

National Survey of Variations in Practice in the Prevention of Surgical Site Infections in Adult Cardiac Surgery, United Kingdom & Republic of Ireland

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2 **Adult Cardiac Surgery, United Kingdom & Republic of Ireland**

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23

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27

## 28 **SUMMARY**

### 29 **Introduction**

30 Currently no national standards exist for the prevention of surgical site infection (SSI) in  
31 cardiac surgery. SSI rates range from 1% to 8% between centres. The aim of this study was  
32 to explore and characterise variation in approaches to SSI prevention in United Kingdom  
33 (UK) and Republic of Ireland (ROI).

### 34 **Methods**

35 Cardiac surgery centres were surveyed using electronic web-based questionnaires to  
36 identify variation in SSI prevention at the level of both institution and consultant teams.  
37 Surveys were developed and undertaken through collaboration between the Cardiothoracic  
38 Interdisciplinary Research Network (CIRN), Public Health England (PHE) and the National  
39 Cardiac Benchmarking Collaborative (NCBC) to encompass routine pre-, intra- and  
40 postoperative practice.

### 41 **Results**

42 Nineteen of 38 centres who were approached provided data and included responses from  
43 139 consultant teams. There was no missing data from those centres that responded. The  
44 results demonstrated substantial variation in over 40 aspects of SSI prevention. These  
45 included variation in SSI surveillance, reporting of SSI infection rates to external bodies,  
46 utilisation of SSI risk prediction tools, and the use of interventions such as sternal support  
47 devices and gentamicin impregnated sponges.

### 48 **Conclusion**

49 Measured variation in SSI prevention in cardiac centres across the UK and ROI is evidence of  
50 clinical uncertainty as to best practice, and has identified areas for quality improvement as  
51 well as knowledge gaps to be addressed by future research.

52

## 53 INTRODUCTION

54 Surgical site infection (SSI) is the most significant healthcare-associated infection affecting  
55 surgical patients.[1] In England, the incidence of SSI at 30-days is 8.6% for coronary artery  
56 bypass grafting (CABG) and 2.2% for non-CABG operations.[2] SSIs following cardiac surgery  
57 can add an additional 2 weeks' stay to a patient's in-hospital care, increase their likely  
58 readmission to hospital six-fold, and require extended outpatient follow-up and  
59 reoperation.[3, 4] These events have significant resource implications and the costs of  
60 treating post-cardiac surgery SSI in the United Kingdom (UK) are estimated to be £15 million  
61 per annum.[3]

62 SSIs are often preventable. It has been estimated that there is a 39% to 55% potential for a  
63 significant reduction in rates of SSI through multifaceted interventions.[5] However, the  
64 certainty of the evidence to support these interventions is low, as acknowledged by both  
65 the 2019 National Institute for Health and Care Excellence (NICE) guidance for SSI  
66 prevention, [6] and the Global Guidelines for the Reduction of Surgical Site Infection  
67 published by the World Health Organisation.[7] Evidence gaps lead to clinical uncertainty  
68 and variations in care. Currently, there are no national standards of care specific to the  
69 prevention of cardiac SSIs in UK cardiac centres. We sought to determine if existing  
70 uncertainty is reflected by variation in SSI prevention practice occurs across UK and Republic  
71 of Ireland (ROI) cardiac surgery centres. These data will provide a benchmark for quality  
72 improvement strategies to reduce SSI rates, as well as evidence of equipoise to justify future  
73 research.

74

75

## 76 METHODS

77 This study was devised and delivered by the Cardiothoracic Interdisciplinary Research  
78 Network (CIRN), a research collaborative established by healthcare professionals including  
79 surgeons and nurses within the field of cardiothoracic surgery. [8] It provides the key  
80 infrastructure for the design and delivery of high-quality patient focused clinical research in  
81 people undergoing cardiothoracic surgery. According to the NHS Health Research Authority,

82 this study is not considered research as defined by the UK Policy Framework for Health and  
83 Social Care Research. Therefore, ethical committee approval was not required.

#### 84 *Sample & Setting*

85 The surveys were issued to all 38 cardiac surgery centres in the UK (n = 35) and ROI (n = 3).

#### 86 *Survey Design*

87 Surveys were developed by a Cardiothoracic Interdisciplinary Research Network (CIRN)  
88 steering committee. To identify variables of interest, the work drew primarily on four  
89 national resources: the National Institute for Health and Care Excellence (NICE) SSI  
90 guidance, the Department of Health (DH) High Impact Intervention care bundle to prevent  
91 SSI [9], a Cochrane review of measures to reduce SSI following cardiac surgery [10], and a  
92 2017 NCBC survey of organisational SSI surveillance strategies. Each source was  
93 methodically reviewed and individual interventions relevant to cardiac surgery were  
94 extracted. In addition, current regulatory standards upheld by the Care Quality Commission  
95 (CQC) such as Regulation 20: Duty of candour [11] were included where appropriate. The  
96 CQC is an independent inspector and regulator of health and social services in England  
97 aimed with ensuring fundamental standards of quality and safety are met. Regulation 20:  
98 Duty of candour ensures that providers are open and transparent with people who use the  
99 service in relation to the care and treatment they receive. After a full list of interventions  
100 and standards was compiled, corresponding survey response options were discussed by the  
101 CIRN steering committee and amended through regular teleconferences to ensure a  
102 standardised closed-question approach with corresponding measures.

