**Diabetes management during cardiac surgery in the UK: a survey**

**Running title: Diabetes management during cardiac surgery**

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**Competing interests**

The authors have no competing interest to report.

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**Novelty Statements**

**What is known?**

* People with diabetes are at higher risk of post-operative complications after surgery
* The Joint British Diabetes Societies have published guidance to improve the management of people with diabetes during surgery

**What this study has found?**

* Cardiothoracic surgeons do not routinely measure HbA1c or refer to a specialist diabetes team prior to surgery
* Practice appears to be driven by individual preference rather than unit policy

**What are the clinical implications of the study?**

* There is an opportunity to improve the surgical outcome of people with diabetes undergoing cardiac surgery through greater involvement of the diabetes team

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**Abstract**

**Objectives:** Better diabetes management is likely to improve surgical outcomes. Our aim was to determine current practice regarding the diabetes management of people undergoing cardiac surgery in the UK.

**Design:** Online survey of UK cardiothoracic surgeons.

**Participants:** All cardiothoracic surgeons listed on the Society of Cardiothoracic Surgery membership directory were invited to participate.

**Methods:** The SurveyMonkey software survey comprised 15 closed and open-ended questions about the management of people with diabetes pre- and peri-operatively.

**Results:** Sixty-two cardiothoracic surgeons from all 33 UK cardiac centres completed the survey. 44% of the surgeons responded that they routinely measure HbA1c pre-operatively for all patients. 19% had an HbA1c threshold above which they would not operate and 21% currently undertake a point-of-care HbA1c measurement during the cardiothoracic out-patient visit. 74% of respondents reported that it was ‘easy’ or ‘very easy’ to obtain a diabetes team review; diabetes nurse specialists were the members of the diabetes team working most closely with cardiac surgeons. Up to a third of the surgeons did not provide physical activity recommendations prior to admission and over 80% did not have a different preoperative or surgical diabetes protocol. Inconsistency in the responses within centres suggests that differences in practice may depend on individual surgeons rather than local policy.

**Conclusions:** The study demonstrates there is only limited peri-operative management of diabetes in people undergoing cardiac surgery in the UK. There is an opportunity for greater involvement of the diabetes specialist team both before and during admission for surgery to improve outcomes.

**Trial registration:** ISRCTN10170306

**Key words**: Cardiothoracic surgery, pre-operative management, diabetes, survey, HbA1c

**Introduction**

Diabetes increases the risk of cardiovascular disease by approximately 2-fold after adjustment for other cardiovascular risk factors [1] such that cardiovascular disease affects approximately a third of all people with type 2 diabetes and is responsible for over 50% of deaths [2]. The pattern of coronary heart disease tends to be more diffuse and progresses more rapidly in people with diabetes. Although the National Adult Cardiac Surgery Audit has reported a significant reduction in referrals for coronary revascularization in the UK over the last two decades as percutaneous procedures have increased [3], coronary artery bypass grafting is still needed for those with multi-vessel disease as these people do better with coronary artery bypass grafting. The profile of people referred for coronary artery bypass grafting has changed; they are older and with more co-morbidities, of which diabetes is a major contributor. Approximately 30-40% of all people undergoing open cardiac surgery have diabetes [4].

People with diabetes are at an up to three-fold higher risk of post-operative complications after cardiac surgery including poor healing, wound complications (2.7% vs 0.8%), and renal failure [5,6]. These complications lead to a longer length of stay and higher re-admission rates. Although there are several reasons for these poorer outcomes in people with diabetes, glycaemic control is a key modifiable factor. The HbA1c at admission is positively associated with perioperative glucose, which in turn predicts 30-day mortality, linearly in non-cardiac and non-linearly in cardiac procedures [7]. HbA1c is also directly related to deep sternal wound infection, respiratory complications and acute kidney injury in people with and without diabetes after coronary artery bypass grafting [6,8-11]. For example, in the E-CABG registry, those with a baseline HbA1c above 53 mmol/mol were more likely to develop a deep sternal wound infection (3.8% vs 1.3%) and acute kidney injury (27% vs 20%) [6].

