required to maintain a temperature gradient between two thermistors that are insulated differently. The technology also allows the clinician to measure CO using the standard thermodilution technique. The aim of the present study was to demonstrate the clinical safety and efficacy of this new PA catheter.

**Methods:** After local research ethics committee approval and informed consent, 20 patients undergoing elective coronary artery bypass grafting were enrolled in this study. The TruCCOMS PA catheter (Aortech International, Bellshill, Scotland) was floated after induction of anaesthesia, through a 9 Fr introducer. CO was measured continuously after arrival in the intensive care unit and for a period of up to 20 h. CO was also determined by using a standardized thermodilution technique at a minimum of 10 time points (as the average of up to six thermodilution curves), each separated by at least 1 h. Haemodynamics were recorded before each measurement of CO by thermodilution. Statistical analysis included Pearson correlation and a Bland–Altman analysis for assessing agreement between the two methods of clinical measurement [1].

**Results:** A total of 174 paired results of continuous and thermodilution recordings of CO were obtained in 16 patients. The Pearson correlation was 0.63. Bland–Altman analysis showed a bias of 0.63 l/min and a precision of 0.95 l/min, with 95% limits of agreement from –1.15 to +2.67 l/min. This compares favourably with values obtained for other commercially available CO monitors.

No safety problems were associated with the use of the catheter, but the catheter could not be wedged in one patient. The radiograph taken as a control showed a kinked catheter in the PA, but no stiffness in the catheter was noted after withdrawal. One of the catheters was rejected after use owing to a thermistor defect. Of the remaining 18 patients, two showed a sudden change in the correlation between CO obtained continuously and that obtained by thermodilution. Closer inspection of the obtained data suggested that the heat transfer device of the catheter was located in a branch of the PA, rather than within the PA itself, and may have resulted from patients being moved or extubated.

**Conclusion:** The present study showed that this catheter is a safe and effective device for continuous real-time monitoring of CO in critically ill patients.

**Acknowledgement:** The present study was sponsored by Aortech International, Scotland.

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## S100β after coronary artery surgery: association with lipid peroxidation and neurocognitive scores

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**Introduction:** Greater levels of S100β after coronary artery bypass grafting (CABG) surgery are thought to indicate cerebral injury [1]. Lipid peroxidation arising from oxidative stress occurs during cardiopulmonary bypass (CPB), and is indicated by increased malondialdehyde concentration [2]. We report the relationships between malondialdehyde production, S100β, and neurological and cognitive scoring 3 months after CABG.

**Method:** Eighty-six patients aged  $60 \pm 10$  years (mean  $\pm$  standard deviation) were studied. A structured neurological examination and a battery of cognitive tests were completed the day before and 3 months after surgery by 68 of these patients. A catheter was positioned in the jugular bulb and blood samples were drawn immediately after CPB (post bypass [PBP]) and 6 h after surgery for estimation of S100β and malondialdehyde levels. Lactated Ringer's was used to prime the CPB circuit in the first 21 patients, and subsequent patients received nonlactated prime. Administration of aprotinin was noted. Interveriable relationships was assessed by two-tail Pearson correlation, and stepwise linear regression analysis was used to model malondialdehyde and S100β production.

**Results:** There was no significant correlation between postsurgical cognitive score and S100β level ( $r = 0.036$ ;  $P > 0.1$ ; Table 1).

**Conclusion:** There is a positive relationship between lipid peroxidation and S100β immediately after CPB. S100β 6 h after surgery is related to neurological score, but not to cognitive score. However, neurological score accounts for only 3% of the variance in S100β, and on the basis of this evidence it can not be recommended as a surrogate marker of subtle neurological outcomes after CABG surgery.

**Acknowledgement:** Funded by Wellcome Trust Grant 050190.

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**Table 1**

Dependent variable	Covariates	Std β	P	Δr <sup>2</sup> (%)
S100β post bypass (PBP)	CPB	0.362	<0.001	20.7
	Aprotinin	-0.230	0.010	7.9
	Age	0.274	0.002	6.8
	Malondialdehyde PBP	0.252	0.008	4.7
S100β (6 h after surgery)	S100β PBP	0.500	<0.001	20.8
	Lactated prime	-0.431	<0.001	19.6
	NS after operation	-0.199	0.034	3.2

Multiple regression models for S100β release.

