District Health Board
Orthopaedic Surgeon, Dr A

A Report by the
Deputy Health and Disability Commissioner

(Case 19HDC00316)

Health and Disability Commissioner
Te Toihau Hauora, Hauātanga

Contents

Executive summary

1. This report concerns the orthopaedic care provided to a woman aged in her sixties by a consultant orthopaedic surgeon during spinal surgery, and the subsequent postoperative care provided by the surgeon and the district health board (DHB). In particular, the report concerns the incorrect insertion of a screw during the surgery, a delay in undertaking further investigation of the woman's neurological compromise postoperatively, as well as a delay in the revision surgery.

Findings

2. The Deputy Commissioner found that the surgeon did not provide services with reasonable care and skill because he failed to investigate the woman's neurological symptoms appropriately in a timely manner following the surgery and, after identifying that the L4 screw was not in the correct position, the surgeon inappropriately delayed the revision surgery a further four days. Accordingly, the Deputy Commissioner found that the surgeon breached Right 4(1) of the Code.

3. The Deputy Commissioner did not find the DHB in breach of the Code.

Recommendations

4. The Deputy Commissioner recommended that the surgeon provide a written apology to the woman, and that the Medical Council of New Zealand consider whether a review of the surgeon's competence is warranted.

5. The Deputy Commissioner recommended that the DHB provide a written apology to the woman and consider HDC's independent advisor's advice regarding improvement to the DHB's Radiology team and the reading of orthopaedic scans.

Complaint and investigation

6. The Health and Disability Commissioner (HDC) received a complaint from Mrs B about the services provided to her by Dr A at the DHB. The following issues were identified for investigation:

- *Whether Dr A provided Mrs B with an appropriate standard of care during June and July 2018 (inclusive).*
- *Whether the DHB provided Mrs B with an appropriate standard of care during June and July 2018 (inclusive).*

7. This report is the opinion of Deputy Health and Disability Commissioner Rose Wall, and is made in accordance with the power delegated to her by the Commissioner.

8. The parties directly involved in the investigation were:

Mrs B	Consumer
Dr A	Provider/orthopaedic surgeon
District health board	Provider

9. Also mentioned in this report:

Dr C	Orthopaedic house officer
Dr D	Radiology consultant
Dr E	Orthopaedic registrar

10. Independent expert advice was obtained from an orthopaedic surgeon, Dr Bruce Hodgson (Appendix A), and a radiologist, Dr Gregory Hunt (Appendix B).

Information gathered during investigation

Introduction

11. This report concerns the orthopaedic care provided by Dr A, a consultant orthopaedic surgeon, to Mrs B, aged in her sixties at the time of events, during her spinal surgery on 19 June 2018, and the subsequent postoperative care provided by Dr A and the DHB. In particular, the report concerns the incorrect insertion of a screw during the surgery, and a delay in undertaking further investigation of Mrs B's neurological compromise postoperatively. The report also discusses the radiology care provided by the DHB following Mrs B's surgery.

Background

12. In 1991, Dr A performed spinal fusion surgery[1] on Mrs B.

13. In August 2017, Mrs B was referred back to Dr A with pain in her left limb around the hip joint and down to the lower part of her leg. A CT scan[2] identified issues around the middle part of the lower segment of the spine (L3/4 level), and also with a disc above the waist (L 2/3). Dr A offered Mrs B spinal surgery to address this. The surgery involved, among other things, the insertion of screws into the lower segment of the spine to improve the poor join between L3 and L4.

[1] Spinal fusion is a surgical procedure used to correct problems with the bones in the spine (vertebrae). Essentially it is a "welding" process that fuses together two or more vertebrae so that they heal into a single, solid bone. This is done to eliminate painful motion or to restore stability to the spine.
[2] Computerised tomography (CT or CAT scan) creates cross-sectional images of the body.

Spinal surgery on 19 June 2018

14. Dr A performed Mrs B's surgery around 12.30pm on 19 June 2018. Although not detected at the time of surgery, a screw in Mrs B's spine was misplaced by Dr A (discussed further below).

15. The surgery took three hours and twenty-five minutes. During the latter part of the operation, Mrs B's blood pressure dropped, but the anaesthetist corrected it. Dr A stated that there was no clear reason for the drop in blood pressure.

16. Images of the lower part of the spine were taken in the operating theatre by a consultant radiologist. His report noted: "Image intensifier used for spinal fixation surgery. Screening time 35 seconds." Dr A reviewed the images and considered that they showed satisfactory positioning of the screws.

Postoperative care

17. At 4pm, following the surgery, Mrs B was admitted to the Intensive Care Unit (ICU). The clinical notes at 6.40pm document that after the surgery, Mrs B complained of limited movement, numbness in both legs, and a heavy left hand. Dr A was present in ICU when these complaints were made by Mrs B. Dr A told HDC that in his experience with this type of operation, these issues are not uncommon.

18. On 20 June 2018, Dr C, an orthopaedic house officer, reviewed Mrs B and noted that she was "feeling good". Dr C documented Dr A's plan for Mrs B, which included receiving "X-rays once out of ICU".

19. At 2pm, Mrs B was reviewed by a physiotherapist. It was noted that Mrs B felt weak in both legs, and that strength testing showed a score of 2/5 power[3] with sensation reduced below her knees. The physiotherapist documented a plan to contact the orthopaedic team about the assessment, and noted: "[A]ltered neurology post-operative ? pre-existing vs new neurology."

20. At 2.55pm, Dr C reviewed Mrs B again as per the physiotherapist's request. Dr C noted that she discussed Mrs B's case with the registrar, and that "as [the] patient [was] an elective spinal case [and had] had significant spinal surgery/manipulation", currently she was not eligible for a spinal cord injury assessment or MRI scan.[4]

21. Dr C also noted: "Patient has had the spine decompressed thus bowel/bladder symptoms as [a] result [of] cauda equina[5] very unlikely." Dr C documented that if there were any new concerns or significant changes then staff were to contact the orthopaedic registrar (Dr E).

[3] A 2/5 grade is assigned when a muscle can contract but cannot move the body part fully against gravity.
[4] Magnetic resonance imaging (MRI) is a type of scan that produces detailed images of the inside of the body.
[5] Cauda equina syndrome (CES) occurs when something compresses the spinal nerve roots and disrupts motor and sensory function to the lower extremities and bladder.

22. The DHB confirmed that Dr C discussed Mrs B's case with Dr E and then returned to ICU and documented the outcome of her communication with Dr E in Mrs B's inpatient records.

23. Dr E said that given the time that has passed, he cannot recall his conversation with Dr C. However, he stated:

> "[A]s a junior registrar, it was my usual practice to liaise with my consultants before I gave advice relating specifically to whether a scan is requested on one of their patients or not … particularly post-operative patients … I would anticipate that I would have discussed this with [Dr A].
>
> …
>
> I believe that I am self-aware of the limitations of my knowledge, consequent on my relative lack of experience — being early in my medical career. I don't hesitate to seek advice where I think it is required."

24. Dr A told HDC that he is sure that he would have been made aware of the physiotherapist's concerns about Mrs B's neurological status. He stated: "I am sure I was but memory fails here and there may not be adequate documentation in the files." Dr A said that based on the clinical picture at the time, he was of the view that his approach was reasonable, but he cannot remember all the details as there is no documentation about this in the notes.

25. Dr C reviewed Mrs B on 21 June 2018 and noted that her neurology was improving but that her left and right legs were weak and had not returned to normal strength.

26. Dr C reviewed Mrs B during the morning Orthopaedic Ward round on 22 June 2018 and noted that she had 3/5 power in her lower legs and was feeling less dizzy that day. At 12.20pm, Mrs B was reviewed by a physiotherapist, who documented that Mrs B's leg strength was similar to the previous day.

27. On 23 June 2018, it is noted that on the previous day (22 June) Mrs B was moved from ICU to the Orthopaedic Ward and had not voiced any new concerns. At 2.30pm, a nurse documented that Mrs B was unable to lift her legs and had a sense of numbness and tingling.

28. Despite Dr C's note (above at paragraph 18) for an X-ray to be performed once Mrs B was transferred out of ICU, no X-ray was performed. Dr A told HDC:

> "X-rays were requested but I felt there was no need to have these immediately performed because the retained images on the image intensifier from the operating theatre [on 19 June] showed the screw positioning satisfactorily in my view."

29. On 25 June 2018, Dr A reviewed Mrs B during the morning ward round. Dr A noted that Mrs B was to move around with the physiotherapist when she was able, and for ankle foot

orthosis[6] to be provided to her. Around 10.30am, Mrs B was reviewed by a physiotherapist, who noted her ongoing lower leg weakness.

30. On 26 June 2018, Dr A reviewed Mrs B during the morning ward round and requested an MRI scan and an X-ray of her lower spine. The MRI was performed on the same day at 2.25pm. Dr A said that "no particular problem (apart from some bleeding and fluid from the surgery) was identified", which was not out of the ordinary for early postoperative imaging.

31. Dr A reviewed Mrs B during the Orthopaedic Ward round on 27 June 2018 and planned a spinal aspiration[7] to drain the fluid.

Spinal aspiration on 27 June

32. Following Dr A's review, Dr C prepared a Radiology Imaging Referral Form, which noted Mrs B's recent lower spinal surgery and her "ongoing/new" neurological symptoms relating to a lack of sensation and weakness in her legs. It was also noted that a recent MRI had shown a build-up of fluid around the surgical site.

33. A CT-guided spinal aspiration was performed at 12.15pm on 27 June 2018.

34. Dr A reviewed Mrs B during the morning ward round on 28 June 2018 and noted that her pain was ongoing and that she still had decreased strength in her legs. It was noted that slow ongoing improvement was expected and that Mrs B was to continue with physiotherapy.

Lower spine X-ray

35. On 28 June 2018, Dr D, a Radiology consultant, performed the lower spine X-ray requested by Dr A on 26 June. The referral form used for this X-ray was the same as that used for the CT-guided aspiration noted above.

36. In his report, Dr D did not note any abnormality with the alignment of the spine or placement of the screws.

Report for CT-guided spinal aspiration

37. Dr A reviewed Mrs B during the ward round on 29 June 2018. He noted that Mrs B "felt like [she had] rods down both legs to [her] knees".

38. Also on 29 June, the Radiology team produced the report for the spinal aspiration performed on 27 June. A radiology consultant and a radiology registrar noted that approximately 15ml of blood-stained fluid was drained and sent to the laboratory for testing. The report contained no information about the positioning of the screws.