In recognition of this, the Joint British Diabetes Societies for in-patient care recommend improving glycaemic control to optimise surgical outcomes [12]. However, there are on-going uncertainties about the optimal peri-operative management of people with diabetes. For example, current UK guidelines recommend delaying surgery if the HbA1c is above 69 mmol/mol, whereas US guidance recommend an optimal HbA1c of below 53 mmol/mol [13]. The current National Institute for Health and Clinical Excellence (NICE) guidelines recognise this evidence gap [14], as do the Joint British Diabetes Societies [12].

The aim of the present study was to explore the management of people with diabetes in UK cardiac surgery units in order to determine the current practice regarding people with diabetes undergoing cardiac surgery.

**Methods**

The survey was conducted as part of the intervention development phase of the OCTOPuS trial (Optimising Cardiac Surgery ouTcOmes in People with diabetes; NIHR 16/25/12). The primary aim of the project is to investigate whether the OCTOPuS intervention (a pre-admission diabetes review by a specialist diabetes team) is clinically- and cost-effective at improving outcomes for people with sub-optimally controlled diabetes in a large multi-centre randomised controlled trial involving at least 15 cardiothoracic UK services. This survey was undertaken to determine current clinical practice to help define “usual care” in the trial.

PARTICIPANTS

The Society of Cardiothoracic Surgery in Great Britain and Ireland (SCTS) is a professional society of approximately 1000 consultant cardiothoracic surgeons or specialist registrars. Most, but not all members, are based in the UK. An email invitation was circulated in June 2019 on our behalf to all SCTS members who were currently listed on their generic mailing list. A further email invitation was circulated by the SCTS in October 2019. We had no access to the SCTS database and therefore could not verify how many email requests were sent and to whom. Similarly we do not have access to the demographic details of the membership, although from the free-text responses, we were able to determine that over 85% of respondents were consultants.

Although the SCTS sent the invitations to individual members, our aim was to obtain at least one response from each UK cardiothoracic centre. Personal emails to cardiac surgeons were therefore sent by the study team to centres that had not responded to the SCTS mailshot to encourage participation until all centres were represented.

SURVEY

An online survey was designed using software SurveyMonkey ([www.surveymonkey.com](http://www.surveymonkey.com)). The survey consisted of 17 closed and open-ended questions about the use of HbA1c by cardiothoracic surgical teams and the involvement of diabetes specialist teams and to explore the interventions, protocols and concerns of cardiothoracic surgical teams in the perioperative management of diabetes (Table 1). Respondents were also asked about other aspects of management and to indicate whether they were interested in participating in the OCTOPuS trial. The questionnaire was piloted for usability, relevance and ease of completion by healthcare professionals in Southampton and revisions made based on feedback from the participants. The survey was open from June to November 2019.

*[Table 1]*

ETHICS

The study was approved by the South Central - Hampshire A Research Ethics Committee (18/SC/0508). Given the nature of the study, it was not necessary to involve patients or members of the public in the design or conduct of the survey.

STATISTICAL ANALYSIS

Open-ended response data were categorised with similar responses grouped appropriately; therefore all data were analysed as n (%). It was not possible to analyse the data per cardiac unit to account for multiple responses in some units because of the differing responses within units, therefore the responses per surgeon are given. The consistency of the responses within unit was examined by analysing n (%) of the units with multiple responses where the responses within unit differed; however it was not considered for open ended questions as the opportunity for inconsistency was too great. All analyses were completed using Microsoft Excel for Office 365.

**Results**

Sixty-two cardiothoracic surgeons from all 33 UK cardiac centres completed the survey. Two additional responses were received from outside the UK (Ireland, Germany) and are not included in the results. The number of responses per centre ranged from 1 to 4, with >1 response received in 18 (55%) centres (Appendix 1).

Allowing for differing responses from surgeons at the same centre, approximately 31 of the 33 units (94%) performed cardiac surgery on over 100 people with diabetes per year, with up to 22 of the units (67%) performing surgery on over 250 people with diabetes per year. The rest of the results are presented below under broad themes.