## The effects of remifentanil on haemodynamic stability during rigid bronchoscopy

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**Introduction:** The hypothesis behind the present study was that remifentanil produces greater haemodynamic stability during rigid bronchoscopy than does the conventional propofol injection technique.

**Method:** This was a double-blind, parallel-group, randomized study. All patients received propofol (2–3 mg/kg) and rocuronium (0.6 mg/kg iv) at induction of anaesthesia. Patients then received either remifentanil ( $n = 11$ ; 1 μg/kg

bolus over 1 min followed by infusion of 0.5 µg/kg) or fentanyl ( $n = 11$ ; 2 µg/kg bolus followed by saline placebo infusion). Escape medications of propofol, atropine and ephedrine were given as required. Their lungs were ventilated with 100% oxygen via a Sanders' injector. Haemodynamic instability was defined as one of the following: lacrimation, sweating; systolic blood pressure = 20 mmHg above or below preoperative baseline for 1 min; and heart rate >100 or <50 beats/min for 1 min.

**Results and conclusion:** There were no significant differences in patient characteristics nor duration of bron-

choscopy between the two groups. Remifentanyl was found to attenuate significantly the haemodynamic response to insertion of a rigid bronchoscope ( $P < 0.05$  for increase in arterial pressure;  $P < 0.01$  for increase in heart rate). During bronchoscopy, five patients showed somatic or autonomic responses in the fentanyl group, compared with none in the remifentanyl group ( $P < 0.01$ ). ST-segment changes occurred in eight patients in the fentanyl group compared with four patients in the remifentanyl group ( $P < 0.05$ ). The total doses of escape medications used and the total episodes of haemodynamic instability during bronchoscopy were significantly reduced in remifentanyl infusion group.

## Acute normovolaemic haemodilution (ANH) is safe in patients with known coronary artery disease

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**Introduction:** The reduction of autologous blood transfusion is a national priority. The use of ANH as a blood conservation strategy remains controversial and under-investigated [1]. A recent paper [2] concluded that ANH should be avoided in patients with critical coronary stenosis or moderate-to-poor left ventricular function. There are no randomized controlled studies of the safety of ANH.

**Objectives:** To investigate the safety of ANH using continuous Holter electrocardiography monitoring, serial analysis of daily postoperative electrocardiography, and by the use of troponin I levels.

**Methods:** Patients presenting for elective coronary artery bypass surgery were randomized into a control or an ANH group. All patients had a four-lead Holter electrocardiography monitor attached 1 h before surgery. After a standard anaesthetic induction, patients in the ANH group had 10 ml/kg blood removed while being maintained within 20% of their baseline blood pressure. This blood was reinfused after cardiopulmonary bypass. Troponin I levels were taken preoperatively, prebypass and at 24 h. All patients had daily postoperative electrocardiography analysis.

**Results:** The results are shown in Table 1.

**Table 1**

Variable	ANH ( $n = 18$ )	Control ( $n = 22$ )	<i>P</i>
Age (years)	64.2 ± 7.28	64.7 ± 8.61	0.880
Parsonnet score	5.39 ± 4.05	7.13 ± 5.84	0.288
Ischaemic burden	20.16 ± 41.7	26.9 ± 97.1	0.600
New ECG changes	2/18	7/22	
Troponin I 24 h (µg/l)	2.39 ± 2.26	4.28 ± 3.59	0.064
Bypass time (min)	73.01 ± 20.76	73.74 ± 16.33	0.907
X-clamp time (min)	44.11 ± 14.12	43.44 ± 9.42	0.855

Values are expressed as mean ± standard deviation, unless otherwise stated. ECG, electrocardiography.