103 In February 2019, the surveys were reviewed by stakeholders at the NCBC annual  
104 conference. Following feedback from senior representatives of 22 cardiac centres including  
105 35 cardiac surgeons, anaesthetists, nurses and managers the questionnaires were finalised.  
106 Two surveys were developed. The **Trust Survey** comprised 13 questions aimed to  
107 capture organisational and policy level data across National Health Service (NHS) or public  
108 institutions; commonly referred to as Hospital Trusts in the UK. This term has been used  
109 across centres in Scotland and ROI for ease. No private institutions were included. The Team  
110 **Survey** aimed to capture routine clinical practice centred around consultant surgeon teams  
111 and comprised 72 questions. Both surveys were translated into a bespoke online tool.

112 The online version (Microsoft Forms, Office 365®) of the surveys were further reviewed and  
113 tested by the collaborative team members prior to roll out. The complete list of questions  
114 for the two surveys are listed in **Appendices B.1 and B.2.**

#### 115 *Pilot Study*

116 To identify any technical, analytical or comprehension problems both surveys were piloted  
117 in May 2019 by 59 surgeons in 9 centres. There was 100% completion within 1-month.

118 Following some minor grammatical changes to the wording all remaining cardiac hospitals in  
119 the UK and ROI were invited via the SCTS, CIRN and NCBC to take part.

#### 120 *Survey Distribution & Data Collection*

121 The two surveys were launched in the UK and ROI in May 2019. Links to the online surveys  
122 were distributed via email to named recipients. Each centre was provided its own unique  
123 code known only to steering committee leads and each consultant was assigned their own  
124 unique identifier known only to local leads to ensure both anonymity of centre and  
125 consultant. Each participating centre had a lead identified through the CIRN, who had  
126 overall responsibility for data collation through consultation with the appropriate teams at  
127 their centre – including infection control, SSI surveillance and surgical teams. They were  
128 either a junior doctor and/or a nurse or allied health professional (AHP). A single **Trust**  
129 **Survey** was completed for each centre. **Team Surveys** were completed once for each adult  
130 cardiac consultant per centre. Reminders were sent via email and text message. For a period  
131 of one-month (July 2019) data were entered onto the online survey. A senior member  
132 (defined as the Clinical Lead, NCBC representative, Line Manager, or a Senior Consultant)  
133 was required to review and authorise each centre's data prior to submission via the online  
134 survey. The online survey permitted final dataset submission only when all questions had  
135 been answered, thereby ensuring completeness.

#### 136 *Data Storage & Governance*

137 All responses were collected and stored on a secure cloud-based server. Patient level data  
138 including identifiable information was not collected. This study was conducted in  
139 accordance with International Conference for Harmonisation of Good Clinical Practice  
140 (ICHGCP) guidelines and the Declaration of Helsinki (World Medical Association 2000)  
141 Research Governance Framework for Health and Social Care.

## 142 *Data analysis*

143 Simple descriptive analyses were performed. Data are presented as a percentage of  
144 respondents in a table and in graphical form when deemed appropriate.

145

146

## 147 RESULTS

### 148 **Responses**

149 The surveys were distributed to 38 hospitals in UK and ROI. Of these 19 agreed to  
150 participate (50% response rate for hospital level data). Surveys were completed by 139  
151 consultant teams working at these hospitals from a potential sample size of 257 (54%). All  
152 surveys were completed in full, with no missing data. SSI rates reported at Trust level  
153 between January and December 2018 ranged from 1% to 9.9% (median 3.4, IQR 2).

### 154 **Hospital Trust Survey**

155 Trust level responses to questions on perioperative SSI prevention practices are listed in  
156 **Table I**. Centres reported which aspects of the DH/National UK High Impact Intervention  
157 bundle (2010/2011) [10] were routinely performed; of these screening for methicillin  
158 resistant *S. aureus* (MRSA) colonisation and hair removal with electric clippers were  
159 performed by all 19 centres (Table I). Preoperative showering and glucose control for  
160 diabetic patients was routinely performed in 18 centres (95%). All but one centre (95%)  
161 provided written information to patients on SSI prevention preoperatively and sixteen (84%)  
162 provided information postoperatively as well. Four centres (21%) provided SSI video  
163 education. Data on Trust SSI surveillance reporting is reported in **Table I and II**. Eighteen  
164 centres participated in external SSI monitoring. Twelve (63%) participated in national  
165 surveillance schemes run by Public Health England (PHE), Public Health Wales or Health  
166 Protection Scotland, eleven (58%) reported deep sternal SSI rates to National Institute for  
167 Cardiovascular Outcomes Research (NICOR), and eight (42%) participated in the Getting It  
168 Right First Time (GIRFT) SSI audit. SSI case definitions used to these external bodies varied.  
169 All centres reported SSI occurring within the primary admission and 18 (95%) centres  
170 included those requiring readmission. Eight (42%) included SSI diagnosed in the community



171 (outpatient/GP), and eleven (58%) recorded superficial infections up to 30 days and deep  
172 incisional organ/space up to 1-year postoperatively. A confirmed diagnosis of mediastinitis  
173 was met with Regulation 20(2): Duty of candour (DoC) [11] in 7 (37%) centres.