39. On 30 June 2018, Dr A reviewed the CT scan and noted that the Right L4 pedicle screw had been placed incorrectly during Mrs B's surgery. He told HDC that it is likely that the reporting radiologist did not comment on the positioning of the screw because "[the Radiology

[6] A device (eg, a brace or splint) used to support or assist movement.
[7] Removal of fluid or other tissue.

team's] efforts [had] concentrated on the appearance and drainage of [the] haematoma[8]". Dr A said that the misplaced screw explained the pain and neurological dysfunction in Mrs B's right leg.

40. Dr A documented that he advised Mrs B that further surgery would be required to fix the incorrectly positioned screw, and that Mrs B agreed to this. The revision surgery was scheduled for 3 July 2018, which was Dr A's next available surgical list.

Revision surgery

41. On 3 July 2018, the Right L4 pedicle screw was repositioned. In response to the provisional decision, Mrs B noted that this was 14 days since her original surgery.

42. There were no issues during the surgery or postoperatively, and Mrs B was discharged on 23 July 2018.

43. Dr A told HDC:

> "I did not feel that the six day interval[9] between the recognition of this malpositioned screw and the revision surgery itself would have materially affected the outcome [—] that being a personal decision made at the time."

Subsequent events

44. On 24 July 2018, Mrs B was transferred for ongoing rehabilitation. She was discharged from hospital on 3 August 2018. Mrs B stated that she was told she would be in hospital for five days but ended up being there for seven weeks.

45. On 3 September 2018, at the first outpatient review, Mrs B was found to have problems with leg pain and fluid and weakness around her right foot and ankle. Dr A requested a further MRI scan, which was performed on 21 September 2018 and showed appropriate screw positioning.

46. Dr A also made a referral to a spinal rehabilitation service for assistance and guidance on ongoing management and appropriate medication. Dr A reviewed Mrs B again on 19 November 2018 and was satisfied that there had been ongoing improvement in the strength of her right ankle, and improvement in her strength overall.

47. Dr A stated:

> "[I]t has been pleasing to note that [Mrs B] is making a gradual recovery from her complications. I noted at her outpatient attendance on [14 October 2019] that she was walking, whereas at all the earlier outpatient review meetings she had been in a wheelchair."

[8] Collection of blood-stained fluid.
[9] Between when the CT scan was completed (27 June) and the revision surgery (3 July).

Further information

48. Mrs B told HDC that the outcome of the surgery on 19 June 2018 left her with extremely poor mobility and poor concentration, and in constant pain.

49. Dr A told HDC:

> "I have on more than one occasion apologised to [Mrs B] for the unfortunate sequence of events following the surgery which I acknowledge does carry risk, and I think she was well enough acquainted with the possible risks associated with such surgical intervention … I do accept responsibility for the malpositioning of the pedicle screw …"

50. Dr A acknowledged that there was a delay in investigating Mrs B's neurological compromise, and that "this delay has not been acceptable". Dr A told HDC:

> "I recall her general medical status influenced my decision re ongoing assessment and management of her neurological decline. I remain of the view that the misplaced right L4 pedicle screw was NOT the substantial cause of her decline but rather the intra operative hypotension was the significant cause."

51. The DHB stated that it "would like to extend a sincere apology to [Mrs B] for any undue anxiety and discomfort caused by this episode of care".

Radiology care

52. The Radiology team stated:

> "This case has been widely reviewed … within our Radiology Department. The radiology studies were 8–10 days post-screw placement. It is agreed that the Right L4 pedicle screw is not positioned correctly and unfortunately not immediately reported, although subsequently noted upon further review within two days."

53. Dr D, the Radiology Head of Department, reviewed the image intensifier images taken on 19 June 2018 and advised:

> "The guide rod is for the Right L4 pedicle screw (subsequently demonstrated misplaced) and this appears low on the image. These images were reviewed by the Surgical team at the time of surgery."

54. Dr D said that the imaging at surgery does show the Right L4 guide to be lower in position than the left.

55. The Radiology team also stated that in relation to the referral form, the clinical details note "ongoing neurology", and that "ongoing is regarded as persisting (presumed pre surgical) and may not be related to surgery. Surgery does not always cure underlying symptoms/ neurology."

Responses to provisional opinion

Mrs B

56. Mrs B was given the opportunity to comment on the "information gathered" section of the provisional opinion.

57. Mrs B told HDC that she has been in constant pain for the last three years, she has poor mobility, and she is on a range of medication. She continues to live with leg weakness, and she has numbness above the waist right down the back of her legs to her feet, and she has sleep problems.

DHB

58. The DHB was given the opportunity to comment on the provisional opinion, and advised that it was shared with the staff involved in Mrs B's care. Dr D commented that the radiologists were accepting of the advice from expert Dr Hunt, and that the radiologists had studied and discussed the case. Dr D noted that the case reflects how, despite "our best efforts, we can still miss subtle but relevant findings".

Dr A

59. Dr A was given an opportunity to comment on the provisional opinion as it relates to him. He accepted full responsibility for the malpositioning of the screw and the consequences of that. He stated that he is fully prepared to provide a written apology to Mrs B.

60. Dr A considers it possible that the hypotension suffered by Mrs B during and following her operation, as well as her postoperative haematoma, may have caused the bilateral neurological compromise, rather than the positioning of the screw.

Opinion: Dr A — breach

Introduction

61. This opinion concerns the surgery performed on Mrs B by Dr A on 19 June 2018, and the postoperative care provided.

Malpositioning of pedicle screw

62. Subsequent to Mrs B's spinal fusion on 19 June 2018, it was discovered that the Right L4 pedicle screw had been positioned incorrectly, and, as a result, Mrs B required revision surgery on 30 June 2018.

63. There is some difference of opinion as to whether the image intensifier viewed by Dr A during surgery to confirm positioning of the screws clearly showed that the Right L4 screw had been misplaced. Dr A said that his review of the images during surgery showed that the positioning of the screws was satisfactory. My orthopaedic expert advisor, Dr Bruce Hodgson, reviewed the images and also considers that they appeared satisfactory. Similarly, my radiology expert adviser, Dr Gregory Hunt, was asked to undertake a blind review of the

images. He advised: "No significant findings were identified by me in my blind report, or by other colleagues on peer review."

64. However, when the DHB's radiologist, Dr D, reviewed the images, he considered that they show the Right L4 screw placed lower than the left screw. I am mindful that Dr D's review was conducted with the benefit of hindsight, following Mrs B's complaint.

65. While I acknowledge that Dr A has accepted responsibility for the incorrectly placed screw, I am prepared to allow the possibility that at the time of surgery the imaging did not identify the misplacement clearly. I am more concerned that Dr A failed to take adequate steps in a timely manner in response to Mrs B's signs of neurological compromise after surgery, as discussed below.

Postoperative care

Investigation of neurological compromise

66. Following the spinal surgery on 19 June 2018, Mrs B was transferred to ICU. Almost immediately after the surgery, Mrs B complained of limited movement and numbness in both legs, which are signs of neurological compromise. Dr A instructed that X-rays be taken once Mrs B was transferred out of ICU. However, when Mrs B was transferred on 22 June 2018, no X-ray was performed. The clinical notes continued to document issues with weakness in Mrs B's legs, but no further investigation was performed until 27 June 2018, when Dr A requested a CT scan and an X-ray.

67. Dr A told HDC that he considered that there was no need to have X-rays taken immediately, as the imaging taken during the surgery showed that the screw positioning was satisfactory. He also said that at the time, his opinion was that Mrs B's deterioration had been caused by the drop in her blood pressure rather than the misplaced screw, and that this may have influenced his decision-making regarding her neurological decline. However, Dr A told HDC that he accepts that there was an inappropriate delay in investigating Mrs B's neurological compromise.

68. My expert advisor, Dr Hodgson, advised that even if Dr A considered that there was no recoverable cause for Mrs B's neurological compromise following the surgery, further investigations should have been carried out. These would have included X-rays to review the position of the metalware, and CT or MRI scans to review potentially recoverable causes for Mrs B's neurological compromise. Dr Hodgson advised that the sooner such investigations are carried out the better.

69. Dr Hodgson stated:

> "In general terms when a significant change or neurologic deficit is noted with a patient in the immediate post-operative phase, then investigations are carried out soon after …
>
> It is important to identify any cause of the neurologic deficit that may be correctable as soon as possible.

> This is a departure from a standard of care that is expected with this type of surgery. I consider this to be of a moderate nature."

70. I accept Dr Hodgson's advice. I am concerned at Dr A's failure to recognise the significance of Mrs B's neurological compromise and ensure that X-rays and other investigations were undertaken expediently to identify the cause. This resulted in a subsequent delay in Mrs B receiving revision surgery.

Response to concerns raised by physiotherapist

71. The day after surgery, a physiotherapist raised concern about Mrs B's altered neurology with a house officer, Dr C, who sought advice from a junior orthopaedic registrar, Dr E. Following Dr C's discussion with Dr E, Dr C documented that it was unlikely that Mrs B was experiencing disruptive motor and sensory function in her lower body (cauda equina syndrome). No further actions were taken by Dr C, and she noted that if there were any new concerns or changes, then staff were to contact Dr E. Dr E cannot remember the discussion with Dr C.

72. Dr E said that at the time, he was a junior registrar, and it was his usual practice to liaise with his consultant (Dr A) before giving any advice to a house officer, particularly for postoperative patients. Dr E believes that he would have discussed Mrs B's care with Dr A, but the clinical notes contain no documentation of such a discussion.

73. Dr A is sure that he would have been made aware of Mrs B's neurological status, but he cannot remember precisely, as no documentation was made regarding this.

74. Owing to the lack of clear recall by either Dr E or Dr A, or any documentation of discussions between them, I am unable to make a finding as to whether Dr E did contact Dr A, or what exactly was discussed between Dr A, Dr E, and Dr C.

75. In any case, clearly Dr A was made aware of Mrs B's neurological compromise postoperatively when she was in ICU, and failed to recognise its significance or order appropriate investigations. As noted by Dr Hodgson, if Dr E did contact Dr A to discuss Mrs B's ongoing neurological issues, and Dr A did not enquire further or order investigations, this would represent a second lost opportunity to investigate the cause of her symptoms.

Delay in performing revision surgery

76. On 30 June 2018, Dr A reviewed the CT scan taken on 27 June and identified that the L4 screw had been placed incorrectly, and he arranged for revision surgery four days later, on 3 July. Dr A considers that the interval between the recognition of the malpositioned screw and the revision surgery itself would not have affected the outcome, and said that this was a personal decision made at the time.

77. Dr Hodgson acknowledged Dr A's comment that the revision surgery itself would not have affected the outcome materially, but advised: "While I accept her neurologic compromise had been present for seven days, I believe waiting a further four days was an oversight." Dr Hodgson stated that in general, the sooner this type of corrective surgery is carried out, the better.