**Conclusion:** ANH is safe. There is no evidence of an additional ischaemic burden after haemodilution.

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## High thoracic epidural and remifentanyl for anaesthesia for cardiac surgery in morbidly obese patients with obese hypoventilation syndrome

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**Introduction:** Patients with morbid obesity and obese hypoventilation syndrome are at a high risk for respiratory

complications after surgery. This risk is increased substantially if sedative opioid analgesia is necessary. This group

of patients present particular challenges when undergoing cardiac surgery, in which opioid anaesthesia is a mainstay of perioperative management. We present a series of such patients anaesthetized using a combination of high thoracic epidural and remifentanil infusion.

**Methods and results:** Over the past 2 years, nine patients presented for anaesthesia to one of the authors (JCB) for cardiac surgery, with both morbid obesity (body mass index ranged from 40.3 to 45.7) and obese hypoventilation syndrome requiring either nocturnal continuous positive airways pressure or, in two cases, nocturnal biphasic positive airways pressure. There were eight men and one woman (age range 43–69 years); seven required coronary revascularization and two required aortic valve replacement.

No sedative premedication was administered. All patients consented to a high thoracic epidural, which was placed by one of the authors (JCB) immediately before induction of anaesthesia after arterial and venous cannulae were in place. The epidural was sited using loss of resistance to saline through a 16g Tuohy needle with the patient in the sitting position in either the C7/T1 (seven cases) or the T1/T2 (two cases) intervertebral space. Anaesthesia was induced with propofol 0.5 mg/kg and remifentanil 1 µg/kg ideal body weight, muscle relaxation with atracurium 0.5 mg/kg, and the patient was intubated.

In the patients who required coronary revascularization 15 ml 0.5% bupivacaine was given as a bolus before sternotomy, and the remifentanil was titrated back to 0.1–0.15 µg/kg per min. In the patients who required aortic valve replacement the bupivacaine was given after the institution of cardiopulmonary bypass, and the remifen-

tanil was maintained at 0.5–1 µg/kg per min until that point. Propofol 3 mg/kg per h was administered throughout.

Propofol and remifentanil were continued after surgery in the intensive care unit, where an epidural infusion of 0.15% bupivacaine was commenced at 8 ml/h. All patients were weaned from mechanical ventilation when usual criteria had been met. The time to extubation ranged from 2 to 18 h (median 7.5) after the end of surgery. No patient required reintubation. One patient spent 3 days in intensive care because of a post-drain removal pneumothorax; no other patient spent more than the first post-operative night in intensive care. Only one patient remained an inpatient longer than 7 days, and he went home 10 days after surgery. The epidural infusions were continued for between 48 and 72 h after surgery and supplemental analgesia was with diclofenac 50–75 mg three times a day or tramadol 50–100 mg three times a day. The epidural infusion required to produce satisfactory analgesia ranged from 6 to 18 ml/h (median 8 ml/h).

**Discussion:** The use of opioids in patients with obese hypoventilation syndrome is known to carry a significant risk of respiratory depression and cardiorespiratory arrest. Providing postoperative analgesia with epidural local anaesthesia avoids the use of opioids postoperatively. Remifentanil administered during anaesthesia allows the benefits of opioid analgesia in such patients during surgery without any residual effects after surgery due to its rapid metabolism by tissue esterases. By using this combination of ultrashort-acting opioid and high thoracic epidural, it has been possible to anaesthetize this high-risk group of patients safely with no increase in duration of intensive care or hospital stay.

## **An audit of blood and blood product use in the Cardiac Intensive Care Unit (CICU)**

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**Introduction:** Cardiac surgical patients use 10–20% of the nation's blood products [1]. Recent work [2] suggests a lower acceptable haematocrit for cardiac surgical patients during the perioperative period. This, and a change in our unit's policy to increase the availability of platelets and clotting factors ('crash packs') for these patients, prompted us to conduct this audit in order to determine whether our therapy was appropriately targeted.

