

**Capital and Coast District Health Board
Cardiothoracic Surgeon, Dr B**

**A Report by the
Health and Disability Commissioner**

(Case 17HDC00159)

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Executive summary

1. Mr A (aged 76 years) had a cardiac anomaly whereby his right coronary artery (RCA) did not originate from the usual place in the heart, and it followed a different course to that of most people. In 2015, cardiothoracic surgeon Dr B performed surgery to replace Mr A's heart valve, but was unaware of the anomaly. During surgery, Dr B placed a suture (stitch) through Mr A's RCA, and this caused poor right cardiac function. Mr A died following the surgery, and the surgical error was identified at autopsy.
2. Two weeks prior to the surgery, Mr A had an angiogram¹ performed by a cardiologist. The cardiologist documented the anomaly in the conclusion section of their report. The cardiologist did not complete a coronary diagram, as this was not a mandatory requirement at Capital and Coast District Health Board (CCDHB). The cardiologist handed over Mr A's case to another cardiologist to present it for discussion at a combined cardiac meeting (CCM).
3. Mr A's case was discussed at the CCM of 10–20 clinicians, including Dr B, to confirm the surgical plan. While two clinical documents referencing the anomaly were circulated to the attendees, and the angiogram images were viewed at the meeting, the anomaly was not discussed at the CCM. Following the CCM but ahead of surgery, three further clinical documents were prepared by clinicians other than Dr B that referenced the anomalous RCA.
4. Dr B confirmed that he reviewed the angiogram images and at least three of the clinical documents ahead of surgery, noting that his focus was on confirming the surgical plan from the CCM rather than making a rare diagnosis.
5. Two anaesthetists subsequently confirmed that they were aware of the anomalous RCA during the surgery, but assumed that the surgical team were already aware of it, so did not discuss it with Dr B during surgery.

Findings

6. Mr A's cardiac anomaly was known by multiple people and recorded in multiple places in CCDHB's system. There were numerous missed opportunities for the information to be communicated to Dr B, and these were contributed to by the fact that CCDHB did not require completion of a coronary diagram ahead of surgery, and that the purpose of the CCM was not clear to its participants. Notwithstanding Dr B's personal responsibility in this case, CCDHB's system failed to alert Dr B to relevant and significant information about Mr A. Accordingly, it was found that CCDHB did not provide services to Mr A with reasonable care and skill, and breached Right 4(1) of the Code of Health and Disability Services Consumers' Rights² (the Code).

¹ A procedure using X-ray imaging to visualise the heart's blood vessels.

² Right 4(1) states: "Every consumer has the right to have services provided with reasonable care and skill."

7. The Commissioner considered there to have been significant failures in the care Dr B provided to Mr A. Dr B did not review the preoperative documentation comprehensively; interpret the angiogram images adequately; identify the RCA ostium during surgery or recognise that it was unusually large; administer antegrade cardioplegia; or document his operation findings adequately. Accordingly, it was found that Dr B breached Right 4(1) of the Code.

Recommendations

8. The Commissioner recommended that CCDHB create terms of reference for the purpose and effect of the CCM; align a policy, regarding the completion of coronary diagrams ahead of cardiac surgery, with national practice; implement a system to ensure that letters or clinical reports finalised after the CCM but ahead of surgery are forwarded to a central repository to be inserted into the cardiothoracic surgery folder; provide in-house training regarding interpretation of angiogram images; ensure that it is clear to all surgery departments that it is expected that the operating surgeon will read all pertinent documentation ahead of surgery; and provide a written apology to the family of Mr A.
9. The Commissioner recommended that Dr B undertake training on angiogram interpretation, and provide a written apology to the family of Mr A. The Commissioner also recommended that the Medical Council of New Zealand consider whether a review of Dr B's competence is warranted.

Complaint and investigation

10. The Commissioner received a complaint from Mrs A about the services provided to her late husband, Mr A, by Capital and Coast District Health Board (CCDHB). The following issues were identified for investigation:
- *The appropriateness of the care provided to Mr A by Capital and Coast District Health Board in 2015.*
 - *The appropriateness of the care provided to Mr A by Dr B in 2015.*
11. The parties directly involved in the investigation were:

Mrs A	Complainant
CCDHB	Provider
Dr B	Provider/cardiothoracic surgeon

Also mentioned in this report:

Dr C	Consultant cardiologist
Dr D	Cardiologist
Dr E	Anaesthetist
Dr F	Senior anaesthetic registrar

Dr G	Clinical Director of Cardiology
Dr H	Cardiologist
Dr I	Cardiologist

12. Further information was received from the Coroner, ACC, and the Medical Council of New Zealand.
13. Independent expert advice was obtained from a cardiothoracic surgeon, Dr Peter Raudkivi, and is included as Appendix A.

Information gathered during investigation

Introduction

14. This report concerns the standard of care provided to Mr A (aged 76 years) in relation to surgery to replace his heart valve. Mr A had a cardiac anomaly whereby his right coronary artery (RCA) did not originate from the usual place in the heart,³ and it followed a different course to that of most people — it went across the ascending aorta,⁴ and so lay close to where the aorta needed to be cut to perform the valve replacement. Mr A's RCA was also unusually large. Cardiothoracic surgeon Dr B performed the surgery but was unaware of the anomaly. During surgery, Dr B placed a suture (stitch) through Mr A's RCA, and this caused poor right cardiac function. Mr A died following the surgery, and the surgical error was identified at autopsy.

Background

15. On 24 Month1,⁵ Mr A was admitted to a regional hospital with shortness of breath. His symptoms were determined to be due to heart failure, and he was transferred to a main centre hospital (the public hospital) on 29 Month1 for further treatment. He was considered to be a high-risk surgical candidate because of his other medical conditions.

Angiogram — 30 Month1

16. On 30 Month1 (two weeks before surgery) Mr A underwent an angiogram⁶ and aortogram⁷ at the public hospital. A locum consultant cardiologist, Dr C, produced a single-page cardiac catheterisation report and documented in the conclusion section of the report: "... Very difficult catheter manipulation ... eventually cannulated RCA using JL5 catheter — anomalous origin from high anterolateral wall above LMS [left main stem] origin ..." This description of where Mr A's RCA originated is not noted under the heading "coronary arteries".

³ Normally the RCA originates above the right cusp of the aortic valve, and supplies blood to the heart muscle.

⁴ The aorta is the large arterial trunk that carries blood from the heart.

⁵ Relevant months are referred to as Months 1–2 to protect privacy.

⁶ A procedure using X-ray imaging to visualise the heart's blood vessels.

⁷ Placement of a catheter in the aorta and injection of contrast material while taking X-rays of the aorta.

17. Dr C did not complete a coronary diagram,⁸ and Mr A's clinical notes contain a coronary diagram template that has been left blank. CCDHB stated that a coronary diagram is not an obligatory part of a cardiac catheterisation report.
18. As Dr C was due to take leave, Dr C handed over Mr A's case to an interventional cardiologist, Dr D, for presentation to the Combined Cardiac Meeting (CCM) due to meet on 2 Month2. The cardiologists use the CCM to discuss and decide on treatment plans for patients (ie, whether to proceed with surgery).
19. In Dr C's response to HDC, Dr C stated: "[I] completed the paperwork and provided a written and verbal handover of the pertinent findings on the angiogram to [Dr D], (including the anomalous origin of the RCA)".

Handover and acceptance from cardiology team to cardiothoracic team — 2 Month2

20. Dr C completed the "handover and acceptance from Cardiology to Cardiothoracic" form (a referral document) on 1 Month2, ahead of the CCM. The form is dated 2 Month2, and states on the first of three pages: "anomalous RCA from anterolateral aspect of aorta above LMS".

Combined Cardiac Meeting — 2 Month2

21. Dr D presented Mr A's case at the CCM, but is unable to recall whether he mentioned the presence of the anomalous RCA. He has subsequently checked with others in attendance at the meeting, all of whom do not recall him mentioning the anomalous RCA. Dr B told HDC that the anomalous RCA was not mentioned during the CCM.
22. Dr D told HDC that although it seems likely that he did not verbally draw attention to the anomalous RCA at the CCM, its existence was documented in several places, including Dr C's cardiac catheterisation report, and the "handover and acceptance from Cardiology to Cardiothoracic" form. Both of these documents had been scanned and emailed to the clinical nurse coordinator for cardiothoracics on the day of the CCM, and were available at the CCM. These documents formed the basis of the cardiothoracic surgery folder (discussed further below).
23. Dr B stated that usually between 10 and 20 people are present at the CCM, including cardiologists, cardiac surgeons, cardiac anaesthetists, and registrars. Dr B said that images from Mr A's cardiac catheter (angiogram) study were projected during the meeting, and everyone failed to recognise that there was an anomalous RCA. Dr B stated that the images are reviewed by the receiving surgeon and the audience at the CCM, rather than the "handover and acceptance from Cardiology to Cardiothoracic" form being read personally.
24. At the CCM, Mr A was accepted for aortic valve replacement and coronary artery bypass grafting surgery.

⁸ A hand-drawn diagram of the location of the patient's blood vessels in the heart.

Dictated patient report — 5 Month2

25. On 1 Month2, Dr D dictated a patient report that is addressed to Dr B. The report was typed on 2 Month2 and approved by Dr D on 5 Month2, at which time it was available for viewing on the electronic records system.
26. The first page of the report contains a “problem list”, which lists 18 medical issues but does not include the anomalous RCA. The second page of the report states: “[Mr A has] an anomalous right coronary artery that arises from the anterolateral aspect of the aorta above the left main stem.” This information is contained in a paragraph that begins: “He has a history of recurrent blisters over his legs.” In response to the provisional opinion, Dr B submitted that this report fails to place any significance on the anomalous RCA.

Discharge summary — 6 Month2

27. Mr A was transferred from the public hospital to another hospital on 6 Month2 to await surgery, and returned to the public hospital on 12 Month2 for the surgery.
28. The second page of the discharge summary from cardiology on 6 Month2 states in a section about the angiogram: “Difficult to visualise RCA ... anomalous origin from high anterolateral wall above LMS origin.”