78. I accept Dr Hodgson's advice and am critical of the unnecessary delay in Dr A performing the revision surgery.

Conclusion

79. While I have accepted some ambiguity around how obvious the misplaced screw was at the time of surgery, I am nonetheless critical of the care provided by Dr A in the following respects:

- Dr A failed to investigate Mrs B's neurological symptoms appropriately in a timely manner following the surgery.
- Subsequently, after identifying that the L4 screw was not in the correct position, Dr A inappropriately delayed the revision surgery a further four days.

80. On that basis, I find that Dr A did not provide services to Mrs B with reasonable care and skill, and breached Right 4(1) of the Code of Health and Disability Services Consumers' Rights (the Code).[10]

Opinion: District Health Board — other comment

81. As a healthcare provider, the DHB is responsible for providing services in accordance with the Code.

82. As noted above at paragraph 80, I have found Dr A in breach of Right 4(1) of the Code. Dr A told HDC that at the time he considered that the postoperative care and the approach taken by him was reasonable, and that this was a "personal decision made at the time".

83. Dr Hodgson advised that the policies at the DHB that were provided are appropriate, and that the documentation of the care provided at the DHB after the spinal surgery was satisfactory.

84. I consider that the delay in investigating Mrs B's neurological symptoms was attributable to Dr A, and did not indicate any organisational issues at the DHB. However, my experts did advise that there are concerns about the Radiology care provided to Mrs B postoperatively, as discussed below.

Radiology care

85. Following the spinal surgery on 19 June 2018, multiple radiologists in the Radiology Department reviewed and reported on Mrs B's various scans.

86. On 27 June 2018, Dr A reviewed Mrs B and requested a CT-guided spinal aspiration. The Radiology Imaging Referral Form noted that there was "ongoing/new neurology lower limbs". However, the Radiology team failed to identify the misplaced L4 pedicle screw

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

following the CT scan. On 28 June 2018, Mrs B received an X-ray of the lumbar spine and, again, the Radiology team did not note that the screw had been positioned incorrectly.

87. My expert radiologist, Dr Gregory Hunt, undertook a blind review of the CT scan and X-ray. In relation to the CT scan, Dr Hunt also did not identify the incorrectly placed L4 screw. He advised:

> "During the planning and performance of the drainage procedure, all attention would have been directed toward the target fluid collection and its safe drainage. Any specific attention to screw position would be secondary and not addressed at the time of the procedure … When the procedure report was dictated, the additional bone reconstructions may or may not have been present. In either event, without any specific clinical question about screw position, close inspection of screw position on every image would probably not take place. Nevertheless, the diagnosis of a misplaced screw was possible at the time of reporting."

88. In relation to the X-ray on 28 June, Dr Hunt advised that the report prepared by the Radiology team at the time matches his blind report in all significant respects. However, Dr Hunt said that when this study was reviewed by seven of his specialist colleagues, four noted the asymmetry of the placement of the L4 screw, and one confidently diagnosed a malpositioned screw on the right. Dr Hunt advised:

> "Accordingly, the report for this study is a mild departure from the accepted standard of care, once again mitigated by the absence of any referral detail to suggest neurological findings suspicious for a misplaced screw. Additional mitigation is that in most radiologists' experience, orthopaedic surgeons usually consider their own evaluation of metalware position to be more clinically relevant."

89. I note that the DHB accepts Dr Hunt's advice.

90. On the other hand, Dr Hodgson, my expert orthopaedic surgeon, advised that the information on the Radiology referral forms provided a very good description, and that from the orthopaedic perspective, "all parts of the x-rays and metalware should have been reviewed and reported, either verbally or in writing back to the Orthopaedic Department".

91. In my view, the CT scan and X-ray offered two opportunities for the Radiology team to detect the misplaced screw. However, I accept that primarily the CT scan was undertaken for the purpose of drainage of the fluid collection and, as Dr A considered that Mrs B's neurological symptoms could be attributed to a decrease in her blood pressure, there was no consideration or mention of a potentially misplaced screw in the referral form. I also accept that half of the radiologists in Dr Hunt's blind review did not detect the misplaced screw. I therefore accept Dr Hunt's advice and acknowledge that there were factors that mitigate the Radiology team's failures in this regard.

Changes made since incident

92. Dr A told HDC that as a result of this incident:

- He now works in a limited and straightforward range of surgical procedures in both private and public health settings. In response to the provisional decision, Dr A advised that he has ceased surgical practice completely, but this decision may be revisited in the future.
- In the event he returns to surgical practice, he has undertaken to have one of his spinal surgical colleagues review any spinal surgery he intends to undertake, to ensure that the procedures fall within his restricted scope of practice. He said that cases such as Mrs B's would no longer fall within his restricted scope of practice. He stated that other steps also involve preoperative discussion and planning, with appropriate imaging and discussion with colleagues, and for two surgeons to be involved in complex surgical cases where indicated.
- A case has been put to the public hospital management for improving the DHB's capabilities to undertake computer navigation in these complex spinal cases.

93. The DHB confirmed that following these events Dr A reduced his scope of practice.

Recommendations

94. I recommend that Dr A provide a written apology to Mrs B for the breach of the Code identified in this report. The apology is to be sent to HDC, for forwarding to Mrs B, within three weeks of the date of this report.

95. I recommend that the Medical Council of New Zealand consider whether a review of Dr A's competence is warranted.

96. I recommend that the DHB:

a) Provide a written apology to Mrs B. The apology is to be sent to HDC, for forwarding to Mrs B, within three weeks of the date of this report.

b) Consider Dr Hunt's advice regarding improvement to the DHB's Radiology team's services and reading of orthopaedic scans. The DHB is to update HDC on the outcome of its consideration and any changes to be made, within four months of the date of this report.

Follow-up actions

97. A copy of this report with details identifying the parties removed, except the experts who advised on this case, will be sent to the Medical Council of New Zealand and the Royal Australasian College of Surgeons, and they will be advised of Dr A's name.

98. A copy of this report with details identifying the parties removed, except the experts who advised on this case, will be placed on the Health and Disability Commissioner website, www.hdc.org.nz, for educational purposes.

Appendix A: Independent clinical advice to the Commissioner

The following expert advice was obtained from an orthopaedic surgeon, Dr Bruce Hodgson:

"Thank you for your request for a Medical Report on complaint [Dr A]/[Mrs B], Reference 19HDC00316. I have agreed to provide expert advice to the Commissioner. I have read the HDC's Guidelines for independent advisors.

I am a vocationally registered Orthopaedic Surgeon with a sub specialist interest in spinal surgery, based in Dunedin Public Hospital.

[Dr A] is known to me on a professional basis through the New Zealand Orthopaedic Association and the New Zealand Orthopaedic Spinal Society. I have never worked with him.

I have had no knowledge of this case or the complaint laid and as such, I do not believe there is a conflict of professional interest in this case. I have made this known to the Commissioner.

Background

On 19 June 2018, [Mrs B] underwent surgery with [Dr A], due to severe spinal stenosis from a surgery in 1991. During the surgery, there was low positioning of the right L4 pedicle screw, causing injury to the right L4 nerve root.

Expert advice requested

Please review the enclosed documentation and advise whether you consider the care provided to [Mrs B] by [Dr A] was reasonable in the circumstances, and why.

In particular, please comment on:

1. **The reasonableness of [Dr A's] decision to confine the surgery to a posterior approach.**
2. **The reasonableness of [Dr A's] use of anteroposterior and lateral imaging using the image intensifier to document position of the pedicle screws.**
3. **Whether there was a departure from the accepted standard of care during the surgery of 19 June 2018, given the mal-positioning of the right L4 pedicle screw.**
4. **The incidence of this event occurring and whether this is an expected risk of this procedure.**
5. **The adequacy of documentation.**
6. **Any other matters in this case that you consider warrant comment.**

For each question, please advise:

a. **What is the standard of care/accepted practice?**

b. **If there has been a departure from the standard of care or accepted practice, how significant a departure do you consider this to be (mild, moderate or severe)?**

c. **How would it be viewed by your peers?**

d. **Recommendations for improvement that may help to prevent a similar occurrence in the future.**

If you note that there are different versions of events in the information provided, please provide your advice in the alternative. For example, whether the care was appropriate based on scenario (a), and whether it was appropriate based on scenario (b).

History:

[Mrs B] is a [woman in her sixties] who was referred to [Dr A], Orthopaedic Surgeon at [the public hospital] by [her general practitioner].

18.5.2017

[The general practitioner's] letter described the reason for referral as back pain/hip pain. Previous surgery metalware in lumbar spine.

He noted she had a lumbar fusion for sciatica in 1991 and now presents with disabling back pain radiating through her hip into her left knee.

14.8.2017

[Mrs B] was seen by [Dr A], Orthopaedic Surgeon at [the public hospital]. The letter of that date made note that [Mrs B] was known to [Dr A]. He had carried out her fusion in 1991. He stated he had used Roy-Camille plates and screws which are quite constrained with fixed screw holes. He stated that over the years [Mrs B] had enjoyed a 'pretty good' result from her fusion, but in the last five to six months had developed pain in her left lower limb, focused around the hip joint, but extending down the lower part of the left leg. He noted she felt subjectively that the leg was a little weak and that she had sensory changes over the medial border of her left foot.

Examination stated she had a remarkably good range of flexion in the lumbar spine, but was limited in extension. Straight leg raise was negative. Reflexes appeared intact and he was not able to demonstrate any weakness today. He noted pulses in the feet were good. He stated x-rays were done which showed the hip showed minimal osteoarthritis of no significance. He noted up right lumbar spine films showed the Roy-Camille plates in the right side, the screw not in the L3 pedicle and the L4 may not be either. He noted the plate went down to S1 and on the left side the plate went from L4 to S2. The left S1 screw was fractured. However, the fusion appeared to be solid around the facet joint posteriorly.

He made arrangements for [Mrs B] to get an MRI scan to see what was going on around the spinal canal and nerve roots.

6.11.2017

[Dr A] reviewed [Mrs B] noting the MRI scan had revealed severe joint arthritis bilaterally at L2/3 with associated ligamentus flavum thickening and facet joint cyst formation causing significant spinal stenosis.

He noted this was the first level above the attempted fusion. He noted the fusion at L3/4 distally looked satisfactory without any nerve root compression.

He made arrangements for her to have a CT scan to assess the fusion status.

8.1.2018

[Dr A] reviewed [Mrs B] noting the CT scan carried out in [town] suggested a sound fusion, but gas in the L3/4 disc. He noted the facet joints may still be open and she was kyphotic at L2/3 with severe stenosis at L2/3.