USE OF HbA1c PRIOR TO CARDIAC SURGERY

27 of the 62 surgeons (44%) responded that they measure HbA1c routinely for all patients listed for surgery regardless of diabetes or not, whereas 15 (25%) never measured HbA1c and another 15 only measured HbA1c in those with a known history of diabetes. For 7 (39%) of centres, there was more than one response to this question, where surgeons within the same centre gave differing answers.

Only 12 of the 62 surgeons had an HbA1c threshold above which they would not proceed to surgery. The threshold for declining surgery ranged from 53 mmol/mol (7%) to 119 mmol/mol (12%). In 6 (33%) of the centres that provided 2 or more responses, cardiac surgeons were not in agreement about the use of a threshold or not.

13 of the 62 (21%) surgeons reported that they currently undertake a point-of-care HbA1c measurement during the cardiothoracic out-patient visit. Of those who do not currently provide this test, 33 (53%) would consider or maybe consider providing it at a cost of £10 per test.

INVOLVEMENT OF DIABETES SPECIALIST TEAM

Although no cardiothoracic unit held a joint clinic with the diabetes specialist team, 74% of respondents reported that it was ‘easy’ or ‘very easy’ to obtain a review from the diabetes team if needed. Only 10% of respondents reported that it was ‘difficult’ or ‘very difficult’. However, only 7% of respondents referred all preoperative patients with diabetes to a diabetes specialist team routinely and only 16% referred all postoperative patients for a diabetes review. Even among those with high HbA1c, half of those surveyed sought no diabetes input before surgery. There was considerable difference in practice within centres with surgeons from 9 of the 18 centres reporting different pre-operative diabetes referral patterns and surgeons from 11 of the 18 centres reporting different post-operative referrals.

The members of the diabetes specialist team who work closely with cardiac surgeons are mostly diabetes nurse specialists followed by dietitians and pharmacists. A diabetes consultant opinion was ‘sought’ or ‘maybe sought’ by fewer than half of surgeons (40%).

DIABETES INTERVENTION AND PROTOCOLS

Almost half of the surgeons did not provide any specific recommendations for physical activity prior to admission. For those who advised on exercise, gentle aerobic activity for up to 30 mins a day was the most common recommendation.

Over 80% of the respondents did not have a different preoperative protocol for patients with diabetes. Very few surgeons had a different perioperative antibiotic regimen (n=2), a postoperative renal protective strategy (n=3) or plans for earlier follow up (n=3). Almost half of the respondents were in favour of stopping metformin (39%), ACE inhibitors (59%) or angiotensin receptor blockers (55%) before surgery but all except one reported restarting these drugs in the postoperative period. Consistency of responses within centre was not assessed for this question as responses were collected as free text.

SURGICAL PROCEDURES

Most surgeons did not change their surgical approach in people with diabetes, however 77% of the surgeons would not use bilateral internal thoracic arteries for surgical revascularization in people with diabetes.

**Discussion**

The results of our survey suggest that a diagnosis of diabetes does not significantly change the management by cardiothoracic surgeons in the pre-operative and peri-operative period. Although liaison with the specialist diabetes team would be feasible, the lack of interaction represents a missed opportunity to prepare people with diabetes for surgery. Except for the use of bilateral internal thoracic arteries for surgical revascularization, surgical procedures are largely unchanged in people with diabetes. The inconsistency of responses within centres suggests that differences in practice may depend more on individual surgeon preference than a common unit protocol.