#### 174 **Team Survey**

##### 175 *Care Bundles*

176 SSI care bundles were used routinely by 105 (76%) consultant teams, of which 92 (66%)  
177 reported care bundle implementation for all patients (Table III). Thirty (22%) consultant  
178 teams targeted SSI care bundle(s) to patients deemed at medium or high-risk of SSI and 17  
179 (12%) targeted high-risk patients only. No standardised method was used to identify  
180 patients at greater risk of SSIs. Eighty-eight (63%) consultant teams reported using no  
181 scoring tool to determine SSI risk. Remaining teams used locally validated tools; 21 (15%)  
182 centres used the Brompton and Harefield Infection Score (BHIS), 15 (11%) used the Barts-  
183 Surgical Infection Score (B-SIRS), and 9 (6.5%) used the Surgical Site Infections (SSI) or  
184 National Nosocomial Infection Surveillance System (NNIS) risk index.

##### 185 *Preoperative Diabetes Management*

186 HbA1c levels were routinely measured by 114 (82%) consultant teams in people with known  
187 diabetes (**Appendix C, Table IV**). Twenty-one (11%) reported testing no patients. In those  
188 screened, who had an abnormal result, optimisation of their diabetes treatment pre-surgery  
189 was reported by 100 (81%) teams. The use of perioperative sliding scale insulin varied. All  
190 patients with diabetes receiving sliding scale insulin for 68 (49%) consultant teams, only  
191 patients with diabetes and abnormal blood glucose for 41 teams (30%), only patients with  
192 diabetes on insulin for 18 teams (13%), and only those with elevated blood glucose  
193 regardless of whether they had diabetes or not for 6 teams (4.3%).

##### 194 *Skin Decolonisation Prior to Surgery*

195 All 139 consultants recommend washing prior to surgery, with 100 (72%) consultant teams  
196 recommending washing the night before surgery and 106 (76%) on the day of surgery (Table  
197 **I V**). One-hundred and thirty-nine (100%) teams routinely removed hair using electric  
198 clippers the day before surgery (44, 32%), the morning of surgery (67, 48%), in the  
199 anaesthetic room (19, 14%) or on the operating table (9, 7%). Hair was not routinely  
200 removed by two consultants. Hair was most commonly removed by ward staff for 90 (65%)

201 consultants although 19 (14%) consultant teams delegated this to patients themselves or  
202 carers.

203 Products used for pre-surgery skin decolonisation included washing with chlorhexidine  
204 gluconate liquid (67, 48%) and Octenisan (46, 33%). Mupirocin (2%) nasal decontamination  
205 was used by 94 (68%) teams although an alternative bactericidal medication was used by 41  
206 (29%) teams. In 62 (45%) teams, skin decolonisation with antimicrobial solution was  
207 restricted to those with a current, previous, or unknown, history of MRSA skin colonisation.  
208 Skin decolonisation with (chlorhexidine gluconate 4% or alternative) was targeted to high-  
209 risk patients by 15 (11%) consultant teams. Mouthwash (chlorhexidine gluconate 0.2%) was  
210 used in 29 (21%) consultant teams in patients with current, historical or an unknown history  
211 of MRSA, high-risk individuals only in 13 (9%) teams and 10 (7%) teams used no form  
212 mouthwash decolonisation. Patients who are transferred from another hospital for “urgent”  
213 inpatient surgery often have a higher risk of SSI. In our survey only 35 (25%) of teams gave  
214 instructions to referring hospitals regarding decolonisation prior to transfer. This highlights a  
215 potential variation in care between those “urgent” patients requiring inpatient transfer and  
216 elective patients.

### 217 *Antibiotic Prophylaxis*

218 The results for antimicrobial prophylaxis are reported in **Table V**. Ninety-five (68%)  
219 consultant teams used a combination of at least two antimicrobials for SSI prophylaxis in  
220 CABG. The most frequently utilised antimicrobials in patients undergoing CABG with no  
221 allergies or known infection were flucloxacillin (88, 63%), gentamicin (79, 57%) and  
222 cefuroxime (39, 28%). The duration of antibiotic prophylaxis treatment ranged from 12  
223 hours (15, 1%) through to 24 (92, 66%) and 48 hours (22, 16%) post anaesthetic induction. In  
224 patients undergoing valve surgery 118 (85%) teams utilised two antibiotics and 21 (15%) a  
225 single antimicrobial. Antimicrobial prophylaxis in patients undergoing valve surgery included  
226 gentamicin (101, 73%), flucloxacillin (88, 63%) and cefuroxime (42, 30%) most commonly.  
227 This was continued up to 24 hours postoperatively in 90 (65%) consultant teams, 21 teams  
228 (15%) continued up to 48 hours, and 3 (2%) teams continuing until the central line is  
229 removed.