He made note that [Mrs B] was resigned to thinking further surgery may be required and he would consider what surgery would be needed depending on the findings.

16.1.2018

The letter to [Mrs B] noted that [Dr A] had given considerable thought to how he would address her issue surgically and described the need to extend the fusion to L2/3, along with decompression of the spinal stenosis at L2/3. He made note of the prospects of surgery both in front or the back of the spine, but at that stage felt that surgery posteriorly would be reasonable and that he was fairly confident that he should be able to achieve everything in one sitting from behind.

He asked [Mrs B] to give some thought to what was discussed and to contact him via phone or email.

5.2.2018

[Dr A] wrote a letter stating that 'subsequent to our past meetings and telephone conversation. I have reviewed the options of how to deal with your back problem and feel I should initially go to the front of your spine, lumbar L3/4 level to put a cage in there to try and restore better sideways balance to your spine, then position you on your tummy, open up your back and we can remove the old screws'. He noted 'we need to decompress your spinal canal at L2/3 where the MRI scan showed things are very tight. We will put new screws in at L2 and down as far into the spine as possible using the holes from the original screws'.

He made note that he had forwarded her name to the waiting list and she would get a call in the near future for the anaesthetic pre-assessment clinic to be checked out prior to surgery being carried out.

19.6.2018

[Mrs B] was admitted to [the public hospital] for surgery to her lumbar spine from a posterior approach.

The informed consent document contained in the body of the HDC notes dated 19.6.2018 indicates she had agreed to the following surgery, treatment and course of treatments 'revision of posterior fusion and decompression and fusion L2/3'. Statements of risks and benefits have been explained to me with specific additional risks and benefits explained, but not limited are infection, nerve damage.

Anaesthetic informed consent document dated the same day indicated risks of sore throat, damage to teeth and tongue, anaphylaxis, aspiration, rare problems with heart, lung, brain, swelling face and blindness.

Operation note:

The operation note from [Dr A] indicated pre-operative diagnosis: 'previous L3 to S1 fusion 1991/current diagnosis proximal failure with severe spinal stenosis at L2/3, discopathy and flattening of back at L3/4'.

Operation: Decompression L2/3, instrumented fusion L2 to L4 after removal of previous metalware.

Four R90 interbody cages at L2/3 and two at L3/4, six Solera screws L2, L3, L4 contoured 8cm rods.

The operation note indicates a standard posterior approach. The Roy-Camille plates were located and removed without any difficulty. The fractured S1 screw remained insitu. Attention turned to decompression at L2/3, and noted as expected a lot of adherent inflammatory material consistent with facet joint cyst and the facet joint osteoarthritis at this level. This was all eventually cleared without any dural breach. A wide decompression was able to get good access to the back of L2/3 and after clearance of the disc in a routine fashion two R90 interbody spaces were inserted. Dissection was carried out inferiorly across the tighter L3/4 disc space. R90 spaces (interbody) were then placed at this level. Next the pedicles were all instrumented using standard guidelines and anterior, posterior and lateral image intensification x-rays to check the screw levels. Rods were locked to the screws restoring the lordosis and then bone graft was packed lateral to each of the cages and the posterolateral gutters.

The wound was washed out and the dura confirmed to be free and pulsatile with no dural breach. It was noted the patient was stable, although did have some degree of hypotension during the preparation of the disc spaces, she was resuscitated from that.

Noted operating time: Three hours and 25 minutes.

Estimated blood loss: 1200 mls.

Post-operative course:

19.6.2018 at 1600 hrs Review at 1840 hrs

Patient was admitted to HDU [the public hospital] where as noted, she had significant pain in both legs, numbness in both legs and limited movement (normal circulation).

1840 hrs

[Dr A] was noted to be present in ICU when these complaints were made apparent.

20.6.2018

ICU ward round: Dictated by [Dr C] (House Surgeon). Note of Grade 3 to 5 power left and right sides from L3 to L5 myotomes: X-rays were to be arranged once out of ICU.

1400 hrs

Physiotherapy stated prior to surgery [Mrs B] mobilised with pain and occasional 'foot drop on right and weakness of left quads'. Today it was noted weakness of both legs from L2 to L5 myotomes with 2/5 power with sensation reduced below the knees.

1455 hrs

The House Surgeon, [Dr C] was notified by the Physiotherapist. Records indicated it was discussed with the Registrar. Written statements noted 'as patient was elective and has significant spinal surgery/manipulation' she was not currently for ASA assessment or MRI scan. 'Patient has had the spine decompressed thus bowel/bladder symptoms as result cauda equina very unlikely.'

21.6.2018

Ward round: Noted neurology was improving, but power 3/5 left and right legs.

22.6.2018

Physiotherapy noted power 2 to 3 out of 5 from L2 to S1 with sensory change below the knees.

Mobilisation sitting only. Indwelling catheter in place.

23.6.2018

Nursing notes indicate patient told there was 'nerve damage'.

25.6.2018

Ward round with [Dr A]: Instructions: mobilise as able with physiotherapy. Ankle foot orthosis please. Physical therapy note the same day indicated power left and right 2 to 3 out of five with sensation below the knees reduced. Suggestion of a referral to [the spinal unit] was made and the Occupational Therapist was asked to measure for a wheelchair.

26.6.2018

Ward round with [Dr A]: An MRI scan and x-ray of spine to be arranged.

27.6.2018

Ward round with [Dr A]: 'noted pain in legs but good power at S1 left and right sides'. Noted the MRI scan showed a small collection and seroma so for CT aspiration to 'debaulk pressure on dura'.

28.6.2018

Ward round with [Dr A]: 15mIs fluid aspirated under CT scan. It was noted there was decreased power in the muscle tib ant and on the right. Physiotherapy note of that date indicated the patient to mobilise with a hoist.

29.6.2018

Ward round with [Dr A]: description of neuropathic pain ('feels likes rods down both legs').

2.7.2018

Ward round with [Dr A]: noted a CT scan revealed a misaligned L4 screw on the right.

Discussion with patient regarding further surgery.

Surgery: [Dr A] 3.7.2018

[Mrs B] was returned to theatre for readjustment of the right L4 screw into the correct position and placement of a metal crosslink.

Operation note: as above.

5.7.2018

Ward round with [Dr A]: noted ongoing pain in both legs with right foot drop.

Physiotherapy note of that date: right ankle dorsiflexion 2/5, left ankle dorsiflextion 3/5.

9.7.2018

Ward round with [Dr A]: noted [Mrs B] was better, feeling good and the wound clean and dry.

But the intraoperative swab had revealed a growth of Propionibacterium Acnes.

Discussion with infection control. Suggested to commence intravenous antibiotics with two weeks of Penicillin then four weeks of Clindamycin.

10.7.2018

Ward round with [Dr A]: intravenous antibiotics given. There was report of slow improvement of motor power in the legs. Note made that the indwelling catheter was still in place.

13.7.2018

Ward round with [Dr A]: rehabilitation was offered along with discussion of removal of catheter as [Mrs B] was able to get up to the toilet. She refused to have the catheter removed as she felt she was unable to manage.

17.7.2018

Assessment by Ortho-Geriatrician considering transfer to [orthogeriatrics].

Written notes: 'no weakness in the legs before surgery, though did have numbness over the medial aspect of the left foot'. Note was made of a long standing history of constipation following spinal surgery in 1991.

[Mrs B] was reported to be fully independent prior to surgery, but post-operatively had significant weakness and neurology in her legs, a secondary wound infection, indwelling catheter was to remain in place. Psychiatric assessment was carried out and discussion regarding further rehabilitation in [the spinal unit].

19.7.2018

Ward round with [Dr A]. He was able to watch [Mrs B] mobilise. He noted the indwelling catheter remained. However, he felt it was appropriate for her to go to the [orthogeriatic unit] rather than [the spinal unit].

20.7.2018

[Mrs B] was transferred [to the orthogeriatric unit] and at that stage was mobilising with a frame. She had an indwelling catheter that remained in place.

30.7.2018

A trial removal of the indwelling catheter was carried out. This proved to be successful.

6.8.2018

Patient was subsequently discharged home with a district nurse referral. An ACC treatment injury claim had been placed.

12.9.2018

Letter from ACC indicating that the treatment injury claim had been accepted.

3.9.2018

[Mrs B] was seen by [Dr A] in outpatients. He noted she had a lot of problems with bilateral leg pain, oedema and weakness. It appeared to be confined to the right leg

and involved a foot drop. He arranged for intense physiotherapy input, an ultrasound scan to exclude a deep vein thrombosis and arranged for a repeat MRI scan, along with further x-rays.

[Dr A] remarked he had written a full report to the Accident Compensation Corporation and stated he had apologised to [Mrs B] and the family members as best as able.

1.10.2018

A letter to [the spinal unit] regarding referral for [Mrs B] through to the clinic.

Same day he saw [Mrs B] and noted there was no real improvement in her symptoms. He reviewed the post operative MRI scan and noted the radiologist had reported clumping of the nerve roots. This was fairly similar as to what was found in her earlier post operative MRI scan following the initial operation in June.

19.11.2018

A letter to the neurophysiologist regarding EMG studies.

15.1.2019

Nerve Conduction EMG studies were carried out by [a clinical neurophysiologist].

[The clinical neurophysiologist] stated that the EMG had shown almost complete denervation of right tibialis anterior and in peroneus longus there was marked chronic denervation.

18.2.2019

[Mrs B] was seen by [Dr A]. He noted the EMG studies and that she continued to use her foot drop splint.

He referred to the ongoing issues of pain, numbness and peripheral oedema.

He had referred [Mrs B] to [the spinal rehabilitation service] and was awaiting their opinion. He made further arrangements for x-rays and made reference to the surgery, in particular the development of the post-operative neurologic problem that he felt may have related to hypotension during the preparation of the spinal canal and wondered if there had been an element of hypotensive assault on her cauda equina. He made further arrangements to see her in three months.

26.2.2019

[Mrs B] was seen by [a doctor from the spinal unit]. The problems were noted, the post operative diagnosis of cauda equina syndrome, secondary to surgery with problems related to bowel management, bladder management, community access and ongoing pain.

Medications at the time included M-Eslon, Sevredol, Paracetamol and Gabapentin.

Examination revealed she was using crutches, but could walk 200 metres (pre-surgery she was able to walk three kilometres). It was noted she was using a right ankle foot orthosis.

[The doctor] stated there were ongoing problems with neuropathic pain affecting her left buttock and leg and he made note of a neurogenic bladder, but indicated there was no incontinence or urinary tract infections.