Dictated cardiac catheterisation report — 7 Month2

29. On 7 Month2, Dr C’s dictated cardiac catheterisation report (from the angiogram of 30 Month1) was typed by a hospital typist and approved by Dr C. The report states: “[T]he right coronary has a very unusual takeoff from the anterolateral position of the aortic wall high above the left main stem. This is a huge vessel.” The report is addressed to Mr A’s GP only, but it was available to view in Mr A’s electronic clinical records.

Preoperative review

30. Dr B told HDC that on the evening prior to the surgery he reviewed his surgical plan and the cardiac catheterisation images and report. He then met with Mr A to obtain his consent for surgery. Dr B told HDC that about half an hour prior to this preoperative assessment he had completed a complex procedure on another patient.
31. Dr B said that prior to Mr A’s operation he reviewed the “clinical details and relevant investigations”, and that “[t]hese were also reviewed by the anaesthetic team and by the consenting cardiothoracic registrar and the cardiothoracic registrar who was to assist with the operation”.
32. Dr B stated that the cardiothoracic and anaesthesia departments had relied heavily on the hard copy cardiothoracic surgery folder as a repository for key information. He confirmed that Dr D’s patient report was in the folder (along with the initial cardiac catheterisation report and the “handover and acceptance from Cardiology to Cardiothoracic” form), but also noted that letters finalised after the CCM may not have reached the cardiothoracic surgery folder. Dr B said that the dictated cardiac catheterisation report was not in the folder.

33. Dr B stated that when he reviewed the angiogram images, his focus was on confirming the plan from the CCM, rather than making a rare diagnosis.
34. Anaesthetist Dr E and senior anaesthetic registrar Dr F were the anaesthetists for Mr A's surgery. Dr E told HDC that Dr F undertook Mr A's anaesthetic pre-assessment. Dr E then reviewed Dr F's pre-assessment sheet, which included details of Mr A's medical conditions, but not his aberrant RCA.

Intra-operative care — 13 Month2

35. Mr A underwent surgery on 13 Month2. A surgical safety checklist and a surgical "time out" checklist were completed before the skin incision was made. These checklists confirm key details, for example the patient's identity; the site/side for the operation; the type of procedure; any allergies; and that consent has been obtained. The checklist prompts the team to consider whether any critical events are anticipated by surgical, anaesthesia, and nursing teams; "no" is checked next to this question.
36. Dr B was unaware of the RCA abnormality. Dr B stated:
- "I did not realise that he had an anomalous RCA until after his death, so I did not modify the position of the left and mid point of the incision into the aorta that was required to perform the aortic valve replacement. Thus when I closed this incision I inadvertently narrowed the lumen⁹ of the RCA."
37. Dr B explained that it is not infrequent for the RCA ostium (opening) not to be visible directly. He said that Mr A had significant calcification,¹⁰ which obscured the view of where a normal RCA ostium would be. In the operation record he documented that there was "calcification in both the left and the right system".
38. Describing the operation, Dr B stated:
- "The presence of this calcium obscured my view of where a normal RCA ostium would be. This contributed to my not noticing that he did not have the usual arrangement of a right coronary ostium in the right coronary sinus. His actual right coronary ostium was positioned close to the normally positioned left coronary ostium."
39. The aortic cross clamp¹¹ time for the surgery was 136 minutes, and Dr B used retrograde¹² cardioplegia solution.¹³ Dr B commented that delivering cardioplegia solution in a retrograde fashion means that it travels through the heart muscle and exits via the coronary ostia to the aortic root. He stated that observing the typically dark coloured cardioplegia solution in each of the coronary sinuses usually signifies normally positioned coronary ostia. Dr B said that he relied on seeing the return of cardioplegia solution as

⁹ The internal space of the artery.

¹⁰ Accumulation of calcium.

¹¹ The cross clamp is a surgical instrument used to clamp the aorta and separate the systemic circulation from the outflow of the heart.

¹² In the reverse direction of normal blood flow.

¹³ Solution given to induce temporary cardiac arrest during heart surgery.

confirmation of the usual position of the RCA, but he acknowledged that this technique failed to alert him to the anomalous position of Mr A's RCA.

40. There was difficulty weaning Mr A off the cardiopulmonary bypass machine during surgery.¹⁴ Dr E told HDC that the cause of the cardiac failure was mainly right ventricular dysfunction, and that this was thought to be caused by either air going down the RCA or temporary dysfunction due to inadequate cardioplegia preservation of the right side of the heart.
41. Dr E stated that Mr A's condition stabilised after insertion of an intra-aortic balloon pump. He said that, at that time, Dr F advised him that Mr A had an aberrant RCA and that she had found out about this only when reviewing the angiography report during the surgery. Dr E stated:

"As this was a critical situation, and because I assumed that the surgical team was aware of this, I did not pass this on to [Dr B], who was also very busy at the time. [Mr A's] condition improved to a stable yet still critical one, allowing the surgical team to close his chest and complete the operation."

42. Dr E said that even if the anaesthetic team had been aware of the aberrant RCA prior to the surgery, it would not have resulted in any change to the anaesthesia.
43. Dr B told HDC that after Mr A had a period of haemodynamic stability¹⁵ (with significant doses of inotropic support)¹⁶ they reached the point where they felt that a return to cardiopulmonary bypass would not be necessary. Accordingly, the operation was completed.

Postoperative care

44. Mr A was intubated, ventilated, and sedated, and taken to the intensive care unit (ICU). Sadly, Mr A's condition continued to deteriorate, and at 11.55pm he passed away.

Post mortem

45. A pathologist performed the autopsy and made the following comments regarding the coronary arteries in the post-mortem report:

"The right coronary ostium is anomalously sited ... a suture is seen within the proximal right coronary artery, approximately 4mm from the right coronary ostium. The right coronary ostium gives rise to the right coronary artery which is patchily atheromatous. There is a focal narrowing of approximately the mid right coronary artery, of approximately 75%."

¹⁴ This temporarily takes over the function of the heart and lungs during surgery, maintaining the circulation of blood and the oxygen content of the patient's body.

¹⁵ Stable blood flow.

¹⁶ Inotropes are medications that change the force of the heart's contractions.

Further information

Dr B

46. Dr B stated that as soon as he realised what had happened, he accepted responsibility and advised his clinical leaders that he had made an error. He travelled to meet with Mr A's family, and said that he provided a full and open disclosure and a sincere apology to Mrs A and other family members present. Dr B stated:

"I acknowledged that I had erred in not identifying the anomalous RCA from the angiographic images or during the operation and explained the contributing factors to this which included not being advised of this during the combined cardiac conference, reviewing his clinical details with an established plan in mind and the extensive calcification in the coronary sinuses and aortic root that contributed to this anomaly not being identified during the operation."

47. Dr B commented that the coronary angiogram images are useful to visualise narrowing of the coronary arteries, but said that the images do not show the origin or course of the RCA very well, as they do not show the position of the coronary ostium relative to the aorta very distinctly. However, he acknowledges in hindsight that the RCA anomaly is identifiable on the angiogram images.

48. Dr B stated that if at any stage anyone had mentioned the presence of the anomaly he would have:

- Avoided the vessel at operation if we knew of this pre-operatively
- Revised my aortic closure if we recognised this intra-operatively
- Grafted the RCA if we recognised this intra-operatively
- Returned [Mr A] to theatre to revise the aortic closure or to graft the RCA if we recognised this after leaving theatre."

49. Dr B considers that a series of factors led to this error. He stated that the process started with a lapse in communication, and was compounded by poor documentation, poorly collated or missing documentation, his confirmation bias when reviewing the angiogram images, others not being aware of or not recognising the anomaly, being an unusual form of a rare finding, his (and his team's) lack of recognition of the anomaly in theatre, and the ICU team's lack of recognition of the anomaly.

50. Dr B stated that the absence of a cardiac diagram contributed to the communication failure in this case. He provided email evidence that he has advocated for the use of coronary diagrams in the past, but said that he has been unsuccessful in the use of these being made mandatory.

51. Dr B stated that as a consequence of this case:

- He has consciously sought to ensure that he avoids confirmation bias.
- He regularly refers to the electronic record to check for information that may not be in hard copy in the cardiothoracic or hospital folders.

- During surgical “time out”, he specifically asks the assembled anaesthetic, nursing, and surgical team, “Is there anything I have missed?”
 - He makes it his practice to show his assistant the position of the ostium during surgery.
 - He has modified his routine for the delivery of cardioplegia by supplementing retrograde with antegrade¹⁷ doses of cardioplegia for cardiac muscle protection.
 - He has lowered his threshold to perform an additional graft if he is concerned about poor cardiac function.
 - He is now more likely to ask for a consultant cardiologist review in theatre.
 - He now provides more detail of the operative findings and relative anatomy in operation reports.
 - The CCDHB template for angiogram reports now has a section to record details about the coronary ostia under the heading “coronary arteries”.
 - Cardiologists have a new appreciation for highlighting information on the cardiac catheterisation reports with bold font or capitalisation.
52. In response to the provisional opinion, Dr B advised that he has shown Mr A’s angiogram to registrars as a learning experience for them and has advised registrars of the risk of confirmation bias.
53. In August 2018, the Medical Council of New Zealand required Dr B to undergo a performance assessment under section 36 of the Health Practitioners Competence Assurance Act 2003. This is a practice visit by a performance assessment committee composed of two peers and a lay member, who conduct a broad assessment of practice to assess whether the practitioner meets the required standard. The Medical Council has confirmed that this process is still ongoing.

Dr D

54. Dr D noted that the anomalous RCA was documented in several places: Dr C’s cardiac catheterisation report and the “handover and acceptance from Cardiology to Cardiothoracic” form (both provided at the CCM), the dictated patient report approved on 5 Month² available for viewing on the electronic records system, the discharge summary of 6 Month² when Mr A was transferred to another hospital to await surgery, and Dr C’s dictated cardiac catheterisation report approved on 7 Month² and available on the electronic records system. Dr D also stated that the presence of the anomalous RCA can also be seen on the angiogram and aortogram images.