### 230 *Theatre Specialisation*

231 **Dedicated cardiac surgery theatres were available to 93 (67%) consultant teams whilst 31**  
232 **(22%) were shared with thoracic surgery and another 15 (11%) shared with other surgical**  
233 **specialties. No centres had a dedicated theatre for infected cases and 36 (26%) used laminar**  
234 **flow ventilation systems.**

#### 235 ***Scrubbing Practices***

236 **Chlorhexidine gluconate (75, 54%) or betadine (46, 33%) was used for surgeon hand**  
237 **washing/ skin decolonisation prior to surgery, with 24 (17%) surgeons reporting no**  
238 **preference (Appendix C, Table VII). Single gloving was reported by 102 (73%) consultant**  
239 **teams, double gloving by 19 (14%) teams, and 18 (13%) double-gloving only in selected**  
240 **cases. In 26 (19%) teams glove changes occurred at specific operative times such as prior to**  
241 **handling of any prosthesis.**

#### 242 ***Skin Preparation & Draping***

243 **One hundred and nineteen (85%) consultant teams used chlorhexidine gluconate for skin**  
244 **preparation (Appendix C, Table VIII). Chlorhexidine gluconate 2% was delivered via**  
245 **applicator (78, 56%) or bottle 26 (19%). Povidone iodine preparations were used by 15**  
246 **(11%) consultant teams. One hundred and twenty-four teams (89%) reported using other**  
247 **skin preparations.**

248 **Eighty-four (60%) used at least two applications of skin preparation either as a pre-**  
249 **preparation in the anaesthetic room prior to transfer into the theatre suite or as double**  
250 **preparation in theatre prior to draping. This was left to air dry for > 2 minutes by 103 (74%)**  
251 **teams. Disposable drapes with additional adhesive drapes for the sternum were used by 126**  
252 **(91%) and 133 (96%) teams respectively. Ioban, an iodophor impregnated additional**  
253 **adhesive drape was used routinely by 106 (76%), Opsite by 27 (19%), or no additional**  
254 **adhesive by 6 (4%) consultant teams. One hundred and twenty-one (87%) teams incised the**  
255 **skin with a scalpel blade and then used diathermy for subcutaneous tissues. Scalpel blade to**  
256 **bone was used by 10 (7.2%) whereas 8 (6%) reported using diathermy for the entire incision,**  
257 **including skin. Bone marrow haemostasis was routinely achieved with bone wax by 109**  
258 **(78%) consultant teams with 18 (13%) using only diathermy. Eleven (8%) consultants did not**  
259 **use any specific technique for bone marrow haemostasis.**

#### 260 ***Conduit Harvesting Techniques & Wound Closure***

261 Conduit harvesting was performed via open surgical technique by 84 (61%) teams,  
262 endoscopic harvesting by 45 (32%), or a bridging technique by 9 (7%) teams (**Appendix C,**  
263 **Table IX**). Radial artery harvest was performed via an open (121, 87%) or 'no touch' (52,  
264 37%) techniques. Subcutaneous drains were routinely used following harvest of the radial  
265 artery and saphenous vein graft in 26 (19%) and 30 (22%) of consultant teams respectively.  
266 Compression bandages were applied to saphenous vein harvest sites for 24 hours by 94  
267 (68%) teams and 48 hours by 43 (31%) teams. For radial artery harvest, the durations were  
268 61% (85) for 24 hours and 9% (13) for 48 hours. Transparent woven island dressings (such as  
269 Opsite Post-op and Mepore) were applied immediately following completion of surgery by  
270 76 (55%) teams. A wound visible dressing (for instance Opsite Post-op Visible) was used by  
271 38 (27%) teams and a topical adhesive such as Dermabond was used by 9 (6%) teams.

#### 272 *Sternal Wound Closure Technique*

273 Sternal wound closure used single wires according to weight (62, 45%), double wire  
274 technique or equivalent (37, 27%), or a standard number of wires regardless of weight (48,  
275 35%) (**Appendix C, Table X**). In obese patients, sternal closure was achieved using a double  
276 wire technique with either two single wires or Mayo wires by 89 (64%) teams, standard  
277 single wires were used by 20 (14%), single wires according to weight by 18 (13%) and a  
278 combination of techniques by 12 (9%) teams which included three with ZipFix and two with  
279 Flexigrip. For the closure of the pre-sternal tissues, uncoated Vicryl was used for both  
280 closure of the muscle layer (104, 75%) and subcutaneous layer (113, 78%) and Monocryl for  
281 skin layer (108, 78%).