The importance of glycaemic control in the peri-operative cardiothoracic period has led to several national and international groups publishing detailed guidelines about the management of diabetes in people undergoing surgery [12-14]. Despite this, however, many people are poorly prepared for surgery. In the E-CABG registry, 54% of people with type 2 diabetes treated with non-insulin medications and 67% of those with insulin-treated diabetes had an HbA1c above 53 mmol/mol (7.0%) [6]. The present study suggests that cardiac surgery practices are not currently taking sufficient account of the perioperative management of people with diabetes. Fewer than half are measuring HbA1c prior to surgery and even fewer are seeking support from a specialist diabetes team. There may be several reasons for this including administrative pressures to keep waiting lists short, expediting cases and increasing the overall throughput in the cardiac surgery care pathways. Cardiac referral patterns, practice and unit activity have substantially changed in the UK over the last decade. There has been a trend towards decreased overall case-load and shorter waiting lists running into weeks rather than months. Increasing case volumes of inpatient urgent cardiac surgery (50% increase over the last decade) and scheduling priorities potentially leave less scope for preoperative optimization of cardiac risk factors including diabetes. Nevertheless if robust protocols were established, an assessment and management plan for people with diabetes could still be undertaken even if the surgery was urgent.

The use of HbA1c as a measure of glycaemic control also presents challenges for cardiac surgical centres, possibly because of lack of awareness or prioritisation of other routine pre-surgical tests for risk profiling and fitness for surgery. Nevertheless the use of cheap rapid point-of-care test kits provides an opportunity to address this gap in care. Where HbA1c is considered by the cardiothoracic surgeons, there is a wide difference in opinion about the threshold above which surgery would not proceed ranging from 53 mmol/mol (7%) to 119 mmol/mol (12%). This may reflect the differences in national and international guidelines but this does not fully explain the chosen cut-offs as the highest recommended threshold for delaying surgery is an HbA1c above 69 mmol/mol (8.5%) [12].

Earlier and greater involvement of the diabetes specialist team is likely to lead to significant improvements in glycaemic control prior to admission to hospital and this has led to the proposal to create “heart teams” for decision making in all people with valvular and ischaemic heart disease and these teams should include a diabetologist and nutritionist, at least for those undergoing complex coronary revascularization [15].

It is encouraging that this survey did not identify access to diabetes specialist teams as a barrier to referral in the pre- and peri-operative period and greater use of this resource should be encouraged. It is notable that most patients are not seen pre-operatively by diabetes consultants. This means that people awaiting cardiac surgery, who most often have the most severe complications related to diabetes, do not receive the benefits of consultant input to reduce their risk of perioperative and long-term adverse events. There is consequently an opportunity to improve care by developing multidisciplinary teams that bring together the skills of both surgical and diabetes teams. As most centres are operating on more than 100 people with diabetes per year, the potential benefits would likely justify the investment in setting up such a service, although the OCTOPuS trial will formally test this hypothesis.

Our aim was to determine a picture of clinical practice across the cardiothoracic units in the UK but the methods of distributing the survey meant that responses were by individual clinicians. It was notable that there was considerable inconsistency within units suggesting that individual surgeons tended to follow their own preferences rather than a unit policy. Adopting unit policies that incorporate evidence and guidance from NICE and JBDS may be a further way of disseminating best practice. The variation in clinical practice creates a challenge for defining “usual care” for the OCTOPuS trial. Entry into the trial, which requires measurement of HbA1c, will mean deviation from “usual care” in a quarter of centres which do not routinely measure HbA1c. In order to mitigate against the differences in usual care, the trial will randomise participants by centre and the trial team will provide centres with information about the importance of diabetes management and current guidance. In addition for a subset of participants in the control arm, actual practice will be documented and reported using a framework such as TIDieR..

Physical activity is an important component of the management of diabetes as it improves fitness, strength and well-being, while reducing the risk of cardiovascular disease. Most guidelines recommend that people with diabetes take at least 150 minutes of exercise per week spread over a minimum of 3 days, ideally combining both aerobic exercise and resistance training. Despite the potential health benefits, 40% of cardiac surgeons do not recommend any form of exercise in the pre-admission period, possibly because of concerns that exercise may provoke angina.

For the most part, cardiac surgeons did not alter their surgical technique for people with diabetes. The one consistently reported change for people with diabetes was the avoidance of the use of bilateral internal mammary arteries. This finding is not surprising, as there is no substantial benefit of bilateral internal mammary arteries over a single internal mammary artery and its use is likely to decline further in the future [17,18].