CCDHB

CCM

55. Mr A’s case was the subject of a preliminary event review and a surgical event review at CCDHB. The case was classified as severity assessment code 3 (moderate). It was found in the surgical event review that there were different views on the purpose of the CCM. CCDHB stated:

¹⁷ Where the solution is introduced into the aortic root.

“The cardiologists are of the opinion that the meeting is to discuss and decide on treatment plans for patients ie proceed for surgery or not. As a result of discussing this event it is now apparent that the cardiothoracic surgeon used the meeting to gather all information to perform surgery. However the cardiologists are not of the opinion that the meeting is to be used with that intent.”

56. CCDHB stated that there are no terms of reference or policy related to the CCM.

Standard of care

57. CCDHB told HDC:

“A coronary angiogram is performed routinely in almost all cardiac patients to alert the surgeon as to the anatomy of the coronary arteries ... The surgeon should also identify the position of the coronary arteries directly at the time of surgery to ensure they are not obstructed at the time of valve implantation. Both measures would have alerted the surgeon to an abnormality in the position of coronary arteries. Both these measures are an accepted standard of care.”

Coronary diagram

58. CCDHB confirmed that there is no protocol in place regarding an expectation that a coronary diagram is completed. It stated that it does not consider it is conventional for a diagram of the coronary anatomy to be produced, and told HDC:

“[T]he practice of providing a hand-drawn diagram has ceased being the standard of care as a consequence of technological advances. This has resulted in the surgeon being required to read and interpret the tests themselves.”

59. CCDHB noted that some cardiologists do not routinely include coronary diagrams as they feel that the depiction is too subjective, and cannot adequately replace viewing the actual images.
60. The Clinical Director of Cardiology, Dr G, commented that coronary diagrams are virtually unknown in most European and United States centres. He noted that coronary diagrams are not recommended by guidelines on coronary artery bypass surgery, guidelines of the Cardiac Society of Australia and New Zealand, or in other specific cardiology reference materials.
61. CCDHB stated that it does not consider that Dr C should have provided a cardiac diagram, as the findings were documented adequately in the body of Dr C’s report.

Changes made

62. CCDHB said that the cardiologist who is presenting a case at the CCM will now read out the conclusion section of the angiogram report if he or she is not the person who carried out the angiogram study.
63. The Cardiology and Cardiothoracic Service has reviewed its documentation process of the CCM. CCDHB advised that all referring cardiologists in the region now use a standardised

form, the outcome of the meeting is communicated to the referring cardiologists to allow confirmation of accuracy, and the referral form and dictated letter summarising the outcome of the discussion (at the CCM) are available on the electronic record.

ACC

64. ACC accepted a treatment injury claim on behalf of Mr A's estate for "inadvertent placement of suture during cardiac surgery resulting in a narrowing of the right coronary artery resulting in decreased cardiac output, acute myocardial infarction and death".

Mrs A

65. Mrs A states that she does not blame individuals for her husband's death, but would like a review of the system and the reporting structure to ensure that this does not happen again.

Responses to provisional opinion

66. Dr B, CCDHB, and Mr A's family were given an opportunity to respond to the relevant sections of the provisional opinion. Where appropriate, changes have been incorporated into the report.

Dr B

67. Dr B submitted that this investigation would never have been required if the presenting cardiologist had clearly communicated to him and the others present at the CCM the vital information about the coronary anomaly. Dr B told HDC that he has always accepted his part in these tragic events, but that responsibility is not his alone.
68. Dr B stated that he could reasonably be expected to rely on the information provided at the CCM, because Dr C specifically handed over details of the anomaly so that it would be communicated at the CCM. In support of this position, Dr B obtained opinions from two cardiologists, Dr H and Dr I. Dr H stated: "I strongly challenge the concept that the [CCM] was not required to alert [Dr B] to this finding. This is the purpose of the meeting and it failed in its clear responsibilities." Dr I stated:

"Unlike most surgical specialties the investigation of the cardiac disease and all important information needed for surgical decisions is undertaken by cardiologists. The initial interpretation of investigations, and decision on whether surgery is appropriate is also made by cardiologists. This information is then communicated to the surgeon, usually at a formal cardiac surgical conference, where further information may be requested by the surgeon. However, the surgeon is dependent on the cardiologist to present all relevant information at this meeting."

69. Dr B submitted that there was a series of communication failures as follows: there was no coronary diagram; the coronary anomaly was not mentioned in the appropriate section of the angiogram report (this view is also supported by Dr H and Dr I); the "handover and acceptance from Cardiology to Cardiothoracic" form failed to notify Dr D or Dr B and his team of the anomaly; the anomaly was not clearly stated in Dr D's dictated patient report (this view is supported by Dr I); and Dr D did not contact Dr B to advise him that he had

omitted to mention the anomaly in the CCM. Dr B also noted that Dr D's dictated patient report, despite being dated 1 Month2, referred to discussions in the CCM that had taken place on 2 Month2.

70. Dr B accepts that the anomalous RCA is clearly visible on the angiogram images when forewarned. However, he noted that it cannot be ignored that the anomaly was missed by at least five cardiologists and two cardiac surgeons at the CCM. He submits that expert observers can miss important detail as a consequence of sustained inattentive blindness, or satisfaction of search.
71. Dr B said that having relied on the CCM to provide crucial information, and having documented a surgical plan, his subsequent reviews of the clinical details and angiogram focused on confirming the appropriateness of the surgical plan. Dr B said that when he studied the coronary arteries he was checking for narrowing rather than looking at the origin and course of the arteries, and that he cross-referenced this with the description of the coronary arteries in the cardiac catheterisation report. He submits that this is an example of confirmation bias, explaining why the anomaly was overlooked.
72. Dr B advised that he disagrees with my expert advisor's comment that Mr A's RCA was "obliterated" by a suture. Dr B clarified that the suture passed through the RCA, and in doing so would have narrowed, rather than obliterated, the lumen of the RCA.
73. Dr B emphasised the importance of teamwork, and the contributions that all involved in delivering cardiac surgery make towards safe outcomes, including the cardiologists and all those involved in pre- and post-operative care. Dr B summarised that the opacity of the available information and the calcification of Mr A's aortic root contributed to his failure to note the presence of Mr A's rare anomaly, as did the failures of others to communicate their knowledge of the anomaly to him.

CCDHB

74. CCDHB told HDC that it has reviewed and discussed the findings and recommendations regarding the extremely sad death of Mr A. It stated: "Our thoughts are with [Mr A's] family through this time."
75. CCDHB said that it accepts the provisional breach finding and the majority of the provisional recommendations.
76. With regard to there being no requirement at CCDHB to complete a coronary diagram, CCDHB advised that its clinical team continues to believe that best practice is to use digital coronary angiographic images with written reports. It reiterated that transcription of findings to a hand-drawn diagram increases the risk of inaccuracies in transcription and interpretation. CCDHB stated that such diagrams are "highly dependent on an individual's artistic ability and interpretation".

Family

77. Mr A's family told HDC that after they met with Dr B following Mr A's death, they felt that some accountability had been taken for his death. However, they stated:

“[T]here were many professionals in different departments in [the public hospital] that have failed to do their jobs. Their incompetence failed us and [Mr A]. The abnormality in [Mr A’s] heart was detected right from the beginning. It was recorded a number of times throughout his stay in [the public hospital] prior to his surgery and yet the surgeon did not know — how is this even possible? With all the modern technology and methods of communication in our world, this should never have been missed and he would still be alive ... To summarise; we are absolutely devastated and have very little to no faith in the procedures that are in place in our hospitals. We entrusted medical professionals to give [Mr A] a better quality of life.”

78. Mr A’s family advised that their main focus, as a result of Mr A’s experience, was that this should never happen to another person and the person’s family.

Opinion: Capital and Coast District Health Board — breach

Coronary diagram

79. Dr C completed Mr A’s angiogram on 30 Month1. Dr C did not complete a coronary diagram, and Mr A’s clinical records contain a blank coronary diagram template.
80. CCDHB does not consider that Dr C should have provided a cardiac diagram, as Dr C’s findings were documented adequately in the body of the report. CCDHB stated that a coronary diagram is not an obligatory part of a cardiac catheterisation report, and some cardiologists do not routinely include these, as they feel that the depiction is too subjective, and cannot adequately replace viewing of the actual images.
81. CCDHB confirmed that it has no protocol in place regarding an expectation that a coronary diagram is completed, and commented that the practice of providing a hand-drawn diagram has ceased being the standard of care.
82. My expert advisor, cardiothoracic surgeon Dr Peter Raudkivi, advised that Dr C’s cardiac catheterisation report regarding the anomalous RCA follows standard practice. However, he stated that in most New Zealand cardiology centres it would be conventional for the cardiologists to provide a diagram of the coronary anatomy and major lesions, especially for surgical cases where coronary artery bypass grafting is anticipated. Dr Raudkivi noted that in New Zealand, coronary diagrams are routinely provided by all cardiac catheterisation laboratories except CCDHB and small satellite laboratories of two other district health boards.
83. Dr Raudkivi explained the advantages of a coronary diagram, which include easy identification of abnormalities separate from the written report; other observers of the angiographic images can use the diagram to correlate their personal interpretation of the images; it can be used as an aide memoire during surgery; and it facilitates planning of the operation.

84. In Dr Raudkivi's opinion, the technical errors in this case (occlusion of the RCA and failure to deliver antegrade cardioplegia) would not have occurred if the coronary anomaly had been recorded on a diagram, and he considers that the CCDHB Cardiology Service should have a routine policy of supplying a coronary diagram for every surgical case.
85. I accept Dr Raudkivi's advice about the usefulness of coronary diagrams, and I accept that in the large majority of New Zealand centres, their use is the norm. While I recognise that a number of documents recorded the presence of Mr A's anomalous RCA, I consider that had a coronary diagram been completed, this would have been a particularly useful visual aid for Dr B.
86. I am not critical of Dr C for not completing the coronary diagram, as it was not the standard practice at CCDHB to do this. However, I am very concerned that completion of a coronary diagram was not, and is not, a requirement at CCDHB, as it is at the vast majority of other New Zealand district health boards. In making this comment, I acknowledge CCDHB's continued belief that digital coronary angiographic images with written reports are best practice, and that transcription of findings to a hand-drawn diagram increases the risk of inaccuracies in transcription and interpretation.