282 Local antibiotics were used for sternal closure by 32 (23%) teams. This included 18 (13%)  
283 gentamicin impregnated sponges, 9 (7%) antibiotic powder and 5 (4%) antibiotic solutions.  
284 Thirty-five (25%) used a Posthorax vest (11, 8%) or Cough lok (24, 17%) in high-risk or  
285 selected patients. Cardiac bras (such as BHIS bra) were routinely used in female patients by  
286 15 (11%) consultant teams or in high-risk, selected individuals by 5 (4%) consultant teams;  
287 patient's own or sports bra style was advised by 48 consultant teams (35%). No additional  
288 sternal support methods were used by 26 (19%) consultant teams.

289

290

## 291 DISCUSSION

### 292 **Main findings**

293 A survey of SSI prevention strategies in cardiac surgery centres in the UK and ROI  
294 demonstrated significant variation in care. Heterogeneity was noted in preoperative risk  
295 stratification, **perioperative** interventions, postoperative SSI surveillance, and reporting  
296 methods.

297 There was low variability between centres for some preoperative SSI prevention  
298 interventions; all 19 centres that responded to the survey reported MRSA screening and hair  
299 removal with single-use electrical clippers, 17 centres (95%) reported preoperative  
300 showering and glucose control for diabetic patients in line with the High Impact Intervention  
301 – Care Bundle to prevent SSI published by the UK Department of Health and NICE [9].

302 Overall this survey has demonstrated that there is no nationally agreed protocols or  
303 standards of care specific to SSI prevention in cardiac surgery, and that practice as well as  
304 SSI rates (1% to 9.9% (median 3.4, IQR 2)) varies widely between different centres and  
305 surgeons.

### 306 **Clinical Importance**

307 This work reinforces the findings of Tanner et al [12] that surveillance definitions and data  
308 collection methods vary between centres. [13] The gold standard PHE SSI surveillance was  
309 only adhered to in a minority of cases, with greater participation in **people undergoing**  
310 CABG. [14] It is therefore paramount that a comprehensive and agreed standard of wound  
311 surveillance is developed within each country and ideally internationally. This presents an  
312 opportunity to encourage participation across all cardiac surgical procedures in national  
313 surveillance (including post-discharge) [15] alongside strategies to engage patients  
314 themselves in SSI prevention such as 'Photo at Discharge' [16] and videos for SSI prevention  
315 for patients and carers recently endorsed by NICE. To ensure precision in both a future  
316 **epidemiological study aiming to develop an** SSI risk prediction tool and a clinical and cost  
317 effectiveness trial of targeted SSI prevention in individuals undergoing adult cardiac surgery,  
318 it is essential that post-discharge PHE SSI surveillance is implemented using standardised  
319 metrics across all centres.

320 At present centres which preoperatively stratify people for SSI risk use a wide variety of risk  
321 prediction tools which have only been validated in local cardiac surgery populations; no  
322 nationally, validated tool exists. The approach of using routinely collected national SSI data  
323 would allow the development of a standardised tool applicable to the population of UK and  
324 ROI patients undergoing adult cardiac surgery thereby allowing preoperative identification  
325 of high-risk patients that may benefit from additional targeted interventions. Indeed, recent  
326 NICE guidance [6] has qualified recommendations on nasal and skin decolonisation,  
327 gentamycin-collagen implants and triclosan-coated sutures in cardiac surgery. The certainty  
328 of evidence to support these interventions is low which may explain the poor uptake found  
329 in our survey. Although increasing compliance to these interventions may reduce SSI, there  
330 is a risk of increasing antimicrobial resistance which is an emerging risk to global health and  
331 is the subject of a five-year action plan (2019- 2024) in the UK [10]. Therefore a balance  
332 between a maximum reduction in SSI and minimal antimicrobial resistance is needed. A  
333 clinical trial comparing decolonisation and gentamycin-collagen implants in all cardiac  
334 surgery patients versus a selected "high risk" group would address this area of uncertainty.

### 335 Limitations

336 The main strengths of this review include the iterative review of content by multiple groups  
337 to ensure that the surveys were comprehensive and efficient, the pilot survey to check  
338 accuracy and precision of the information collected, and the senior sign-off of the data that  
339 coupled with the 100% completion rate will have increased the accuracy of the data. The  
340 main limitation of the study is the self-determined nature of Trust and team involvement.  
341 This introduces the potential for non-response error that may impact on the generalisability  
342 of the findings. In mitigation, it may be surmised that the centres that declined to take part  
343 will have lower adherence to evidence based practice than responders. In which case their  
344 omission will not have produced elevated estimates of variation in practice. In addition, the  
345 intentional omission of any an analysis of association between variation in practice and  
346 centre specific SSI rates will have avoided the identification of spurious associations based  
347 on incomplete data. This was intentional, only randomised trials can demonstrate causal  
348 relationships between interventions and outcomes. The cross-sectional design of the survey  
349 only reflects practice only at the time in which it was completed. The 2019 NICE guidance on  
350 SSI prevention, published two months prior to the survey, may have longer-term effects on

351 SSI care bundle implementation that will not have been measured. However, it is worth  
352 noting that the NICE guidance made only one specific recommendation for cardiac surgery  
353 patients, consideration of gentamicin collagen implants and this survey identified many  
354 more aspects of SSI prevention where there was important variability [6].