**Method:** During a 3-month period we issued forms to the attending anaesthetist for all cardiac surgical procedures requesting information regarding demographics, preoperative drug history and baseline haematology. Intraoperative use of and indications for packed cells, fresh frozen

plasma and platelets were noted. Postoperatively the attending nurse recorded the haematocrit, drain losses, and the use of and indications for red cells and clotting factors. Coagulation studies, and haemoglobin on CICU discharge and hospital discharge were also documented.

**Results:** Out of a possible 245, 183 forms were returned. Before bypass, 5.6% of patients were given blood, all of whom received 1 unit (mean haematocrit of 24.6%); the remainder had a mean haematocrit of 34.5%. Blood was received by 8.5, 0.6 and 0.6% (1, 2 and 3 units, respectively) on pump, with mean trigger haematocrits of 17.9, 18 and 19%, respectively. Postpump, 1.8% received blood, 1 unit each (mean haematocrit of 20.3%) versus

98.2% whose mean haematocrit was 22.7%. Overall, intraoperatively 83.6% received no blood, and 14.7% received only 1 unit of packed red cells (PRC). On CICU admission the mean haematocrit was 27% (no blood given), 24% (1 unit PRC), 21% (2 units PRC) and 19% (3 units PRC). The mean haematocrit on discharge from CICU was 27.8% where no blood was given, compared with 26.7%. Only one patient left hospital with a haemoglobin of below 8 g/dl. That patient had received no PRC. Of the 12% of patients who received 2 units PRC, 55% left hospital with a haemoglobin greater than 10 g/dl (12 out of 22); of the 4% of patients who received 5 units PRC, 57% left hospital with a haemoglobin greater than 10 g/dl (four out of seven). Of the 12% of patients who received only 1 unit PRC, 31% left hospital with a haemoglobin greater than 10 g/dl (four out of 13). Overall, 40% of patients received no blood during their admission, whereas 11% received only 1 unit of PRC. Patients weighing less than 60 kg had significantly greater PRC use, with 100% of this group requiring blood (mean 3 units/patient), compared with 53% of those who were over 60 kg in weight (mean 1.4 units/patient).

Fifteen per cent of patients received a 'crash pack' in CICU. Only 68% of these had formal coagulation studies done. Of these only 20% had abnormal screens, defined as prothrombin time and partial thromboplastin time greater than 3 and 5 s over control, respectively. Of those who received a crash pack, only 48% had a full blood count done first. Of these only 20% had platelet counts below  $100 \times 10^9/l$ . Only one patient of the six who had fibrinogen measured had levels below 1; five had 'crash packs'. The mean total drainage was 1725 ml where a crash pack was given, compared with 797 ml where no clotting factors were given. The mean drainage in the 4.4% of patients done 'off-pump' was 1120 ml, compared with 901 ml in the 95.6% whose procedures were performed on cardiopulmonary bypass (CPB). The mean

CICU admission haematocrit was 32% (off-pump) versus 26% (post-CPB). Those done 'off-pump' were given a mean of 2 units PRC versus 1.7 units PRC in those done on CPB. Of cases done off-pump, 33% had a crash pack. All of the 4.6% who were re-explored had crash packs.

Preoperative medication made no difference to mediastinal drainage or to crash pack use. The drain losses and crash pack use in smokers was no different from that in nonsmokers.

**Conclusion:** The present results suggest that our use of red cells could be targeted at lower haematocrits both intraoperatively and in CICU. There is a subgroup of patients who are given relatively small transfusions and are discharged with high haemoglobin concentrations. It would be prudent to evaluate means to avoid this, and this may particularly benefit those weighing below 60 kg. The drain losses and transfusion requirements in those patients undergoing coronary artery bypass grafting 'off-pump' were significantly higher than expected, although this sample was small and may reflect a 'learning curve'. Those patients receiving clotting factors and platelets had significantly higher mediastinal drainage than those who did not. Only a small percentage of postoperative coagulation studies/platelet counts were abnormal. From our current data it is difficult to assess the contribution to haemostasis of the blood products given. A more accessible/rapid assessment of the coagulation system and platelet numbers and function may be helpful in directing our use of clotting factors and platelet concentrate.

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