General physical examination showed strength (ASIA muscle grading):

	Right	**Left**
Upper limbs	Normal	Normal
Hip flexors	5	5
Knee extensors	5	5
Ankle dorsiflexors	1	5
EHL	2	5
Ankle plantar flexors	**4**	5
AIS upper limb score:	50/50	
AIS lower limb score:	32/50	

Sensation (pin prick) intact to T12. Impaired L1, L2, L3 and absent L4 and below bilaterally.

He advised self propelled wheelchair, electric bed, AFO/splint, crutches advised, ACC support via National Serious Injury Service.

Summary and Opinion:

[Mrs B] has suffered from back pain in 1991 for which she has undergone a posterior instrumented fusion from L3 to S1 under the care of [Dr A].

She has made a very good recovery from the surgery and has been very well up until six months prior to her admission to [the public hospital] on 19 June 2018.

She has suffered from back pain and associated left leg pain with a feeling of weakness in the left leg and some altered sensation over the medial aspect of the left ankle and foot.

Prior to her admission for surgery, it has been stated she could walk three kilometres.

Investigations following her initial consultation with [Dr A] included plain x-rays, MRI scanning and CT scanning.

These investigations have revealed significant spinal stenosis at L2/3 (narrowing of the spinal canal). This, on the basis of arthritis at the L2/3 facet joints with development of facet joint cysts and compression of the spinal sac at this level.

It is noted that the fusion from L3 to S1 has been solid, though [Dr A] has commented that the lumbar lordosis was reduced and her back was 'somewhat flattened'.

When surgery such as a lumbar fusion is carried out, it is important to maintain the correction alignment and orientation of the lumbar spine in an anatomic (lordotic) fashion.

This anatomic position allows the patient to maintain normal balance with the head centred over the pelvis and legs.

If the lumbar spine is left 'flattened' (reduced lordosis) then a patient will have to flex their hips and their knees in order to maintain an adequate balance. This leads to increased strain and stress on a patient's back and legs and leads to pain and loss of function (walking ability).

For this reason, spinal surgeons endeavour to carry out a lumbar fusion by incorporating lordosis into the lumbar spine fusion construct. To do this spinal interbody cages are inserted into the discs spaces and rods lock the vertebrae together to allow the bone graft to fuse without movement.

Sometimes a patient will require anterior surgery to be able to place the interbody cages, though on occasions a surgeon will be able to carry this surgery out through a posterior approach. This is standard surgery for an experienced spinal surgeon. However, it is technically demanding.

[Mrs B] had previous lumbar surgery from L3 to S1 and her lumbar spine lordosis was markedly reduced.

A normal lordosis from the first lumbar vertebra to the first sacral vertebra usually measures 55°.

This correlates with the shape of the pelvis and hips (pelvic incidence) which also averages 55°.

In [Mrs B's] case her measurement from L1 to S1 prior to her recent surgery showed the lumbar lordosis measured 21°. This indicated significant 'flattening' of the lumbar spine.

For this reason, [Dr A] felt it appropriate to not only look at the decompression of the spinal stenosis at L2/3 (free the nerves that were compressed) but also to realign her lumbar spine to improve the lumbar lordosis and restore her back to a more anatomic alignment and hopefully improve her post operative function.

This type of surgery is a serious and major undertaking. Particularly where previous surgery has been carried out. There are known to be scarring of nerve roots, soft tissues and joints related to previous surgery.

[Dr A] was well aware of these potential difficulties and discussed, quite openly (both verbally and in writing) the possibilities of carrying out surgery through an anterior or posterior (or both) approach. In my opinion, this was very sensible and the open discussion very important.

At the time of her admission for surgery, [Dr A] felt he was able to carry out her surgery through a posterior alone approach. From his description of the surgery it appeared that the surgical decompression at L2/3 was very satisfactory and exposure of the spinal canal allowed adequate access from the back to place the interbody cages at L2/3 and L3/4 in front of the spinal sac through a posterior alone approach.

In general terms, if there is any significant scarring of the spinal canal, or particularly the nerve roots, then pressure applied to these nerve roots during surgery can lead to damage to the nerves. It is for this reason that spinal surgeons will often carry out the surgery through a posterior approach, but may look at anterior surgery in order to reduce any tension or excessive pressure to the lumbar nerve roots and cauda equina.

[Dr A's] detailed operative note indicated that there was no problem with obtaining access to the L2/3 or L3/4 levels, that the spinal nerve roots and thecal sac were seen to be soft and intact and he was able to carry out the surgery adequately.

Unfortunately, during the surgical procedure there was a period of hypotension (low blood pressure) noted.

It would seem that despite the technical aspects of the surgical procedure described as being carried out without difficulty, the right L4 pedicle screw was not placed correctly. The intraoperative image intensifier x-rays were not correct.

[The] neurologic change has been noted and documented soon after in HDU that night. No apparent orders or investigations were suggested regarding these findings other than documenting them. [Dr A] was present at that time. (From the notes made in ICU/HDU [Dr A] was made aware of the weakness in [Mrs B's] legs and sensory change). He did ask for x-rays to be performed on the ward when she left ICU. The following morning (20.6.18) in ICU a note was made of her general status and neurology.

A comment was made about an x-ray to be arranged once she was out of ICU. But, it would appear that no x-rays or scans were carried out on an urgent basis. These were carried out on 26 June 2018. Of more importance, on 20.6.18 at 1400 hrs the Physiotherapist accurately documented [Mrs B's] neurologic deficit in her legs.

Quite correctly, the House Surgeon was notified who then contacted the Registrar.

The documented advice from the Registrar stated that '[Mrs B's] surgery was elective and a decompression, cauda equina was unlikely and she was not for investigations such as MRI scan'.

In general terms, when a significant change or neurologic deficit is noted with a patient in the immediate post-operative phase, then investigations are carried out soon after (x-rays to review position of metalware, MRI scans to review possibility of potentially reversible conditions that compress the spinal cord or nerves such as epidural haematoma).

It is important to identify any cause of the neurologic deficit that may be correctable as soon as possible.

This is a departure from a standard of care that is expected with this type of surgery. I consider this to be of a moderate nature.

[Mrs B's] neurologic state was carefully documented in the Ward. The Physiotherapist communicated this important adverse finding to the House Surgeon, who quite correctly contacted his senior medical advisor, the Registrar. I am unable to determine whether these facts were related to [Dr A].

I am also unable to identify from the notes whether the Registrar came and examined [Mrs B], but the advice conveyed to the House Surgeon, to the ward staff and Physiotherapist, was clearly incorrect and inappropriate.

In my opinion, this is a major oversight on behalf of [Dr A's] surgical Registrar. This has led the concerned staff to consider [Mrs B's] neurologic condition was accepted and not of significance.

It was only on 26 June 2018 that [Dr A] ordered an MRI and x-ray of the spine. It has been stated in ICU an x-ray would be done the next day in the Ward, but I can find no record of this.

When the x-ray was carried out (26.6.18) it revealed malposition of the L4 screw on the right side. The MRI scan demonstrated a fluid collection in the posterior structures (haematoma) which was reported to be causing some compression of the spinal-thecal sac. As a result of this, a CT scan was carried out to aspirate the fluid posteriorly. The CT scan also revealed the L4 pedicle screw was misaligned on the right.

By that stage, [Mrs B] was noted to have not only a profound deficit in the right L4 nerve root, but also, weakness in the other leg and bilateral sensory changes.

Four days later on 3 July 2018 [Dr A] returned [Mrs B] to theatre to redirect the malpositioned L4 screw on the right. I am unable to determine why, when identified and in the presence of a significant neurologic deficit this surgery was not carried out sooner.

[Mrs B] then underwent a slow, prolonged rehabilitation in the surgical ward then subsequently under the care of the Ortho-Geriatricians.

Fortunately, for [Mrs B] there has been an improvement in her post operative neurologic function. Though, she has been left with persistent pain and significant weakness of the muscles supplied by the right L4 and L5 nerve roots. This weakness has been attributed to the malposition of the right L4 screw.

[Mrs B] has ongoing follow up assessments with [Dr A] and [the spinal unit].

A working diagnosis has been that she has suffered neurologic compromise of her cauda equina, secondary to the surgery (Cauda Equina Syndrome).

This has been accepted by the ACC as a treatment injury claim.

Discussion:

[Mrs B] has developed, as a result of her surgery significant neurologic compromise, as compared to her preoperative status.

I am unable to identify from the body of the notes whether this compromise was reviewed as of significance or importance. [Dr A] was made aware of this postoperatively in ICU. The next day the Physiotherapist has considered this compromise as significant and has contacted the House Surgeon, who quite correctly has contacted the surgical Registrar.

From the written notes available the Registrar has not examined [Mrs B] and has made an incorrect assessment regarding the underlying problem. This has led to a significant delay in arranging appropriate investigations, namely x-rays and MRI/CT scan.

I am not able to determine whether [Dr A] was made aware of the significant neurologic deficit by the Registrar.

If he was, I would expect investigations would have been carried out much sooner. The corrective surgery to replace the right L4 screw would have been carried out. In my opinion, this process has been a departure of care of a moderate nature and has significantly compromised [Mrs B's] potential recovery from her neurologic injury to both her cauda equina and her right fourth lumbar nerve root.

Unfortunately, [Mrs B] has been left with persistent neurologic compromise, which the [the spinal unit] has described as Cauda Equina Syndrome.

In answer to the specific questions:

1. The reasonableness of [Dr A's] decision to confine the surgery to a posterior approach.

In my opinion, [Dr A's] decision was entirely reasonable and, as described, was carried out to a satisfactory technical manner.

2. The reasonableness of [Dr A's] use of anteroposterior and lateral imaging using the image intensifier to document position of the pedicle screw.

[Dr A] has carried out a standard assessment of placement of the pedicle screws using an x-ray image intensifier, both in the AP and lateral imaging. This has been carried out to a satisfactory standard.

3. Whether there was a departure from the accepted standard of care during the surgery of 19 June 2018, given the mal-positioning of the right L4 pedicle screw.

[Dr A's] operation note indicates that the surgery has been carried out without specific concern. Notably the nerve roots and spinal sac (thecal) were soft and pliable with no evidence of damage.

The x-ray image intensifier has indicated the pedicle screws have been placed in a satisfactory position and I have reviewed the images provided on CD by the HDC and believe they looked satisfactory on the images provided.

Clearly, something has happened to the right hand L4 screw between the x-ray images and the final position when all the instrumentation has been connected. It has shifted in position once the rods have been connected and locked to the pedicle screws. This change is confirmed on post operative x-rays taken some six days after surgery. CT scans of the malposition of the L4 screw have confirmed it has compressed the right L4 root.