355

356

### 357 **Conclusion**

358 A cross-sectional survey of cardiac surgery centres in the UK and Ireland identified  
359 significant variation in the implementation of SSI prevention care bundles, both at  
360 institutional level and at the level of the individual consultant. There was also significant  
361 variation in SSI rates. Given the knowledge gaps identified in previous work, including  
362 contemporary treatment guidelines, we conclude that these results are evidence of clinical  
363 uncertainty. Together these findings support the need for implementation of quality  
364 improvement initiatives to standardise care as well as research that will address existing  
365 knowledge gaps.

366

367

### 368 **Appendices**

369 A Authorship Contributions

370 B.1 Trust/Health Board Questionnaire

371 B.2 Team Questionnaire

372 C Supplementary Tables

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375 Network (CIRN), Public Health England (PHE) and the National Cardiac Benchmarking  
376 Collaborative (NCBC). There were over 149 individuals who contributed to the delivery of  
377 this project. Individuals names and contributions are presented in Appendix A. The delivery

378 of this project would not have been possible without the collaborative work of all these  
379 individuals.

380 **Conflict of Interest:** RM & SG; directors of Miles-Green Associates which runs and manages  
381 [NCBC. MR](#); BHIS Bra (registered inventor), creator 'photo at discharge' scheme. No other  
382 conflicts declared by authors.

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| <b>Table I. Perioperative SSI prevention practices, UK &amp; Ireland 2019 - Trust Survey</b>   | <b>%</b>   | <b>Centres (n=19)</b> |
|--|------------|-----------------------|
| <b>What aspects of the current DH/National UK high impact intervention bundle (2010/2011) does your hospital implement for cardiac surgery patients?</b> |            |                       |
| MRSA screening, and decolonisation as required   | 100%       | 19                    |
| Hair removal with electric clippers  | 100%       | 19                    |
| Preoperative showering   | 95%        | 18                    |
| Glucose control for diabetic patients (< 11 mmol/L)  | 95%        | 18                    |
| Prophylactic antibiotics within 60 minutes of skin incision  | 90%        | 17                    |
| Iodophor-impregnated incise drapes   | 74%        | 14                    |
| Regular hand hygiene audits  | 84%        | 16                    |
| Skin preparation with alcohol-based solution of chlorhexidine  | 63%        | 12                    |
| Interactive surgical dressing for 48 hours   | 58%        | 11                    |
| Supplemental oxygen to in the early postoperative phase  | 84%        | 16                    |
| <b>Does your cardiac centre use a policy(s) or guideline(s) for the prevention of cardiac surgical site infections?</b>                                  |            |                       |
| Yes  | 53%        | 10                    |
| No   | 47%        | 9                     |
| <b>Which external bodies do you report your surgical site infection data to?</b>   |            |                       |
| Public Health England/Public Health Wales/Health Protection Scotland   | 63%        | 12                    |
| Society of Cardiothoracic Surgery (SCTS)/National Institute for Cardiovascular Outcomes Research (NICOR)   | 58%        | 11                    |
| GIRFT SSI audit (Getting It Right First Time)  | 42%        | 8                     |
| None   | 5%         | 5                     |
| <b>Please indicate the frequency that reports relating to surgical site infections are sent to consultants?</b>  |            |                       |
| Monthly  | 37%        | 7                     |
| Quarterly  | 32%        | 6                     |
| Not routinely provided   | 32%        | 6                     |
| <b>Are deep sternal wound infections recorded on the local incident reporting system?</b>  |            |                       |
| Yes  | 47%        | 9                     |
| No   | 53%        | 10                    |
| <b>Is SSI data collected by a dedicated individual and/or team?</b>  |            |                       |
| Yes  | <b>68%</b> | 13                    |
| No   | 32%        | 6                     |
| <b>Do you have a dedicated wound clinic available?</b>   |            |                       |
| Yes  | 58%        | 11                    |
| No   | 42%        | 8                     |
| <b>What information is provided to patients/carers for SSI prevention?</b>   |            |                       |
| Preoperative printed information – e.g. when and how to wash   | 95%        | 18                    |
| Postoperative printed information – e.g. signs of SSI and who to contact   | 84%        | 16                    |
| Video(s) on SSI prevention   | 21%        | 4                     |
| Dedicated group teaching sessions (preoperative)   | 16%        | 3                     |
| Dedicated group teaching sessions (postoperative)  | 42%        | 8                     |
| Photo at discharge   | 37%        | 7                     |
| Posters in ward showers and/or printed instructions  | 47%        | 9                     |
| Please note, some questions allowed multiple options to be selected so may not add up to 100%.   |            |                       |