The present study is not without limitations. As in any self-report study, there are a number of sources of potential bias. Although we were able to secure responses from each cardiothoracic unit, overall our response rate is likely to be less than 10%. As we did not have access to detailed demographic information about the SCTS members to whom the survey invitation was circulated, we cannot be sure that our sample was representative of the whole membership. It is also unclear to what extent individual responses reflect actual individual and unit practice. On the one hand, people may over-estimate the extent to which they believe they follow guidelines, while on the other, there is also the possibility for under-estimation as well, if the person completing the questionnaire is not responsible for certain aspects of care such as organising routine pre-op tests. A final limitation is that this study was undertaken solely within the UK National Health Service and it is unclear whether similar issues face clinicians working in other countries and healthcare settings.

**Conclusions**

Despite the well-known adverse outcomes in people with diabetes, the survey demonstrates that many cardiac surgeons have limited involvement in the pre-operative and perioperative management of diabetes in cardiac surgery units across UK. Greater interaction with diabetes specialist teams, particularly consultants, has the potential to improve the clinical outcomes of people with diabetes undergoing cardiac surgery. Developing unit policies for the management of diabetes prior to surgery and during admission is likely to reduce the variation in practice and improve the care of people with diabetes.

**Members of the OCTOPuS study group**

The following are the members of the OCTOPuS study in addition to the authors of this article: Mayank Patel, Mark Green, Philip Newland-Jones, Rita Trodden, Paula Johnston, Jana Rojkova, Thea Sass, Jo Stanley (University Hospital Southampton), Susi Renz, Andrew Cook, Michelle Light, Jess Boxall (Southampton Clinical Trials Unit), Jo Lord (University of Southampton), Katharine Barnard (Barnard Health), John Niven (patient representative), Helen Partridge (Royal Bournemouth Hospital).

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**Table 1**. All survey responses summarised as n (%) of respondents by category; and n (%) of centres with multiple responses where there was disagreement within centre to closed-ended questions.