As I have noted, when a patient has developed a post operative neurologic deficit, which was not present prior to surgery, then it becomes necessary to investigate that as soon as possible. In general terms, the sooner the investigations are carried out the better. If there is a correctable lesion, such as a compressive haematoma or malpositioned metalware, then this can be identified and corrected. The neurologic compromise may well be reversed.

In the body of the notes further investigations including x-rays, MRI or CT scanning were not carried out once it was noted in ICU that [Mrs B] had developed weakness of her legs including sensory change.

[Dr A] has been aware of this change in ICU. Orders regarding x-ray investigations have been made, but not followed. The neurologic compromise was clearly documented the next day and on each following day post operatively until the x-rays and scans were arranged on 26 June 2018. Once the scans and x-rays were made available an appropriate process was carried out with repositioning of the malpositioned right L4 pedicle screw.

In my opinion, this delay in investigation was significant and is a moderate departure from an accepted standard of care.

[Dr A] indicated he believed the period of hypotension had led to the compromise of her neurologic condition. While I agree this is the most likely cause, it is not acceptable

that investigations including plain x-rays, MRI or CT scanning were not carried out at an earlier stage to exclude a potentially recoverable cause for her neurologic compromise. In my opinion, there were two opportunities lost to carry these investigations out.

The first, following her admission to ICU when [Dr A] was present. The second, the next day when the Physiotherapist was concerned and contacted the House Surgeon, who gained advice from the surgical Registrar that was not appropriate.

The fact that it has been considered there was 'no recoverable cause' for her neurologic compromise following surgery, in my opinion, does not mean that investigations did not need to be carried out.

The right L4 screw was misaligned and permanent damage has been done to the right L4 nerve root.

It is difficult to determine what the neurologic outcome would have been if second surgery had been carried out without delay, but in general terms the sooner this is done, the better.

4. The incidence of this event occurring and whether this is an expected risk of this procedure.

The incidence of neurologic compromise suffered by [Mrs B] following this type of procedure is unusual and in general terms, cauda equina syndrome such as this will occur in less than 1 to 2% of surgical cases.

Injuries to specific nerve roots, such as the L4 nerve root compromise due to mal-placement of a screw can occur in 1 to 5% of cases, but I believe the L4 misplaced screw has not led to the full compromise of her cauda equina neurologic state seen post operatively. The malpositioned L4 screw has occurred some time between placement of the screw and subsequent connection of the metalware, as on the x-ray image intensifier views (without all metalware rods connected) the screw appears to be in a satisfactory position, though clearly in the post operative CT scan, it is not. I suspect that when the screws were connected to the rods, there was some shift in the right L4 screw and this has broken through the right L4 pedicle and led to the compromise of the right L4 nerve root. In particular, the significant loss of neurologic function to the tibialis anterior and peroneal muscles, giving rise to her major right foot drop.

This L4 screw malposition however, is not the cause of her cauda equina symptoms that were experienced post operatively. These, in my opinion, most likely relate to the period of hypotension that occurred during her surgery.

5. The adequacy of documentation.

The documentation provided in her notes is very satisfactory. The quality of the operative notes is of good standard, as are the post operative notes.

6. Any other matters in this case that you consider warrant comment.

This is a difficult case as [Mrs B] has had significant problems with spinal stenosis and 'transitional syndrome' above a previously well fused lumbar spine from L3 to S1.

The surgery required to correct, not only her spinal stenosis, but also her malalignment of her lumbar spine is technically demanding and is known to be associated with post operative complications, some of which can be significant (neurologic compromise).

Neurologic compromise associated with this type of surgery can relate to specific damage to the nerve roots at the time of surgery, blood supply to the spinal canal, cord and nerve roots (periods of hypotension) or significant change in the alignment of the spine associated with the redevelopment of an appropriate anatomic curvature that can lengthen the spinal column.

In [Mrs B's] case, it appears her surgery has been carried out very satisfactorily. Her spinal decompression has been carried out to a high level of skill and nerve roots and spinal thecal sac were seen to be quite soft, her surgical correction with the interbody cages in front of the spine, along with screws posteriorly have been placed satisfactorily.

Reviewing the x-rays provided, there has been no lengthening of the spine. Her spinal shape (alignment) has improved from a pre-operative lumbar lordosis of 21° to 34° post-operatively, which is a very satisfactory technical correction.

Unfortunately, [Mrs B] has suffered a neurologic compromise post surgery, which in my opinion, relates to both a period of hypotension and misplacement of the right L4 pedicle screw. The hypotension has compromised the blood supply to the nerves of the cauda equine and led to their deterioration.

There has also been a technical failure of the final placement of the right L4 screw, which has led to significant compromise of the right L4 nerve root and the permanent damage seen clinically and confirmed on EMG studies.

Postoperatively, her neurologic compromise has been altered. I have been unable to understand why the documented neurologic compromise, while noted, was not acted upon by the medical staff with appropriate investigations such as plain x-rays, MRI or CT scanning at an early stage to determine whether there was a remedial solution for improving the neurologic compromise. In my opinion, this delay has affected the chance of neurologic recovery for [Mrs B]. This is a moderate departure from a standard of accepted care.

However, it is gratifying that [Mrs B's] neurologic function has continued to improve and I would hope may continue to do so.

Yours faithfully

Bruce F. Hodgson
Consultant Orthopaedic Surgeon"

The following further advice was obtained from Dr Hodgson:

"Thank you for your letter and request for further opinion regarding this case.

As noted in my original report dated 21 October 2019, I know [Dr A] on a professional basis through the New Zealand Orthopaedic Association and the New Zealand Orthopaedic Spine Society. I have never worked with him.

I did not have any knowledge of this case or the complaint laid prior to contact from the HDC. I do not believe I have a conflict of interest either personally or professionally in this case.

I have agreed to provide the expert advice to the Commissioner and have read the appropriate HDC guidelines for independent advisors.

Documents provided:

1. Letter of complaint dated 19 February 2019
2. [Dr A's] response dated 20 March 2019
3. Clinical records from [the] District Health Board covering the relevant period.
4. [Dr A's] letter to ACC dated 25 July 2018.
5. [The DHB's] response dated 6 March 2020 and its attachments including radiology history, admission history, investigation results and relevant policies and protocols.
6. [Dr A's] response dated 5 February 2020.
7. Statement from [Dr E].
8. [Dr D's] report.

Expert advice requested:

Please review the enclosed documentation and advise whether it causes you to amend the conclusions drawn in your initial advice, or make any additional comments. You may choose to re-issue that advice with any changes incorporated, or write a separate addendum.

In particular, please also comment on:

1. Any further comment you may have about the care provided by [Dr A].
2. The adequacy/appropriateness of [the DHB's] policies.
3. Whether the error identified by you was due (or partly due) to any systemic issues at [the DHB] or whether it was more attributable to an individual. If there are systemic issues, please elaborate on these with reference to how other hospitals operate in those respects.
4. Any other matters in this case that you consider warrant comment.

For each question, please advise:

a. What is the standard of care/accepted practice?

b. If there has been a departure from the standard of care or accepted practice, how significant (mild, moderate or severe) a departure do you consider this to be?

c. How would it be viewed by your peers?

d. Recommendations for improvement that may help to prevent a similar occurrence in the future.

Further documentation has been provided by [Dr A] on 5 February 2020 and by [Dr E], Registrar who provided advice to [Dr C] (House Surgeon) when involved with [Mrs B's] care.

A review of the radiological reports has been provided by [Dr D], Head of Radiology Department, [the DHB].

Summary and Opinon:

[Mrs B] underwent extensive surgery to her lumbar spine on 19 June 2018.

As noted in my report, the operation carried out by [Dr A] proceeded in a satisfactory technical manner with placement of screws into the pedicles from L2, L3 and L4 with x-ray image intensification identification that these were satisfactorily placed. Interbody cages were placed in the discs of L2/3 and L3/4.

During the operation a period of hypotension occurred, for which [Dr A] was unsure of the cause. [Dr A] has made reference that there was no extensive loss of blood to explain the hypotension. Post-operatively [Mrs B] was transferred through to the ICU Department where it was noted she was 'somewhat unstable' with a period of hypotension and medical issues in the ICU.

I should make note from the hospital records, the HDU had made reference to the fact that [Mrs B's] legs were not moving properly and she had sensory changes on examination.

[Dr A] was notified of this neurologic change when he visited the ICU the evening after surgery. No further written comment is made regarding the importance of this, nor the specific investigation or treatment of the neurologic change found on examination.

[Dr A] did advise that he would like x-rays of the spine as soon as [Mrs B] left the ICU.

The following day (20 June 2018) a note dictated by [Dr C] indicated [Mrs B] had Grade 3–5 power of the left and right legs from the L3 to L5 myotomes. Note was made that x-rays were to be arranged once [Mrs B] was out of ICU.

1400 hours 20.6.18

The Physiotherapist stated that prior to surgery [Mrs B] mobilised with pain and occasional foot drop on right with weakness of the left quads. However, 'today' it was noted weakness in both legs from L2 to L5 myotomes with 2/5 power and reduced sensation below the knees.

1455 hours 20.6.18

The House Surgeon [Dr C] was contacted by the Physiotherapist with her concerns. The records indicate this problem was discussed with the Registrar ([Dr E]).

Further records and comments provided by [the DHB] make reference to the House Surgeon's conversation with the Registrar [Dr E]. She was able to find text messages related to the discussion of the case with [Dr E] in the Outpatients Surgical Unit. The content of this discussion was written in the notes that the patient had had a decompression and that there was no likelihood of cauda equina syndrome.

The written report provided by [Dr E] stated that he was no longer working in Orthopaedics, but at the time of [Mrs B's] surgery was working as a Junior Registrar on the Orthopaedic Ward.

[Dr E] stated he had minimal personal recollection of [Mrs B] during her admission and the time that had passed. His recollection was mainly limited to the documented clinical notes. He stated his role on the team was as a Junior non-training Registrar. His involvement in [Mrs B's] care consisted of 'review of her progress post-operatively' and documented this on the daily Ward rounds, including a copy in the clinical notes. He stated that the 'decision making component' of the care lay with the Consultant involved in her care.

He stated he did not recall the documented conversation with [Dr C] and was unable to comment on this. He did add it was his usual practice to liaise with a Consultant before he gave advice, specifically as to whether a scan was requested on one of the patients or not.

Radiology Report

[Dr D], head of Radiology at [the DHB] has written a report regarding the imaging (x-ray scans) carried out on [Mrs B] during her admission.