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| <b>Table II. SSI surveillance, UK &amp; Ireland 2019 - Trust Survey</b>                             | <b>%</b> | <b>Centres<br/>(n=19)</b> |
|---|----------|---------------------------|
| <b>How are you detecting SSIs that are included in your annual rate?</b>                            |          |                           |
| Inpatient stay (primary admission)  | 100%     | 19                        |
| Readmission to (primary) hospital for SSI   | 95%      | 18                        |
| Outpatient/GP   | 42%      | 8                         |
| Superficial SSI recorded up 30 days postoperatively   | 58%      | 11                        |
| Deep and organ or space up to 1-year  | 58%      | 11                        |
| <b>How do you identify surgical site infections following discharge from hospital?</b>              |          |                           |
| No system in place  | 58%      | 11                        |
| Post-discharge questionnaire (PDQ) given to patients  | 21%      | 4                         |
| GP practice reporting systems   | 21%      | 4                         |
| Follow-up telephone calls for non-responders (patients) to PDQ                                      | 11%      | 2                         |
| Follow-up telephone calls   | 32%      | 6                         |
| District General Reporting systems  | 11%      | 2                         |
| <b>Does the CABG SSI rate include?</b>  |          |                           |
| Superficial incisional - sternal  | 90%      | 17                        |
| Superficial incisional - leg  | 84%      | 16                        |
| Superficial incisional - radial   | 74%      | 14                        |
| Deep incisional - sternal   | 100%     | 19                        |
| Deep incisional - leg   | 79%      | 15                        |
| Deep incisional - radial  | 79%      | 15                        |
| Organ/Space (e.g. mediastinitis/infective endocarditis)   | 84%      | 16                        |
| <b>Does a confirmed case of mediastinitis postoperatively trigger duty of candour requirements?</b> |          |                           |
| Yes   | 37%      | 7                         |
| No  | 63%      | 12                        |
| Please note, some questions allowed multiple options to be selected so may not add up to 100%.      |          |                           |

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| <b>Table III. Care Bundles and Risk Scores, UK &amp; Ireland 2019 - Team Survey</b> | <b>%</b> | <b>Teams</b> |
|---|----------|--------------|
|---|----------|--------------|

|   |     | (n=139)   |
|---|-----|-----------|
| <b>Does this consultant's team use a locally developed care bundle(s) for the prevention and/or management of cardiac surgery SSIs?</b> |     |           |
| Yes   | 77% | 105       |
| No  | 23% | 32        |
| <b>Does the team use only one SSI care bundle or more than one?</b>   |     |           |
| None  | 23% | 32        |
| 1   | 55% | 77        |
| 2   | 1%  | 2         |
| 3 or more   | 20% | 28        |
| <b>How long has this current care bundle(s) been in use in your team?</b>   |     |           |
| <b>No</b> care bundle used  | 23% | 32        |
| 6 months – 1 year   | 6%  | 8         |
| <b>1</b> – 2 years  | 36% | 50        |
| > 2 years   | 35% | 49        |
| <b>Which of the following patients are your care bundle(s) used on?</b>   |     |           |
| <b>No</b> care bundle used  | 23% | 32        |
| <b>All patients</b>   | 51% | 71        |
| Medium & high-risk patients   | 17% | 23        |
| High-risk patients only   | 9%  | 13        |
| <b>What scoring system do you use to assess patient risk of getting an SSI?</b>   |     |           |
| <b>No</b> scoring system used   | 63% | <b>88</b> |
| <b>BHIS</b>   | 15% | 21        |
| Local <b>B-SIR</b>  | 11% | 15        |
| SSI Risk Index (NNIS Risk Index)  | 6%  | 9         |
| Local Scoring System  | 4%  | 6         |

Please note, some questions allowed multiple options to be selected so may not add up to 100%.