Knowledge of Mr A's anomalous RCA available in CCDHB's system

87. Dr B was not aware of Mr A's anomalous RCA until after Mr A's death. However, the finding was known to Dr C and Dr D preoperatively, and to Dr E and Dr F intraoperatively. Dr C and Dr D finalised clinical documents that included details of the finding on 30 Month1, 1 Month2, 5 Month2, and 7 Month2, and the angiogram images also showed the finding and were projected to the audience of 10–20 clinicians for viewing at the CCM on 2 Month2. However, the anomaly was not discussed at the CCM.
88. Dr Raudkivi advised that as the RCA did not require bypass grafting, and most cardiologists would not appreciate the operative implications of an abnormal origin and course of this vessel in the context of an aortic valve replacement operation, the lack of particular attention to it during the CCM is not surprising. I note, however, that Dr Raudkivi advised that the right coronary abnormality is "glaringly obvious" on the angiogram images. Accordingly, I would expect the surgeons present at the meeting to recognise the implications for surgery. In my view, this was a missed opportunity for the anomaly to be discussed.
89. It is ultimately the responsibility of the operating surgeon to ensure that he or she has reviewed the preoperative documentation carefully. However, the CCDHB system must also bear responsibility for this information not being known by Dr B, given that the critical information was available in five documents, angiogram images, and by four other clinicians who have stated that they were aware of the anomaly. I also acknowledge that Dr B, and cardiologists Dr H and Dr I, were critical of the manner in which some of the documents were completed by cardiologists — i.e., that pertinent information was not highlighted appropriately. Despite this, I note that the necessary information was contained in these documents and I remain concerned that Dr B did not identify at least one version of the description of the anomalous RCA.

90. In my view, there were a number of key missed opportunities for Dr B to be informed of the anomaly directly by his colleagues, the most crucial of which were during the CCM and during the operation. The CCM was a forum to discuss the angiogram images, the angiogram report, and the “handover and acceptance from Cardiology to Cardiothoracic” form. All of these documents were available at the meeting, and I am concerned that despite a group of 10–20 clinicians being assembled to discuss this case, the anomalous RCA was not mentioned.
91. In its surgical event review, CCDHB found that its staff had different views about the purpose of the CCM, and noted that Dr B used this meeting to gather all information prior to surgery. In response to the provisional opinion, Dr B submitted comments from cardiologists Dr H and Dr I that in their view it is the purpose of CCMs to convey pertinent information to the surgeon. I consider that it was a systemic weakness that the clinicians in the CCM did not all attend the meeting with the same purpose in mind. I find it extraordinary that it was usual for Dr B to use this forum to obtain key clinical information ahead of surgery, and while the cardiology service disagreed with this being the intent of the meeting, there are no terms of reference or policy documents relating to the purpose of the CCM. I consider that there should be clarity as to the purpose of this meeting, so as to minimise the risk that a participant inappropriately rely on it to receive information relevant to surgery, as Dr B did. I am critical that the purpose of the meeting was not clear to its attendants, and I consider the DHB to be responsible for ensuring that there is clarity.
92. Dr B stated that the cardiothoracic and anaesthesia departments had relied heavily on the hard copy cardiothoracic surgery folder as a repository for key information. The discharge summary and dictated cardiac catheterisation report were not included in the cardiothoracic surgery folder. These were further opportunities for Dr B to be apprised of the fact of the anomaly. Packages of information — whether digital or in hard copy — that are available to and relied upon by surgeons preoperatively should be accurate and comprehensive. In this case, there were two key reports that were not included in the folder. I consider it to be imperative for key clinical reports generated between the CCM and surgery dates to be included in that folder for the surgeon’s review.
93. Dr E told HDC that when Dr F brought the anomaly to his attention during surgery, he assumed that the surgical team were already aware of it, which is why he did not mention it. While I accept that Dr E assumed that Dr B already knew about the anomaly, I consider that this was another missed opportunity for Dr B to be informed of it.
94. Although the procedure being undertaken was usual, Mr A’s heart was unusual. I would expect any information about the patient that is unusual to be discussed amongst the surgical team, regardless of whether team members believe it is already known to others in the room. The whole team has a responsibility to ensure that relevant and significant information is shared amongst everyone in the operating theatre, and as this case has demonstrated, it is dangerous to make assumptions about what people already know. I encourage any surgical team member to speak up if there is any doubt in their mind about whether the surgeon knows about a key piece of information.

Conclusion

95. CCDHB had a responsibility to provide services to Mr A with reasonable care and skill. Mr A's cardiac anomaly was known by multiple people and recorded in multiple places in CCDHB's system. There were numerous missed opportunities for this information to be communicated to Dr B, as outlined above. I consider that these missed opportunities were contributed to by the fact that CCDHB did not require completion of a coronary diagram ahead of surgery, and that the purpose of the CCM was not clear to its participants. Notwithstanding Dr B's personal responsibility in this case, CCDHB's system failed to alert Dr B to relevant and significant information about Mr A. Accordingly, I find that CCDHB did not provide services to Mr A with reasonable care and skill, and breached Right 4(1) of the Code.

Postoperative care — other comment

96. Regarding Mr A's postoperative care, Dr Raudkivi advised:
- “Without reviewing the coronary anatomy, the surgical team rendered appropriate measures in hopeless circumstances. The only potential solution would have been to re-examine the images and correct the blood flow problem to the right coronary artery; not impractical but unlikely to occur in the typical dynamics of a cardiac operation, and unlikely to be successful anyway. In short, the technical error would not be identified in the early postoperative phase.”
97. I accept Dr Raudkivi's advice, and have no concerns about the standard of care provided to Mr A in his early postoperative phase.

Opinion: Dr B — breach

Preoperative assessment

Document review

98. Information about Mr A's anomalous RCA was contained in five key documents. Dr B has acknowledged that three of these documents (the cardiac catheterisation report of 30 Month1, the “handover and acceptance from Cardiology to Cardiothoracic” form of 2 Month2, and the dictated patient report of 5 Month2) were in the hard copy cardiothoracic surgery folder that was available ahead of Mr A's surgery. The other two documents (the discharge summary of 6 Month2 and the dictated cardiac catheterisation report approved on 7 Month2) were available on the electronic system ahead of Mr A's surgery, but were not in the cardiothoracic surgery folder.
99. My expert advisor, cardiothoracic surgeon Dr Peter Raudkivi, stated that accepted practice would be to view all sources of information about the coronary anatomy. He commented that failure to identify, or to comprehend, at least one of these items appears to be a serious oversight, and would be judged as unacceptable by other cardiac surgeons.

100. I accept Dr Raudkivi's advice. While I note Dr B's comments about the information being poorly collated, and the supporting opinions Dr B provided from cardiologists Dr H and Dr I, I remain concerned that Dr B did not identify at least one version of the description.
101. Dr Raudkivi commented that mitigating factors can include fatigue after a day of operating, and clinical records being poorly collated and key pieces of information being difficult to locate. I accept that Dr B may have been fatigued when he reviewed the documentation at the end of the day, as he had just completed a complex procedure on another patient. However, I do not consider that this excuses him from carefully reviewing three documents that had the imperative information recorded on the first or second pages. I also consider that Dr B should have turned his mind to reviewing other relevant documentation that was not in the cardiothoracic surgery folder — for example, the discharge summary document from Mr A's recent hospital transfer, which was available on the electronic record.

Angiogram interpretation

102. Dr B confirmed that he reviewed Mr A's angiogram images ahead of surgery. While he stated that the images do not show the position of the coronary ostium relative to the aorta very well, he acknowledges in hindsight that the RCA anomaly is identifiable on the angiogram images. In response to the provisional opinion, Dr B said that his subsequent reviews of the clinical details and angiogram focused on confirming the appropriateness of the surgical plan, and submits that this is an example of confirmation bias, explaining why the anomaly was overlooked. Dr B also highlighted that none of the other experienced clinicians in the CCM noted the anomaly.
103. Dr Raudkivi advised:
- “The right coronary abnormality is glaringly obvious. The proximal right coronary is remarkably large. It crosses the proximal ascending aorta well above the aortic valve much higher than usual and from the left side of the aorta (which is very unusual).”
104. Dr Raudkivi stated that he does not accept that the combined abnormality is evident only in hindsight. He advised:
- “Correct evaluation of coronary angiograms is an important part of many cardiac operations. Consultant surgeons are required to be independent and skeptical in their acquisition and interpretation of perioperative information.”
105. Dr Raudkivi advised that it is the surgeon's inescapable obligation to make a correct interpretation of the coronary angiogram, and that in this case, “a serious and unacceptable error of this interpretation has occurred” given that Dr B saw the angiogram images and did not note the size or abnormal origin of the RCA.
106. Notwithstanding Dr B's explanation that he was influenced by confirmation bias when reviewing the angiogram images, and that other clinicians did not note the anomaly during the CCM, I accept Dr Raudkivi's advice, and am very concerned that Dr B failed to recognise the size and abnormal origin of Mr A's RCA when viewing the angiogram images.