| **Survey question** | **N (%)** | **Disagreement within centres** |
| --- | --- | --- |
| N | 62 | 18 |
| How many people with diabetes are listed for elective surgery in your centre each year? |   |  |
| *<50* | 0 (0.0%) | 12 (67%) |
| *50-100* | 3 (5%) |  |
| *100-250* | 25 (40%) |  |
| *>250* | 33 (53%) |  |
| *Not answered* | 1 (2%) |  |
| Do you measure HbA1c routinely when someone is listed for cardiac surgery? |   |  |
| *Yes, all patients* | 27 (44%) | 7 (39%) |
| *Yes, if known history of diabetes* | 15 (24%) |  |
| *Not measured routinely* | 15 (24%) |  |
| *Not answered* | 5 (8%) |  |
| Do you have an HbA1c threshold above which you will not operate? *(Yes)* | 12 (19%)  | 6 (33%) |
|  |   |  |
| If yes, what is the HbA1c threshold above which you will not operate? |   |  |
| *50-59 mmol/mol* | 1 (8%) | 6 (33%) |
| *60-69 mmol/mol* | 6 (50%) |  |
| *70-79 mmol/mol* | 2 (17%) |  |
| *80-89 mmol/mol* | 1 (8%) |  |
| *90+ mmol/mol* | 2 (17%) |  |
| Do you ask a specialist diabetes team to review pre-operative patients with diabetes? |   |  |
| *Yes, for all people with diabetes* | 4 (6%) | 9 (50%) |
| *Yes, only for those with high HbA1c* | 31 (50%) |  |
| *No* | 25 (40%) |  |
| *Not answered* | 2 (3%) |  |
|  |   |  |
| If yes, what threshold would trigger a referral? |   |  |
| *40-49 mmol/mol* | 1 (3%) | 3 (17%) |
| *50-59 mmol/mol* | 1 (3%) |  |
| *60-69 mmol/mol* | 4 (11%) |  |
| *70-79 mmol/mol* | 1 (3%) |  |
| *80-89 mmol/mol* | 2 (5.7%) |  |
| *90+ mmol/mol* | 0 (0%) |  |
| *Not answered* | 26 (74%) |  |
| Do you ask a specialist diabetes team to see patients post operatively? |   |  |
| *Yes, all patients* | 10 (16%) | 11 (61%) |
| *Yes, some patients* | 37 (60%) |  |
| *No* | 10 (16%) |  |
| *Not answered* | 5 (8%) |  |
|  |   |  |
| With which members of the specialist diabetes team do you work closely? *(Yes or maybe)* |  |  |
| *Consultants* | 25 (40%) | 11 (61%) |
| *Diabetes Nurse Specialists* | 58 (94%) | 2 (11%) |
| *Pharmacists* | 37 (60%) | 14 (78%) |
| *Dieticians* | 42 (68%) | 12 (67%) |
| How easy is it for you to obtain a review from a dedicated specialist diabetes team? |   |  |
| *Very easy* | 13 (21%) | 14 (78%) |
| *Easy* | 33 (53%) |  |
| *Neither easy nor difficult* | 8 (13%) |  |
| *Difficult* | 4 (7%) |  |
| *Very difficult* | 2 (3%) |  |
| *Not answered* | 2 (3%) |  |
| Do you hold joint clinics with a dedicated specialist diabetes team? |   |  |
| *No* | 60 (97%) | 0 (0.0%) |
| *Not answered* | 2 (3%) |  |
| Does diabetes affect your surgical strategy? |  |  |
| *Using Bilateral mammaries* | 48 (77%) | 13 (72%) |
| *Using single mammary* | 9 (15%) | 4 (22%) |
| *Off pump surgery* | 10 (16%) | 6 (33%) |
| *Tissue versus mechanical valves* | 3 (5%) | 3 (17%) |
| *Endoscopic vein harvesting* | 18 (29%) | 10 (56%) |
| *Minimally invasive surgery* | 11 (18%) | 8 (44%) |
| Do you have a different pre-operative protocol for the management of diabetes? *(Yes)* | 11 (18%) | 12 (67%) |
|  |   |  |
| If yes, what is it?1 |   |  |
| *Sliding scale* | 5 (45%) | - |
| *First on the list* | 3 (27%) |  |
| *GKI Infusion* | 2 (18%) |  |
| *Blood glucose monitoring* | 1 (9%) |  |
| *Other2* | 2 (18%) |  |
| What recommendations do you give people about physical activity in the pre-operative waiting period? |   |  |
| Type of physical activity |  |  |
| *Aerobic* | 21 (34%) | 12 (67%) |
| *Resistance* | 1 (2%) |  |
| *Both* | 13 (21%) |  |
| *Not recommended* | 21 (34%) |  |
| *Not answered* | 6 (10%) |  |
| *How much?* |  |  |
| *15-30 minutes per day* | 18 (29%) | 6 (33%) |
| *30-60 minutes per day* | 9 (15%) |  |
| *>60 minutes per day* | 1 (2%) |  |
| *Not recommended* | 12 (19%) |  |
| *Not answered* | 22 (35%) |  |
| Intensity |  |  |
| *Gentle* | 20 (32%) | 6 (33%) |
| *Moderate* | 14 (23%) |  |
| *Intense* | 0 (0%) |  |
| *Not recommended* | 5 (8%) |  |
| *Not answered* | 23 (37%) |  |
| Do you have a different peri-operative protocol for the management of diabetes with regards to any of the following? |  |  |
| *Antibiotic regimen* | 2 (3%) | 2 (11%) |
| *Routine post-operative frusemide infusion* | 3 (5%) | 3 (17%) |
| *Earlier follow up* | 3 (5%) | 2 (11%) |
| *Other3* | 4 (6%) | 2 (11%) |
| *Any of these* | 9 (15%) | 5 (28%) |
| Do you commonly stop any medication prior to surgery? |  |  |
| *Metformin* | 24 (39%) | 8 (44%) |
| *ACE inhibitors* | 37 (60%) | 7 (39%) |
| *ARB* | 34 (55%) | 11 (61%) |
| *Other4* | 1 (2%) | - |
| If you do stop any of the medications above, when do you restart them? | **Metformin** | **ACE inhibitors** | **ARB** |  |
| *Immediately* | 3 (5%) | 1 (2%) | 1 (2%) | - |
| *1 day post-surgery* | 5 (8%) | 4 (6%) | 5 (8%) |  |
| *2 days post-surgery* | 6 (10%) | 12 (19%) | 12 (19%) |  |
| *3+ days post-surgery* | 3 (5%) | 7 (11%) | 7 (11%) |  |
| *Once oral intake resumed* | 13 (21%) | 1 (2%) | 1 (2%) |  |
| *When renal function and/or BP allow* | 2 (3%) | 9 (15%) | 9 (15%) |  |
| *On discharge* | 0 (0%) | 3 (5%) | 3 (5%) |  |
| *Other* | 2 (3%)5 | 3 (5%)6 | 1 (2%)7 |  |
| Do you routinely complete HbA1c as a point of care test at the cardiac clinic visit? |   |  |
| *Yes* | 13 (21%) | 7 (39%) |
| *No* | 46 (74%) |  |
| *Not sure* | 2 (3%) |  |
| *Not answered* | 1 (2%) |  |
| If you do not provide it, would you consider providing it (at a cost of £10 per patient)? |    |  |
| *Yes* | 16 (26%) |  |
| *Maybe* | 17 (27%) |  |
| *No* | 4 (6%) |  |
| *Not answered* | 9 (15%) |  |