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| <b>Table IV.</b> Preoperative preparation for surgery by cardiac teams (n=139), UK & Ireland 2019 - Team Survey   | %    | <b>Teams (n=139)</b> |
|---|------|----------------------|
| <b>What is your recommended routine protocol for patients regarding the timing and frequency of pre-washing prior to surgery? (Exclude high risk patients and those with MRSA/MSSA)</b> |      |                      |
| Day of surgery  | 76%  | 106                  |
| Night before surgery  | 72%  | 100                  |
| Three days of washing prior to surgery  | 13%  | 18                   |
| Five days of washing prior to surgery   | 1%   | 1                    |
| <b>What product(s) do you ask patients to wash with on the day of surgery?</b>  |      |                      |
| Plain soap (bar or liquid)  | 4%   | 6                    |
| Octenisan   | 33%  | 46                   |
| Chlorhexidine gluconate liquid  | 71%  | <b>98</b>            |
| Chlorhexidine gluconate wipes   | 6%   | 8                    |
| No specific advice on which wash product to use   | 2%   | 3                    |
| <b>What additional decolonisation measures do you use to reduce SSI risk? (Excluding standard MRSA/MSSA decolonisation measures)</b>  |      |                      |
| Nasal decontamination Mupirocin 2% - current/history/unknown MRSA status  | 27%  | 38                   |
| Nasal decontamination Other - current history/unknown/MRSA status   | 17%  | 24                   |
| Nasal decontamination Mupirocin 2% - all patients (no screening)  | 30%  | 42                   |
| Nasal decontamination Other - all patients (no screening)   | 12%  | 17                   |
| Nasal decontamination Mupirocin 2% - selected patients (i.e. high-risk SSI)   | 10%  | 14                   |
| Nasal decontamination Other - selected patients (i.e. high-risk SSI)  | 1%   | 2                    |
| Mouthwash - current/history/unknown MRSA status   | 21%  | 29                   |
| Mouthwash - selected patients (i.e. high-risk SSI)  | 9%   | 13                   |
| No decolonisation   | 7%   | 10                   |
| <b>Do you routinely give instructions to referring hospitals regarding decolonisation of patients prior to transfer for surgery?</b>  |      |                      |
| Yes   | 25%  | 35                   |
| No  | 75%  | 104                  |
| <b>How is body hair removed from the surgical sites prior to surgery?</b>   |      |                      |
| Electric clipper  | 100% | 139                  |
| Hair is not routinely removed   | 0%   | 0                    |
| <b>Who routinely removes patient hair?</b>  |      |                      |
| Patient/carer   | 14%  | 19                   |
| Ward staff  | 65%  | 90                   |
| Theatre nursing staff   | 10%  | 14                   |
| Surgical team   | 4%   | 6                    |
| Surgical Care Practitioner (SCP)  | 4%   | 6                    |
| No standard   | 3%   | 4                    |
| <b>When is hair routinely removed?</b>  |      |                      |
| Day before surgery  | 32%  | 44                   |
| Morning of surgery  | 48%  | 67                   |
| In the anaesthetic room   | 14%  | 19                   |
| On the operating table  | 6%   | 9                    |
| <b>How is body hair cleaned up following removal?</b>   |      |                      |
| Patient showers after removal   | 61%  | 85                   |
| Adhesive tape   | 12%  | 17                   |
| Sticky mitts  | 23%  | 32                   |
| Sheets and gown changed   | 4%   | 5                    |
| Please note, some questions allowed multiple options to be selected so may not add up to 100%.  |      |                      |

| <b>Table V. Prophylactic Antibiotics, UK &amp; Ireland 2019 - Team Survey</b>   | <b>%</b> | <b>Teams<br/>(n=139)</b> |
|---|----------|--------------------------|
| <b>How many antibiotics are used for prophylaxis in patients undergoing CABG (Excluding patients with allergies or ongoing infections)</b>          |          |                          |
| Combination of two or more antibiotics  | 68%      | 95                       |
| Single antibiotics only   | 32%      | 44                       |
| <b>What antibiotic prophylaxis is used for patients undergoing CABG? (excluding patients with allergies and no ongoing infections)</b>              |          |                          |
| Flucloxacillin  | 63%      | <b>88</b>                |
| Gentamicin  | 57%      | 79                       |
| Cefuroxime  | 28%      | 39                       |
| Vancomycin  | 7%       | 10                       |
| Teicoplanin   | 25%      | 35                       |
| Ciprofloxacin   | 2%       | 3                        |
| <b>What is the routine duration of prophylactic antibiotics in these CABG patients? (excluding patients with post-operative infections)</b>         |          |                          |
| <b>Up to 24 hours</b>   | 66%      | 92                       |
| 12 hours  | 11%      | 15                       |
| Up to 48 hours  | 16%      | 22                       |
| Three doses   | 1%       | 2                        |
| Single dose within 60 minutes of skin incision  | 6%       | 8                        |
| <b>How many antibiotics are used for prophylaxis in patients undergoing valve surgery (excluding patients with allergies or ongoing infections)</b> |          |                          |
| Combination of 2 or more antibiotics  | 85%      | 118                      |
| Single antibiotic only  | 15%      | 21                       |
| <b>What antibiotic prophylaxis is used for patients undergoing valve surgery? (Excluding patients with allergies or 1 ongoing infections)</b>       |          |                          |
| Flucloxacillin  | 63%      | <b>88</b>                |
| Gentamicin  | 73%      | 101                      |
| Cefuroxime  | 30%      | 42                       |
| Vancomycin  | 7%       | 10                       |
| Teicoplanin   | 25%      | 35                       |
| Ciprofloxacin   | 2%       | 3                        |
| <b>What is the routine duration of prophylactic antibiotics in valve patients? (excluding patients with infections)</b>                             |          |                          |
| Single dose < 60 minutes prior to skin incision   | 6%       | 8                        |
| Up to 12 hours  | 11%      | 15                       |
| Up to 24 hours  | 65%      | 90                       |
| Up to 48 hours  | 15%      | 21                       |
| Three doses   | 1%       | 2                        |
| Until central line is removed   | 2%       | 3                        |
| Please note, some questions allowed multiple options to be selected so may not add up to 100%.  |          |                          |