Surgery

Failure to identify coronary anatomy and administer antegrade cardioplegia

107. Dr B did not identify the ostium of Mr A's RCA during the surgery. Dr B explained:
- “[T]he presence of ... calcium obscured my view of where a normal RCA ostium would be. This contributed to my not noticing that he did not have the usual arrangement of a right coronary ostium in the right coronary sinus.”
108. Dr Raudkivi commented that whilst a calcified ridge above the right coronary ostium (in normal anatomy) may obscure the usual anterior origin, it is generally possible to gain sight of it, and in the most difficult circumstances to obtain confirmation of its location using a dental mirror. He stated that failure to identify the origin should prompt a prudent surgeon to proceed more cautiously. Dr Raudkivi advised that failure to identify the ostium of such a large artery by examination of the interior of the aortic root is “surprising and a serious departure from the usual standard of care”. He further noted that Dr B failed to systematically analyse and describe the anatomy of the aortic root, and to identify the origin of the left coronary artery.
109. The Clinical Leader of the Cardiothoracic Service also noted that at the time of surgery, the surgeon should identify the position of the coronary arteries directly, to ensure that they are not obstructed at the time of valve implantation.
110. I accept Dr Raudkivi's advice and note the Clinical Leader's comment. I am concerned that Dr B did not take steps during the surgery to satisfy himself of the exact location of the right coronary ostium (or the aortic root or left coronary ostium), particularly when he encountered calcification.
111. During the operation, Dr B administered retrograde cardioplegia, but not antegrade cardioplegia. Dr Raudkivi advised:
- “[T]he cross-clamp time of 136 minutes seems to be quite long for aortic valve replacement ... Such a long clamp time has important implications for protection of the right ventricular heart muscle, because in these circumstances retrograde cardioplegia infusion alone is known to be suboptimal.”
112. Dr Raudkivi commented that generally, a surgeon needing to work with a prolonged clamp time will supplement retrograde cardioplegia with antegrade cardioplegia directly into the right coronary ostium. He noted that given that Mr A's RCA was unusually large, and therefore subtending¹⁸ a large amount of heart muscle, antegrade cardioplegia was imperative.
113. Dr Raudkivi stated:
- “A failure to appreciate the unusual diameter of the right coronary artery and to visualise its correspondingly large opening in the aortic root caused a misjudgement in

¹⁸ Attaching to.

the method of myocardial protection. Whilst suture obliteration of the right coronary was the main cause of terminal right ventricular failure (markedly diminished blood flow to the right ventricular heart muscle), unsatisfactory myocardial protection would have been a significant contributory factor.”

114. Dr Raudkivi considers that the failure to observe that the RCA was large, and to account for its significance by administering adequate myocardial protection, is a serious departure from normal surgical standards.
115. I accept Dr Raudkivi’s advice, and am very concerned that Dr B did not identify during surgery that Mr A’s RCA was unusually large, and did not administer antegrade cardioplegia. I am critical that during the surgery Dr B did not identify Mr A’s cardiac abnormalities, which meant that he inadvertently placed a suture that narrowed Mr A’s RCA.

Documentation

116. Regarding Dr B’s report of Mr A’s operation, Dr Raudkivi advised:

“The report is strikingly deficient, in failing to record the size of the aorta, the incision used for aortic valve replacement, the presence or absence of calcification or atheroma in the aorta or root, the degree of calcification of the aortic valve and the severity of stenosis, the diameter of the annulus, whether there was calcification in the membranous septum or anterior mitral leaflet, the extent of annular calcification, the size and position of the coronary ostia, and whether there was calcification above or around the coronary ostia.”

117. I accept Dr Raudkivi’s advice, and consider that Dr B should have included further detail in his operation report, particularly regarding the location of the coronary ostia.

Conclusion

118. As discussed above, Dr Raudkivi concluded that there were three crucial mistakes made by Dr B:

“Firstly, somehow, he has not seen the abnormal right coronary artery ... Secondly, at the operation, there was a failure to systematically analyse and describe the anatomy of the aortic root, and especially to identify the origins of the [two] coronary arteries (left and right) ... Thirdly, a failure to appreciate the unusual diameter of the right coronary artery and to visualise its correspondingly large opening in the aortic root caused a misjudgement in the method of myocardial protection. Whilst suture obliteration of the right coronary was the main cause of terminal right ventricular failure (markedly diminished blood flow to the right ventricular heart muscle), unsatisfactory myocardial protection would have been a significant contributory factor.”

119. Dr B had a responsibility to provide Mr A services with reasonable care and skill. I consider there to have been significant failures in the care Dr B provided to Mr A, and therefore that Dr B did not meet this responsibility. Dr B did not:
- Review the preoperative documentation comprehensively;
 - Interpret the angiogram images adequately;
 - Identify the RCA ostium during surgery or recognise that it was unusually large;
 - Administer antegrade cardioplegia; and
 - Document his operation findings adequately.
120. Accordingly, I find that Dr B breached Right 4(1) of the Code.
-

Recommendations

121. I recommend that CCDHB:
- a) Create terms of reference for the purpose and effect of the CCM, and ensure that these are available to all staff who attend the CCM.
 - b) Align a policy, regarding the completion of coronary diagrams ahead of cardiac surgery, with national practice.
 - c) Implement a system to ensure that letters or clinical reports finalised after the CCM but ahead of surgery are forwarded to a central repository to be inserted into the cardiothoracic surgery folder.
 - d) Provide in-house training to cardiology and cardiothoracic medical staff regarding interpretation of angiogram images.
 - e) Ensure that it is clear to all surgery departments that it is expected that the operating surgeon will read all pertinent documentation ahead of surgery.
 - f) Provide to HDC, within three months of the date of this opinion, evidence that the above recommendations have been implemented.
122. I recommend that within three weeks of the date of this opinion, CCDHB provide a written apology to the family of Mr A. The apology should be provided to HDC for forwarding.
123. I recommend that the Medical Council of New Zealand consider whether a review of Dr B's competence is warranted.
124. I recommend that within three months of the date of this opinion, Dr B undertake training on angiogram interpretation.

125. I recommend that within three weeks of the date of this opinion, Dr B provide a written apology to the family of Mr A. The apology should be provided to HDC for forwarding.
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Follow-up actions

126. A copy of this report will be sent to the Coroner.
127. A copy of this report with details identifying the parties removed, except the expert who advised on this case and CCDHB, will be sent to all district health boards.
128. A copy of this report with details identifying the parties removed, except the expert who advised on this case and CCDHB, will be sent to the Medical Council of New Zealand, and it will be advised of Dr B's name.
129. A copy of this report with details identifying the parties removed, except the expert who advised on this case and CCDHB, will be sent to the Royal Australasian College of Surgeons, the National Chief Medical Officer Group, ACC, and the Health Quality & Safety Commission, and placed on the Health and Disability Commissioner website, www.hdc.org.nz, for educational purposes.

Appendix A: Independent advice to the Commissioner

The following expert advice was obtained from Dr Peter Raudkivi:

“I have been asked to provide an opinion about the Complaint concerning [Mr A]. I have read and agreed to follow the Commissioner’s Guidelines for Independent Advisors.

My full name is Peter Jaan Raudkivi. I graduated from the University of Auckland (BSc, MBChB) in 1976. I gained Fellowship of the Royal Australasian College of Surgeons by examination in 1982. I am a vocationally registered cardiothoracic surgeon employed by the Auckland District Health Board. After postgraduate experience in the USA and England, I was appointed Cardiothoracic Surgeon at Green Lane Hospital in 1988. I have been an accredited specialist at the Mercy and Ascot Integrated Hospitals (1990–2010), and have been an Examiner in Cardiothoracic Surgery for the Royal Australasian College of Surgeons (2002–2010).

My referral instructions are documented in the letter of 25th July, received from [HDC].

On receipt of these instructions, I explained to [HDC] that [Dr B] worked with me [some years ago]. Subsequently, I have had infrequent brief contacts with him, only at surgical conferences. [HDC] advised me to proceed with my opinion.

I have reviewed the file received from the HDC Office, including in particular:

- [1] the complaint from the wife of the deceased (undated)
- [2] the response from [CCDHB]
- [3] the autopsy report by [pathologist]
- [4] [Dr C’s] letter to the HDC (concerning the report of the coronary angiogram)
- [5] correspondence from [Dr D], Interventional Cardiologist, concerning his attendance at the Cardiosurgical Conference and reporting of the angiogram
- [6] the cardiac catheterisation report written by [Dr C] (locum Consultant Cardiologist) (30 [Month1])
- [7] the Cardiology referral letter written by [Dr D] (1 [Month2])
- [8] [Dr B’s] report to the HDC (undated)
- [9] [Dr B’s] operation report (13 [Month2])
- [10] The CCDHB Hospital file for [Mr A] (deceased), including the coronary angiograms (provided on disks)

[11] Coronary angiogram report written by [Registrar] for [Consultant Cardiologist]

In the following written statements, some of these documents are numerically referenced in square brackets. Also, three images are attached to my report, labelled 1–3.

CLINICAL SUMMARY

[Mr A] (aged 76) was referred for surgical treatment of his calcified and narrowed aortic valve. He was considered to be a high risk surgical candidate because of obesity (BMI 38), obstructive sleep apnoea, previous right lower lobectomy (for pulmonary tuberculosis), a history of deep venous thrombosis and pulmonary embolism (2009), chronic atrial fibrillation, chronic kidney disease, prostate cancer, and polymyalgia rheumatica requiring long term steroid treatment with Prednisone (10mg daily).

On 30 [Month1], two weeks before surgery, a coronary angiogram was done. This identified coronary artery narrowings and a large calibre right coronary artery with a congenitally abnormal origin from the posterior aspect of the aorta. That Cardiologist (not the referring doctor) described this abnormality in a brief written report but did not prepare a diagram of the coronary arteries. The description of the coronary abnormality was also noted in three other parts of the clinical records, including the referral letter from the Cardiologist to the Cardiac Surgeon. None of these descriptions were seen by the Surgeon.

Prior to the surgery, the Surgeon either did not see the images, or failed to interpret the images correctly. During the operation he was unaware of the coronary abnormality, the right coronary origin was never identified and the right coronary artery was occluded whilst closing the aortic incision used for aortic valve replacement. This resulted in profound failure of the right ventricle and the patient's early demise.

Expert advice requested

Do you consider more emphasis should have been placed on the anomalous right coronary artery in [Dr C's] angiogram report (e.g. a different font, bold, etc)?

The written report [6] adequately describes the difficulty in locating the origin of the right coronary ostium and subsequently the abnormal location and unusual size of the right coronary artery. Therefore the written report about this particular detail follows standard practice and additional methods of emphasis would not be expected.

In most New Zealand cardiology centres, however, it would be conventional for the cardiologists to provide a diagram of the coronary anatomy and major lesions, especially for surgical cases where coronary artery bypass grafting is anticipated. It is acknowledged that sometimes this does not occur.

Would you have expected special attention to have been drawn to the presence of anomalous RCA during the CCM by [Dr D]?