He made note that the image intensifier images on 19 June 2008 demonstrate that the disc cages at L2/3 and L3/4 and five of the six pedicle screws are in position together with a guiding rod for the sixth screw. He made note that the orientation of the AP image was not labelled, but flipped left to right compared to conventional views. The guide rod in the right L4 pedicle screw appears low on the image.

He made note that no imaging was done post-operatively between 20 June 2018 and 25 June 2018.

A report of the MRI scan carried out on 26 June 2018 indicates the alignment of the screws appeared satisfactory. At levels L2, L3 and L4 there is a fluid collection insinuating about the posterior elements and metalware which measures 6.5cm craniocaudal by 3.5cm AP and 5.8cm transverse, this is extra thecal in location, it does result in moderate thecal sac narrowing with crowding of the nerve roots seen at L2/3, there is not internal T1 hyperintensity with the fluid collection demonstrated homogenous high T2 and low T1 signal.

Note, on MRI screw position it is difficult to fully assess due to metal artefact collection demonstrated leading to the next procedure.

26.6.18
CT guided spinal drain procedure. Performed to drain an extra thecal collection. This was not done to assess orthopaedic hardware and it was a drainage procedure that is reported.

Retrospectively, the preliminary scans do demonstrate the malpositioned screw at L4, but these images have not been reported.

28.6.18
X-ray lumbar spine. Indication 'ongoing neurology assess alignment. Hardware noted although position of right L4 screw noted to be abnormal. Alignment normal with improved disc spaces.'

Overall comment: The image intensifier imaging at surgery does show the right L4 guide to be lower in position than the left. Imaging post-op will depend on the clinical picture. Subsequent radiology dating from seven days post surgery demonstrates malpositioning of the right L4 screw, although this was not noted specifically or reported at the time.

The clinical findings were not typical of focal nerve root irritation always being bilateral with leg swelling, it is possible these symptoms may be due to other pathology, possibly related to profound hypertension during surgery.

The most pertinent comments are: image intensifier images at the time of surgery — note the orientation of the AP image is not labelled but is flipped left to right compared to conventional views. The guide rod is for the right L4 pedicle screws (subsequently demonstrated in this place) this appears low on the image. These images reviewed by the surgical team at the time of surgery. I.e: it appears that the right screw guide was in the incorrect position at the time of surgery (as opposed to the Ortho expert statement that it moved).

MRI scan note on MRI screw position is difficult to fully assess due to metal artefact.

CT guided spinal drainage procedure performed to drain an extra thecal collection not as a diagnostic study. Retrospectively, this does show the screw to be malpositioned.

[Dr A's] letter:
One concern is the interpretation of the post operative imaging, specifically a CT scan, which was carried out on 27 June 2018 when it was recognised there was a malpositioned right L4 pedicle screw. He stated he noted this personally on 30 June 2018 and it was also suspected on the MRI scan which had been done on 26 June 2018.

[Dr A] went on to state that he noted the malposition of the screw on 30 June 2018 and plans were made to revise this on the next available surgical list on 3 July 2018. He stated he did not feel that the six day interval between recognition of this

malpositioned screw and the revision surgery would have materially affected the outcome, that being a personal decision made at the time.

The next question asked about the delay investigating [Mrs B's] neurologic compromise. [Dr A] accepted this delay had not been acceptable. He stated x-rays were requested but he felt there was no need to have these immediately performed because the retained images on the image intensifier from the operating theatre showed the screw position satisfactory.

He stated [Mrs B's] general medical condition was far from satisfactory after the initial surgery and she required a considerable period of time in ICU for inotropic support (medical support for low blood pressure and blood transfusions).

[Dr A] acknowledged there was technical failure in final placement of the right L4 pedicle screw.

[Dr A] was asked about the escalation of the Physiotherapist's concern about [Mrs B's] neurologic status. He stated he would have been sure he would have been made aware of that, but he stated he did not think that the mild malpositioning of the right pedicle screw would explain all the symptoms. He stated there was no apparent written record as to what statements he made when these concerns were raised with him.

[Dr A] made note that [Mrs B] is making a gradual recovery from her complications. When seen on 14 October 2019 she was walking. He noted that there was an absence of right tibialis anterior function (foot drop), but the EMG studies did suggest some improvement occurring. He made note that she had sensory changes below her knees, which he felt related to the cauda equina ischemia related to hypotension during the initial surgery. He had asked for a specialist opinion from [a colleague] regarding surgery to her ankle. [The colleague] had recommended an ongoing period of observation, but possible consideration for tendon transfer procedure if the foot drop did not recover.

[DHB] Practice and Policies:

These have been provided and are extensive. They relate to review of practice management, initially in 2018 and more recently in April 2020.

These policies cover a number of surgical and medical procedures carried out either through the Emergency Department or within the auspices of [the DHB].

In particular, I refer to Policy 6.1.2 protocol 1: Medical responsibility for patient care delegated to RMOs — when to call the Consultant on call.

These records clearly state responsibility of Resident Medical Officers (RMOs) who work at [the DHB]. In particular, when there should be an escalation of concerns, adverse event management, supervision of junior doctors, radiological referral and emergencies regarding Orthopaedic surgery, of which neurologic compromise is noted.

In my opinion, the documented policies provided by [the DHB] are satisfactory, comprehensive and appropriate in April 2020.

However, I am unable to determine whether [Dr E] was aware of these policies or requirements when he cared for [Mrs B].

Summary and Comment:
[Mrs B] has undergone extensive surgery to her lumbar spine under the care of [Dr A] on 19 June 2018.

[Mrs B] has suffered a bout of hypotension during her surgery and has been admitted to the ICU post surgery for management of her ongoing hypotension. She has required medical support for this. It has been noted in the ICU on her admission that she had neurologic compromise in her lower legs, both sensory and motor. This has been brought to the attention of [Dr A] upon his post operative visit.

[Dr A] has stated that x-rays of her lumbar spine would be required post operatively upon her discharge from the ICU. There was no further written documentation regarding any specific concern or further investigation of her neurologic compromise (cauda equina syndrome) following her surgery.

[Dr A] has stated in his letter to the Commissioner that he has considered the metal instrumentation that was placed in her back was in satisfactory position, having reviewed the image intensification during her surgery.

He has attributed [Mrs B's] neurologic compromise to the hypotension (low blood pressure) both during surgery and post-operatively. By this he means because the blood pressure was low, there was poor blood supply to the nerves in the spinal sac and they have become damaged from this lack of adequate blood supply.

From the notes provided [Dr A] did not believe that further investigation of her cauda equina compromise was required (other than plain x-rays upon her leaving ICU and returning to the Ward).

The following day on a Ward round, it was noted [Mrs B] had neurologic compromise in her legs and later that same day the Physiotherapist documented the neurologic compromise and specifically spoke to [Dr C] the House Surgeon of her concern. [Dr C] made contact with the surgical registrar [Dr E] regarding this problem and what further management would be needed.

[Dr E's] reply to the Commissioner indicated that he could not recall [Mrs B] or the events surrounding her surgery.

In his report to the Commissioner [Dr E] stated he could not recall the circumstances, but he was aware of the position and felt he would of contacted the Consultant regarding any further imaging. There is no written confirmation of this statement, nor is there any reference to this in the notes.

[Dr C] was able to provide text messages indicating she had discussed the case with [Dr E]. She subsequently wrote in the notes that [Dr E] had stated that [Mrs B] had had a 'decompression and that there was no need for further imaging as this was not cauda equina syndrome'.

In my opinion, this was a major oversight on the part of [Dr E].

A further opportunity was lost to investigate [Mrs B's] neurologic compromise and possibly reverse any problem that was causing it.

In my opinion, this demonstrates a lack of understanding on [Dr E's] part as to the importance of post operative neurologic compromise and its investigation in the surgical post operative phase. It is difficult to know if [Dr E] was aware of the [DHB] 'standing orders' about escalation of care. I feel that if [Dr A] had been made aware of the continuing neurologic compromise he would have arranged for further investigations (as happened six days later).

[Mrs B's] condition failed to improve and [Dr A] stated that imaging was arranged and carried out on 26 June 2018. This initially being an MRI scan. This revealed an extra dural fluid collection measuring 6.5 x 3.5 x 5.8cm at the level of L2/3. Of note, there was clumping of the nerve roots at L2/3.

On the basis of these findings [Dr A] asked for a CT guided drainage of the extra dural collection. This was carried out on 27 June 18.

At the time of the CT scan the L4 pedicle screw on the right side was seen to be misplaced. This was not stated by the Radiologist nor relayed to the Orthopaedic team (written report). It was noted in retrospect ([Dr D]).

Subsequently a plain x-ray of her spine was carried out on 28 June 2018 which also noted the malposition of the right L4 screw.

[Dr A] stated that he was 'aware' of the malpositioned right L4 screw on 30.6.18. This is a number of days after investigations were carried out. I am not sure why there was this delay. Due to the ongoing neurologic compromise and the right L4 screw malposition, he elected to carry out a revision of the malpositioned screw, on his first available surgical list on 3 July 2018.

In his letter to the Commissioner, he stated that at the time, despite her neurologic compromise the revision surgery itself would not have materially affected the outcome 'that being a personal decision made at the time'. While I accept her neurologic compromise had been present for seven days, I believe waiting a further four days was an oversight.

[Mrs B] subsequently underwent surgery as noted. She recovered from this second surgery then commenced a slow rehabilitative process. She is still making progress with improvement in her neurologic compromise.

Opinion:

As I have noted in my original report, when a patient has developed an unexplained post-operative neurologic deficit, which was not present prior to surgery, it then becomes necessary to investigate the reasons for that deficit as soon as possible. In general terms, the sooner the investigations are carried out the better. If there is a correctable lesion such as a compressive haematoma or malpositioned metalware pinching the nerves or spinal cord, then this can be identified and corrected. The neurologic compromise may well be reversed.

For [Mrs B], the neurologic compromise (cauda equina syndrome) was noted when she reached the ICU. This was brought to [Dr A's] attention when he visited for his post operative Ward round. Other than ordering plain x-rays upon her leaving the ICU, [Dr A] has stated he felt the neurologic compromise related to the period of hypotension and medical instability that occurred during surgery and in the ICU.

Plain x-rays were not arranged in the ICU. In fact, no imaging was arranged for [Mrs B] at all over the course of the next week.

The following morning after surgery when the neurologic compromise was once again noted, [Mrs B's] medical problems with hypotension had stabilised. The House Surgeon, [Dr C] when notified by the Physiotherapist, contacted [Dr E], the Surgical Registrar who stated that the surgery was a 'decompression' and this was not cauda equina syndrome. No further information was available as to whether [Dr E] notified [Dr A] or whether there was verbal or written correspondence related to this. [Dr E] in his letter to the Commissioner stated he was unable to remember.