1Multiple answers given by 2 respondents

2Insulin iV Oreo of WBG > 10, 1 (1.6%); established pre-operative/intra-operative/post-operative protocols, 1 (1.6%)

3Insulin infusion, 2 (3.2%); Special protocol, 1 (1.6%); VAC dressing for patients in high infection risk group, 1 (1.6%)

4Nicorandil, 1 (1.6%)

5Yes, 1 (1.6%); After surgery when weaning off sliding scale, 1 (1.6%)

6Yes but reduced dose, 1 (1.6%); Post op and usually before discharge, 1 (1.6%); Not at all, 1 (1.6%)

7Yes but reduced dose, 1 (1.6%)

**Appendix 1**. Number of individual responses received from each UK cardiothoracic centre.

|  |  |  |
| --- | --- | --- |
| **No of responses per centre** | **N (%) of centres** | **Cardiothoracic centres** |
| 1 | 14(42%) | Aberdeen Royal InfirmaryBasildon and Thurrock University Hospital NHS Foundation TrustCentral Manchester University Hospitals NHS Foundation TrustGolden Jubilee National Hospital, Clydebank, GlasgowGuys' and St Thomas' NHS Foundation TrustKing's College Hospital NHS Foundation TrustLeeds Teaching Hospitals NHS TrustOxford University Hospitals NHS TrustRoyal Stoke University HospitalRoyal Victoria HospitalSouth Tees Hospitals NHS Foundation TrustUniversity Hospital of Wales (Cardiff)University Hospitals Birmingham NHS Foundation TrustUniversity Hospitals Coventry and Warwickshire NHS Trust |
| 2 | 9(27%) | Blackpool Teaching Hospitals NHS Foundation TrustLiverpool Heart and Chest NHS Foundation TrustMorriston Hospital (Swansea)Nottingham University Hospital NHS TrustPlymouth Hospitals NHS TrustRoyal Infirmary EdinburghRoyal Wolverhampton NHS TrustSheffield Teaching Hospitals NHS Foundation TrustSt George's Healthcare NHS Trust |
| 3 | 7(21%) | Barts Health NHS TrustHarefield Hospital, Royal Brompton and Harefield NHS Foundation TrustHull and East Yorkshire Hospitals NHS TrustImperial College Healthcare NHS TrustNewcastle Upon Tyne Hospitals NHS Foundation TrustUniversity Hospital Bristol NHS Foundation TrustUniversity Hospitals of Leicester NHS Trust |
| 4 | 2(6%) | Royal Papworth Hospital NHS Foundation TrustUniversity Hospital Southampton NHS Foundation Trust |