The details of the presentation to the Cardiosurgical Conference are not accurately known or recorded, which is also not unusual.

It is quite possible that mention was made of the requirement for one coronary bypass graft, without viewing of the images in the Conference. Alternatively, knowing that the right coronary artery did not require grafting may have led the Conference to focus on images only of the left coronary system.

The right coronary artery did not require bypass grafting and most cardiologists would not appreciate the operative implications of an abnormal origin and course of this vessel, in the context of an aortic valve replacement operation. So, the lack of particular attention to that matter is not surprising.

Given that it seems [Dr D] did not verbally mention the anomalous RCA at the CCM, do you consider [Dr B] should have identified its presence from the clinical notes?

The cardiology referral letter from [Dr D] [7], addressed to [Dr B], indicated a requirement for aortic valve replacement and coronary artery bypass grafting. Therefore, accepted practice would be to view all sources of information about the coronary anatomy. In this case, the right coronary abnormality had been described in 4 separate documents, viz.: coronary angiogram report (30 [Month1]), referral letter for surgery (1 [Month2]), discharge summary (6 [Month2]), handover and acceptance from Cardiology to Cardiothoracic (2 [Month2]).

Failure to identify, or to comprehend, at least one of these items appears to be a serious oversight and would be judged as unacceptable by other cardiac surgeons. [Dr B] should have discovered at least one version of the description.

Do you consider [Dr B's] pre-operative review of [Mr A's] clinical information was sufficient?

There is no formal record of [Dr B's] preoperative assessment and no return referral letter to the cardiologists. The consent form is annotated in respect of typical complications relevant to cardiac surgery, including the choice of a biological valve replacement, but there is no specific indication about plans for coronary artery bypass grafting.

The absence of a coronary diagram would normally provoke a surgeon to seek a written report (which was available two weeks before surgery) and to personally examine the images.

Failure to identify or comprehend any one of the 4 separate descriptions of the coronary anatomy, or to recognise the abnormality by direct viewing of the images, appears to be a serious lapse and likely would be judged as unacceptable by my peers.

There may be mitigating circumstances. The cardiology referral letter to [Dr B] was signed off 8 days before surgery but it is not known when it was received or read. The consent was obtained in the day before surgery, but the time of day was not recorded.

It is, however, not unusual for the preoperative visit to occur late in the day when the surgeon is fatigued from a long period of operating (note that [Mr A] himself was in the operating room for more than 9 hours). And, in the usual way, clinical records are poorly collated and key pieces of information are often difficult to locate or obscure in poorly constructed letters.

Perusal, for example, of the cardiology referral letter [7] written by [Dr D] (1 [Month2]) shows that ischaemic heart disease/coronary artery pathology is missing from the Problem List, the need for coronary artery surgery is mentioned in the second paragraph, but the right coronary anomaly is recorded only in the fourth paragraph which begins *'He has a history of recurrent blisters over his legs but has not had any for more than 2 years. His legs have stasis dermatitis but no current ulcers ...'*

Is it possible to identify the anomalous RCA from the angiogram images provided?

The coronary angiogram ([Mr A] had his first angiogram in 2013 and that is incorrectly reported [11]) has been reviewed by the Advisor and a senior cardiology colleague. The right coronary abnormality is glaringly obvious. The proximal right coronary is remarkably large. It crosses the proximal ascending aorta well above the aortic valve much higher than usual and from the left side of the aorta (which is very unusual). (See attachment 3, annotated by the Advisor).

All cardiac surgeons are trained to examine coronary angiograms and it is normal practice to review the images immediately before any coronary artery operation.

If [Dr B] had seen the relevant images without noting the size and abnormal origin of the right coronary artery, then a serious and unacceptable error of this interpretation has occurred. Unfortunately, in my view, his subsequent report to the HDC [8], referencing Figures 8 and 9 (labelled attachments 1 & 2) emphasises the obviously abnormal right coronary artery (Figure 8 is normal anatomy and Figure 9 is [Mr A's] right coronary image).

Given [Dr B's] description of the surgical technique used and his description of [Mr A's] anatomy, do you consider sufficient care and skill was demonstrated during the operation?

[Dr B's] description of the operative details in the typed 13 [Month2] operation report [9] and in his report (written much later, not dated) to [the] (Executive Clinical Director) [2] are confusing and contradictory.

The Findings/Procedure section of the typed operation report (page 2) describes the appearance of retrograde blood flow from both coronary arteries: *'Following this the aorta was opened and an additional dose of cardioplegia was given to ensure that there was good return via the left and right coronary ostia'*. There is, however, no actual description of either coronary artery origin/location, or of unusual aortic root calcification and (page 1) *'... we turned our attention to the aortic valve which is a three leaflet valve and replaced that ... without any difficulty'*.

Turning now to [Dr B's] report to [the] (Executive Clinical Director) [2], he said (Section 5) *'[Mr A] had significant aortic root calcification including above/in the right coronary sinus where the right coronary ostium is usually located. The presence of this calcium obscured my view of where a normal right coronary artery ostium would be'*.

In reporting to the HDC [8] (undated report, no page number), [Dr B] states *'... we struggled to wean [Mr A] from cardiopulmonary support. The anaesthetic team and I attributed this to the prolonged cross-clamp time that had been required to replace his heavily calcified aortic valve and time to close his calcified aorta'*.

In the Clinical Record [10], however, the only mention of any calcification is in the postoperative histology (reported 19 [Month2]), in the referral letter from [the regional hospital] (25 [Month1]) and the Cardiology handover notes (undated). These all refer only to the aortic valve and not to the aorta.

Calcification of the valve or aortic root is not mentioned in the operation report which reads as a pro forma document. The report is strikingly deficient, in failing to record the size of the aorta, the incision used for aortic valve replacement, the presence or absence of calcification or atheroma in the aorta or root, the degree of calcification of the aortic valve and the severity of stenosis, the diameter of the annulus, whether there was calcification in the membranous septum or anterior mitral leaflet, the extent of annular calcification, the size and position of the coronary ostia, and whether there was calcification above or around the coronary ostia.

Root calcification and difficulty with closure of the aortic incision are also not described in the hand-written operation report (written presumably by an assistant).

Furthermore, the coronary angiogram/aortogram images do not reveal obvious calcification, aortic root or calcification of the aorta is not mentioned in the CT Scan (done on 24 [Month1] to exclude a pulmonary embolus) and aortic calcification is not mentioned in the echocardiogram report (5 [Month2]).

And at autopsy [3] (page 7) *'there is moderate atherosclerosis of the aorta'*. The report identifies the tissue aortic valve replacement but makes no mention of root calcification even though the iatrogenic occlusion of the right coronary artery is recognised. (For the non-medical reader, the root refers to the aorta around the valve).

Therefore, the Advisor is obliged to conclude that there was no significant calcification of the aortic root or ascending aorta.

The Advisor notes that the cross-clamp time of 136 minutes seems to be quite long for aortic valve replacement and single coronary artery graft which, according to the typed operation report, proceeded *'without any difficulty'*. Such a long clamp time has important implications for protection of the right ventricular heart muscle, because in these circumstances retrograde cardioplegia infusion alone is known to be

suboptimal. [Dr B], however, appears to have not made any attempt to deliver antegrade cardioplegia into the right coronary ostium.

In general, a surgeon needing to work with a prolonged clamp time will supplement retrograde cardioplegia with antegrade cardioplegia directly into the right coronary ostium. And, knowing from the angiogram that the right coronary artery was unusually large, and therefore subtending a large amount of heart muscle, the imperative for antegrade injection would be mandatory. Evidently, this would require discovery of the anomalously located ostium.

The right coronary abnormality described in this case is quite rare, but the Advisor has encountered it in the context of routine aortic valve replacement, aortic root replacement and in paediatric heart operations. Typically, the opening (ostium) is in the posterior aorta, just above the left coronary ostium, often on or above the sinotubular junction. The ostium is obvious and an intra-mural course (passage of the vessel through the wall of the aorta) is to be anticipated.

In normal anatomy, the right coronary origin from the proximal aorta is usually easily identified. External identification of the origin is done routinely by some surgeons (including the Advisor), especially as a means of judging the position of the aortic incision and avoiding injury to the origin. Furthermore, failure to locate the origin would alert the surgeon to the possibility of an unusual location. Indeed, authoritative text books such as *Cardiac Surgery* by Kirklin and Barratt-Boyes, and *Cardiac Surgery in the Adult* edited by Lawrence Cohn, recommend this methodology but the Advisor knows that it is not routine practice by some cardiac surgeons in New Zealand.

Failure to identify the ostium of such a large artery by examination of the interior of the aortic root is, however, surprising and a serious departure from the usual standard of care.

Whilst it is true that a calcified ridge above the right coronary ostium (in normal anatomy) may obscure the usual anterior origin, it is generally possible to gain sight of it, and in the most difficult circumstances to obtain confirmation of its location using a dental mirror. Failure to identify the origin should prompt a prudent surgeon to proceed more cautiously. But, in fact, the operation report (both typed and hand-written versions) do not record any attempt to locate the right coronary ostium.

The Advisor endorses the statement of [the] Clinical Leader of the CCDHB Cardiothoracic Service (Section 5, letter to the Executive Clinical Director): *'The surgeon should also identify the position of the coronary arteries directly at the time of surgery to ensure they are not obstructed at the time of valve implantation. Both measures would have alerted the surgeon to an abnormality in the position of coronary arteries. Both these measures are an accepted standard of care'*. ('Both' refers also to the coronary angiogram — Advisor's note).

Given the duration of the operation, the opaque description of the root anatomy, the failure to correctly identify the coronary ostia or to consider the need for antegrade infusion of maintenance cardioplegic solution into the right coronary ostium (in the context of a long cross-clamp time), the Advisor is obliged to conclude that there is evidence of suboptimal skill, which my peers would regard as moderately serious, perhaps worse. The subsequent reports about operative difficulties to the HDC and to the Executive Clinical Director seem to contradict the clinical information supplied to the Advisor.

Do you consider that the cause of [Mr A's] poor recovery postoperatively could have been identified earlier?

[Mr A's] poor recovery was due to right heart failure. The common causes would be unsatisfactory myocardial protection (very likely in this case), poor blood flow in the right coronary artery (certain in this case) and air in the right coronary artery (usually a transient phenomenon and irrelevant in this case). The recovery of right heart function due to unsatisfactory myocardial protection or coronary blood flow is usually difficult, often unsuccessful.

Without reviewing the coronary anatomy, the surgical team rendered appropriate measures in hopeless circumstances. The only potential solution would have been to re-examine the images and correct the blood flow problem to the right coronary artery; not impractical but unlikely to occur in the typical dynamics of a cardiac operation, and unlikely to be successful anyway. In short, the technical error would not be identified in the early postoperative phase.

Do you consider the remedial action taken by Capital & Coast DHB is sufficient? If not, what other measures should be taken to prevent an error like this from recurring?

In reviewing the documents supplied, it is my opinion that the CCDHB has taken no useful remedial action.

Fundamentally, the technical errors in this operation (occlusion of the right coronary artery and failure to deliver antegrade cardioplegia) would not have occurred if the coronary anomaly had been recorded on a diagram.

In my opinion, the CCDHB Cardiology Service should have a routine policy of supplying a coronary diagram for every surgical case.

The advantages of a coronary diagram are:

Other observers of the angiographic images, including the surgeon, can use the diagram to correlate their personal interpretation of the images, and indeed to question discrepancies.

Abnormalities are easily identified, separately from the written report.

The diagram can be placed within sight of the surgical team and will be used as an aide-memoire, especially when multiple coronary artery grafts are anticipated.

The diagram facilitates planning of the operation. Some surgeons will actually annotate the diagram preoperatively.

It is remarkable, perhaps, that the Clinical Director for Cardiothoracic Surgery has not insisted on this policy or at least promulgated the notion that a diagram should be routinely available and easily viewed in the course of a cardiac operation. If it has been a routine policy, then its absence from [Mr A's] case is all the more questionable.

The Advisor considers the statement in Section 7 (letter from [the Executive Clinical Director]) [2] to be facile. The notion of increased font size/bolding is entirely dependent on the Cardiologist's view of the significance and relevance of the main lesions and anomalies identified. In any event, coronary anomalies are relatively rare, whilst coronary artery narrowings are very common and often multiple, in which case there could be an argument for highlighting the entire report frequently. Plainly, that is absurd.

I am also in firm disagreement with the comments provided by [the] (Executive Clinical Director). She said (Section 3 of [Executive Clinical Director's] report) '*A coronary diagram is not an obligatory part of a cardiac catheterisation report and some cardiologists do not routinely include this as they feel that the depiction is too subjective and cannot adequately replace viewing*'.

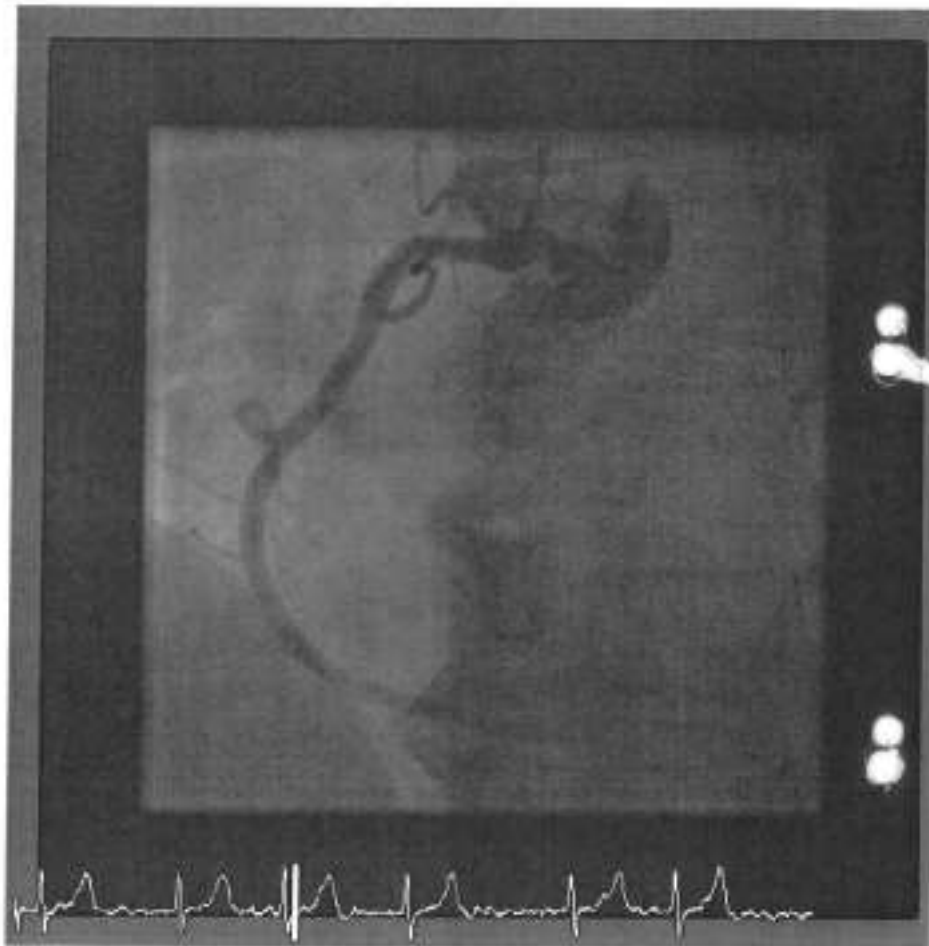
That is contrary to the Advisor's practice of 35 years, within three large volume Cardiac Surgery Hospitals in New Zealand, in which routine coronary artery surgery is not undertaken without the diagram; in my experience, the surgeon will always request the diagram (with urgency) if one has not been prepared. The diagram is routinely attached to private referral letters or displayed at Conference presentations. And, in the operating room nursing staff will routinely display it close to the surgeon for the duration of the operation.

As stated elsewhere, a diagram is much more useful than a written summary. Inherently it will show the origin and anatomic disposition of the coronary arteries, as well as significant narrowings and occlusions. Diagrammatic representation of coronary angiograms has a 40 year track record, of untold value, and the only excuse for its omission seems to be a disinclination to commit the time required.

The Advisor considers that the Surgeon's failure to observe that the right coronary artery was large ('huge', as described by the Cardiologist) and to account for its significance in respect of myocardial protection, let alone its anatomic origin and thereby its importance relevant to the aortic incision, as serious departures from normal surgical standards. These matters would be regarded as unacceptable by my peers. Therefore, it would not be unreasonable to enquire into other aspects of the Surgeon's operative outcomes."

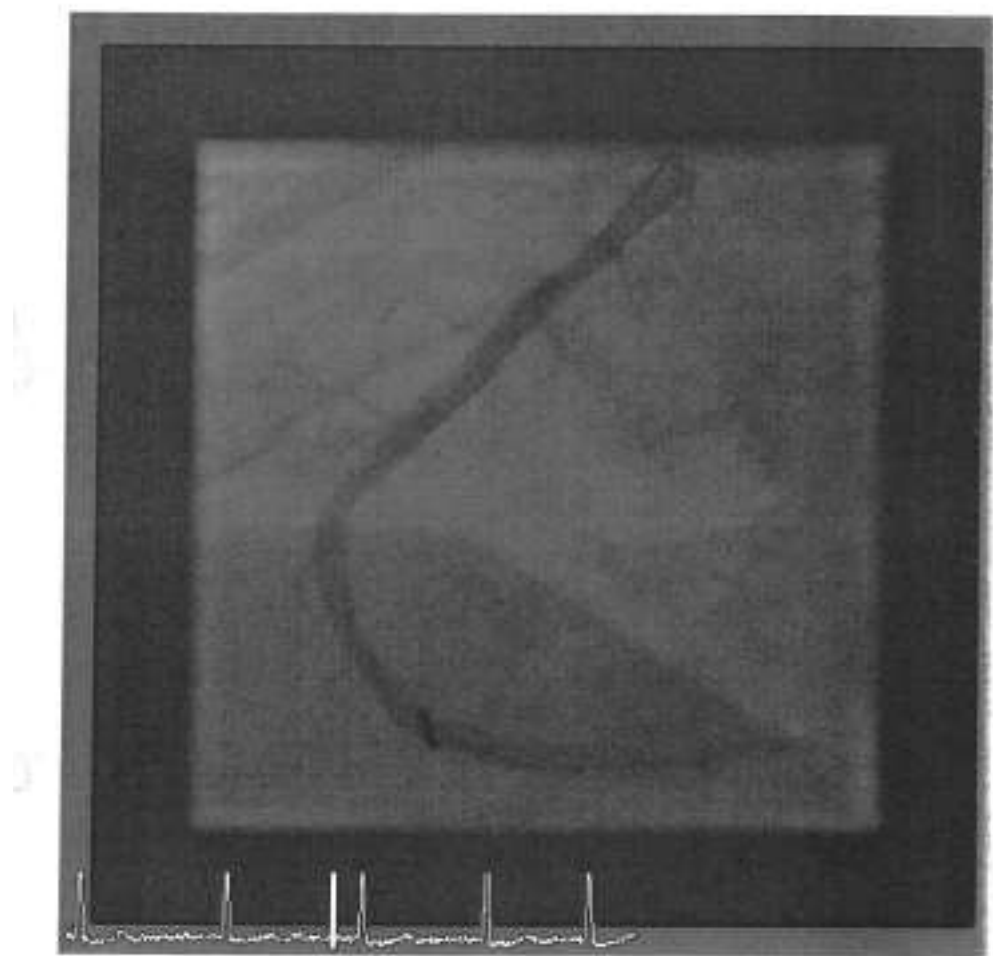
①

Figure 8: RCA angiogram

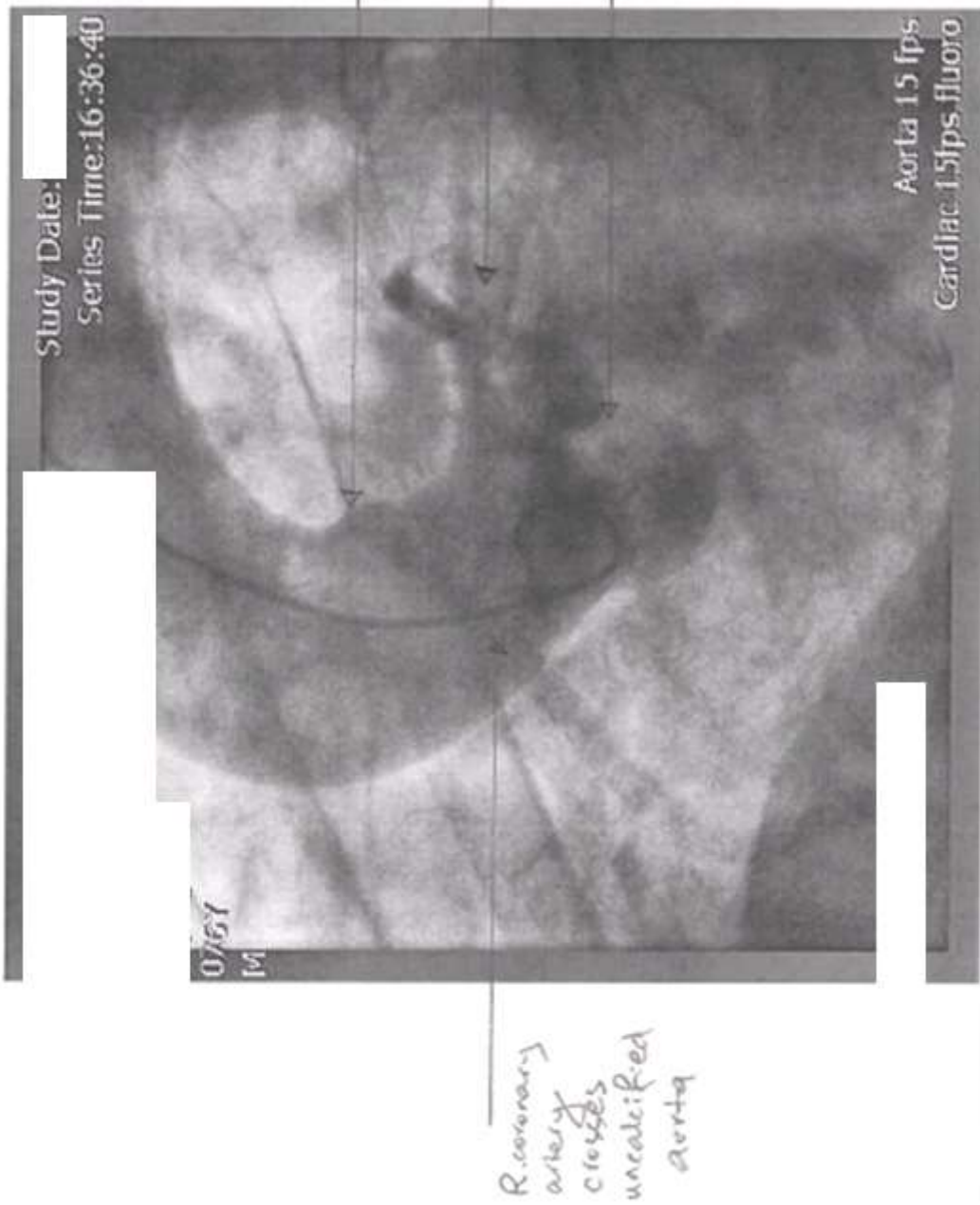


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Figure 9: RCA angiogram



3



The following further advice was received from Dr Raudkivi:

“I have been asked to provide further expert evidence, following receipt of documents obtained since my initial letter of advice.

I have examined all of these documents which include the letter and response from [Dr B] (89 pages), letters from [the] (Chief Medical Officer) and [Dr G] (Clinical Director Cardiology Department) (each 3 pages), a report from the Consultant Anaesthetist (8 pages), the Deceased Patient Summary (2 pages), a Statement from [a] (Cardiologist) (2 pages), and the Autopsy Report (12 pages).

The Commissioner is advised that I do not wish to modify or redact any part of my initial opinion (12 page document).

I should, however, like to make some observations relevant to the correspondence provided by [Dr B], [Dr G] and [the Chief Medical Officer].

It is the Surgeon’s inescapable obligation to make a correct interpretation of the coronary angiogram.

Nevertheless, [Dr G] is disingenuous in advising that *‘We do not see that a coronary diagram would have significantly altered the outcome’* (p.3, paragraph 2). To the contrary, it is obvious that a glance at an appropriately annotated diagram would have alerted the Surgeon in his viewing of the images, thereby significantly diminishing the risk of an error of interpretation. The availability of such a diagram in the operating room would also direct the attention of the surgical and anaesthetic team to important abnormalities.

My opinion of 6 September 2017, on page 8, lists the advantages of a coronary diagram.

[Dr G] attempts to diminish the value of diagrams by suggesting that they were historically appropriate only in the context of film rather than digitised images, that they are not recommended by textbooks or guidelines from professional bodies, and that they may be misleading because of ‘variable drawing skills’ (his words, p.2, paragraph 1). In fact, textbooks and guidelines make no recommendations about coronary diagrams and they are certainly not countermanded.

In New Zealand, coronary diagrams are routinely provided by all of the cardiac catheterisation laboratories except [CCDHB] and the small satellite laboratories of [two other DHBs]. My surgical colleagues throughout the country attest to their value.

[Dr B] himself, in 2009, requested that coronary diagrams be provided for surgical cases but the lack of cooperation from the CCDHB Cardiology Service is revealed in his statement: *‘It has not been routine policy for the cardiologists to provide a cardiac diagram. However, the fact that [Mr A’s] notes contain a blank cardiology diagram (Appendix 10) reflects the mismatch between expectation and delivery. I have*

advocated for this in the past but have been unsuccessful in achieving this mandatory practise (sic). Requests for a cardiac diagram are generally fruitless’.

[Dr G] seems to affirm the difficulty with coronary diagrams in the CCDHB Cardiology Service (p.2, paragraph 7): ***‘It is at the discretion of the operator to use a coronary diagram. If a cardiac surgeon requires a diagram we are prepared to supply one, this has not happened in the last ten years at CCDHB’.***

[Dr G] is correct when he states that diagrams are not routinely provided in overseas institutions. This was certainly my experience in Australia (as an examiner) and in the USA (as a postgraduate fellow at the Brigham and Women’s Hospital/Harvard Medical School). In these countries, however, cardiac catheterisations are fee-paying procedures and the time required for diagrams would not attract additional remuneration. It was my observation that the lack of a diagram was hardly satisfactory and the surgical team would often produce a sketch diagram to compensate.

To be candid, NZ cardiologists also often seem unenthusiastic about creating diagrams. The process requires a viewing and synthesis of multiple short cine loops, may be time consuming and is commonly delegated to the registrar/trainee as an educational process, with ‘loose oversight’.

[Dr B’s] report substantially traverses material covered in his original letter to the Commissioner. It does not cause me to alter my initial report and I do not consider that a complete point by point commentary improves the understanding of this case. But in summary, with regard to the patient, unfortunately, [Dr B] has made 3 crucial mistakes.

Firstly, somehow, he has not seen the abnormal right coronary artery. As was mentioned in my initial opinion (p.4), *‘The right coronary abnormality is glaringly obvious.’* Aside from its abnormally high origin, it is strikingly large. I do not accept that the combined abnormality is evident only in hindsight.

Correct evaluation of coronary angiograms is an important part of many cardiac operations. Cardiac surgeons are obliged to make accurate and insightful interpretations of coronary angiograms. It is unfortunate that the Conference, surgical assistants, and other members of the medical team in the operating room did not notice the coronary abnormality or appreciate its significance, but this is irrelevant. Consultant surgeons are required to be independent and skeptical in their acquisition and interpretation of perioperative information.

Secondly, at the operation, there was a failure to systematically analyse and describe the anatomy of the aortic root, and especially to identify the origins of the 2 coronary arteries (left and right) (p. 6 of my initial report). This led to suture obliteration of the right coronary artery.

I do not accept [Dr B’s] statement that the right coronary artery was obscured by *‘the unopened portion of the aorta’* (p.15, last paragraph). Conventional incisions in the

aorta for aortic valve replacement allow an excellent view of the left coronary ostium. The Advisor considers it remarkable that the adjacent right coronary ostium was not seen. The Autopsy Report (page 6) confirms the location of the right coronary ostium, in the typical site for this anomaly: *'The right coronary ostium is 10 mm superior to the left coronary ostium, and is not sited correctly, circumferentially, i.e. it is too close to the left coronary ostium'*.

Thirdly, a failure to appreciate the unusual diameter of the right coronary artery and to visualise its correspondingly large opening in the aortic root caused a misjudgement in the method of myocardial protection. Whilst suture obliteration of the right coronary was the main cause of terminal right ventricular failure (markedly diminished blood flow to the right ventricular heart muscle), unsatisfactory myocardial protection would have been a significant contributory factor.

In the substantial correspondence from the surgeon, and letters from the Clinical Directors of the Cardiology Service and Medicine, and from the Chief Medical Officers, there seems to be an attempt to justify diminished rather than enhanced reporting of diagnostic and procedural activities. This is apparent in the views of the CCDHB Cardiology Service that coronary diagrams are not useful in clarifying the description of coronary anatomy and [Dr G's] statement: *'We do not see that a coronary diagram would have significantly altered the outcome'* (p.3).

By his own account, it is also manifest in [Dr B's] pro forma description of the operation and his notion that lack of detailed description based on careful systematic assessment of key operative findings is acceptable because of a similar standard observed in the practice of his local colleagues.

Substandard analysis and documentation have been the major factors causing the death of [Mr A].

My credentials were detailed in the initial report. I now advise the Commissioner that as of November 2017 I am retired from clinical practice and am no longer a registered medical practitioner. I retain Fellowship of the Royal Australasian College of Surgeons and Membership of the European Association for Cardio-Thoracic Surgeons, and I am a Senior Member of the Australian and New Zealand Society of Cardiac and Thoracic Surgeons."