In my opinion, this was not satisfactory. As I have stated, time was lost to investigate [Mrs B] to see if there was a surgically correctable problem that had led to the development of her cauda equina syndrome.

[Mrs B's] early post operative management of her cauda equina syndrome has not been satisfactory.

[Dr A] has been made aware of her neurologic compromise after theatre. He has presumed this related to her 'hypotension' and has not investigated further as he has relied on the intraoperative x-ray images being accurate.

ICU has not arranged for the plain x-rays. Had these been done they may have alerted [Dr A] to the right L4 pedicle screw malposition.

[Dr E] has been alerted to [Mrs B's] neurologic compromise the next day by the concerned physiotherapist and House Surgeon. He has 'presumed' the problem was not cauda equina because the operation was a decompression.

There have been a number of decisions made regarding [Mrs B's] neurologic compromise without apparent reference to other potential remedial causes of her problem.

This process in the early phase of [Mrs B's] post-operative recovery has been a departure of care of a moderate nature and has significantly compromised her potential recovery from a neurologic injury, both her cauda equina and her right fourth lumbar nerve root.

The fact, [Dr A] has considered that there was not a recoverable cause for her neurologic compromise following surgery, in my opinion, was not correct. This does not mean that investigations did not need to be carried out. The decision [Dr A] made is not of an adequate standard of care in these circumstances and is a moderate departure from a standard of care that is expected by spinal surgeons undertaking this type of surgery.

[Dr A's] reliance on the intraoperative x-ray images has not been satisfactory, given the significance of the bilateral symptoms of neurologic compromise.

However, on the balance of probabilities, it is difficult to determine whether [Mrs B's] neurologic outcome would have been better if the second surgery had been carried out without delay. But as noted in my opinion, in general terms, the sooner this type of corrective surgery is carried out, the better.

It is better to investigate a neurologically compromised patient and find there is nothing that can be done than to 'presume' and then find out later there is a correctable cause for the problem but too much time has been lost.

In answer to the specific questions required following the further request on 29 April 2020:

1. Any further comment you may have about the care provided by [Dr A].

[Dr A] has seen [Mrs B] with a significant problem regarding her back and legs due to spinal stenosis at L2/3 and previous well fused L3 to S1 lumbar spine from previous surgery.

He had arranged for extensive surgery to be carried out. Which on the basis of the notes provided has been carried out to a very high technical standard.

Unfortunately, [Mrs B] has suffered a period of 'medical instability' during her operation, for which there was no apparent cause (hypotension).

During the same surgery there has been misplacement of the right L4 pedicle screw which has compromised the right L4 nerve root.

[Mrs B] has suffered a cauda equina syndrome, a result of her surgery and period of hypotension during that surgery. She has also suffered damage to her right L4 nerve root due to the malpositioned right L4 pedicle screw.

This has been brought to the attention of [Dr A] by the ICU and his written comment to the Commissioner indicated he accepts that the delay in investigation is not acceptable.

He stated x-rays were requested, but he felt there was no need to have these immediately performed because of the retained images on the image intensifier from the operating theatre. This has been an oversight on his part.

He stated that he disagreed with my comments regarding movement of the right L4 screw on connection of the rods and the Radiologist [Dr D] has also noted that the screw was misplaced on the image intensifier.

I accept this comment from [Dr A] and [Dr D]. He stated [Mrs B's] general condition was far from satisfactory and she required a considerable period of time in intensive care for support of her low blood pressure.

He considered her low blood pressure had caused her cauda equina syndrome.

I accept that [Mrs B's] cauda equina syndrome may well be related to the period of hypotension during surgery, but it was not satisfactory that her condition was investigated one week after the onset of the neurologic compromise.

It is well accepted by Spinal Surgeons that any 'new' post-operative neurologic compromise, once noted requires urgent clinical and radiologic assessment whether x-rays, CT scanning or MRI scans. It is most important to find out whether there is a surgically correctable lesion. Then this surgery should be carried out as soon as possible to reverse the compromise of the nerves or spinal cord.

In my opinion, there has been a departure from an adequate standard of care by [Dr A]. This is of a moderate nature.

The following day [Mrs B] has also been noted to be neurologically compromised and while the House Surgeon, [Dr C] and the Physiotherapist have noted this, they have relayed their concern to the Medical Registrar [Dr E], who has stated that [Mrs B] has had a 'surgical decompression and this was not cauda equina syndrome'. As stated, this is incorrect and inappropriate in my opinion, both statement and the fact he has not made reference to contacting [Dr A] regarding further investigation of the compromise.

In my opinion, this is a departure from an adequate standard of care expected of a supervising Surgical Registrar. This is a moderate departure of care.

2. The adequacy/appropriateness of [the DHB's] policies.
The policies provided and reassessed from the date of April 2020 appear to be satisfactory.

3. Whether the error identified by you was due (or partly due) to any systemic issues at [the DHB] or whether it was more attributable to an individual. If there are systemic issues, please elaborate on these with reference to how other hospitals operate in those respects.
There are a number of concerns regarding [Mrs B's] post-operative care.

Firstly, in ICU it was noted she had a significant neurologic compromise. There is little documentation in the notes to explain why this was so. There was nothing in the notes

to suggest it was a significant problem other than the information had been passed onto [Dr A].

[Dr A] had relied on his intraoperative assessment of the metalware placement. This clearly affected his decision to obtain a new set of plain x-rays that night.

[Dr A] asked for the x-rays when [Mrs B] left ICU. These were not done for a week.

They were not done the next day when the Physiotherapist and House Surgeon contacted the Registrar [Dr E].

I am unable to explain why these x-rays were not done, but had that occurred, [Dr A] would have recognised the misplaced right L4 screw and 'reacted' at an earlier stage.

Secondly, the standard of radiology reporting has not been adequate.

[Dr D] reviewing [Mrs B's] imaging has stated that in retrospect the images intraoperatively show the right L4 pedicle screw was not properly placed.

The MRI scan has been done for assessment of neurologic compromise, but not metalware placement. I agree that pedicle screw position can be difficult to assess on an MRI scan.

The CT scan has been done for fluid collection, but not as an assessment of pedicle screw position.

The right L4 screw malposition has been visible on a number of occasions, but the radiology reports pertain to the investigation asked of. It is difficult to understand that with two image modalities the radiologist reporting the films have not made reference to the misplaced right L4 pedicle screw.

In my opinion, this is not an adequate standard of radiology reporting.

I am unable to state whether these concerns indicate systemic issues at [the DHB].

These issues, while in themselves do not demonstrate a lack of care for [Mrs B]. But, when added together lead to the unfortunate chain of events that in my opinion, delayed appropriate investigation and decision making in [Mrs B's] care.

4. Any other matters in this case that you consider warrant comment.
It is with some disappointment that I note [Dr A] has stated that as a result of this case and others, he has elected to reflect considerably on his spinal practice and has now limited his practice to a more straightforward range of surgical procedures.

However, it is gratifying that [Mrs B] is making a satisfactory recovery from her cauda equina syndrome and is now walking. It is also gratifying that her foot drop on the right is improving and that she is now under care regarding further surgery that may aid her ability to return to gainful function.

Yours faithfully

Bruce F. Hodgson, Consultant Orthopaedic Surgeon"

Dr Hodgson further advised:

> "Thank you for your email of 25 June 2020 and the enclosed referral forms from the Orthopaedic Team to the Radiology Team for [Mrs B's] case.
>
> The Radiology imaging referral form for 19 June 2018 requests an L3/4 lumbar interbody fusion and image intensification screening during surgery. This is a standard form and the request is satisfactory.
>
> The second form dated 26 June 2018 and 28 June 2018 is a request for an x-ray.
>
> The examinations requested are lumbar x-rays.
>
> The relevant clinical history given: 'revision surgery post fusion and decompression fusion L3/4 ALIF/OLIF L2/3 ongoing neurology post-op'."

Addendum to Dr Hodgson's advice:

> "Thank you for your email of 10 July 2020.
>
> You have asked for clarification regarding [Dr E's] response when contacted by the Physiotherapist and [Dr C].
>
> [Dr E] has made the statement that he could not remember all the details, but noted that he was a Junior Registrar and would likely have contacted the Consultant in charge.
>
> Thank you for the clarification that [Dr A] stated 'I am sure I would have been made aware of that contact'.
>
> I am unable to make any comment regarding the factual basis of this communication on the basis of the written notes provided to me.
>
> **In answer to your specific questions:**
>
> **If [Dr E] did consult with [Dr A] and that was the advice he was given which he then advised [Dr C] — would there still be a departure by [Dr E] (if so is it still a moderate departure)?**
>
> In my opinion, this would not be a departure by [Dr E].
>
> If [Dr E] had contacted [Dr A] and [Dr A] had given the advice he stated, then that would absolve [Dr E] of any departure from standard of care, particularly if [Dr A] had been made aware of the deterioration of [Mrs B's] neurologic situation.
>
> However, on review of [Dr A's] response I would take note that the day after surgery he did not know that the right pedicle screw at L4 was malpositioned.
>
> [Dr A] stated in his original letter that he only became aware of the malposition of the L4 screw one week later when x-rays were finally taken.

[Dr A], the day following surgery, when giving his advice to [Dr E] had been relying on the intra-operative x-rays of the image intensifier and had accepted (during surgery) that the metal instrumentation was in the correct position.

The following day he was not aware that the L4 screw had been mildly malpositioned as he stated in his response. He only became aware of that one week later when the investigations were carried out.

If [Dr A] was indeed advised of the neurological compromise by either the registrar or the physiotherapist, but then no further investigation was advised/arranged by him — would that be a further departure by [Dr A] (if so please advise the level of departure)?

[Dr A] has not asked for further investigations for [Mrs B], despite a known deterioration in her neurology. This is a departure of care.

You will see that I have advised that if [Mrs B] was neurologically compromised after surgery then there should have been instructions to have appropriate x-rays and if need be, scans carried out to investigate the neurologic compromise.

In my opinion, that is a departure from a level of satisfactory care of a moderate nature.

I hope this is of some help.

Yours faithfully

Bruce F. Hodgson
Consultant Orthopaedic Surgeon

The clinical question: alignment post-op.

This request form is very satisfactory. The relevant clinical history is given and for a radiologist, in particular, this indicates that there is ongoing neurology post-operatively.

The information given on the request form should highlight to a radiologist that there was concern following surgery related to nerve injury. It should make a radiologist think about what has happened to cause this.

A competent radiologist should review the placement of the metalware and spinal alignment and that it would be necessary to look at the anatomic placement of metalware in the spinal vertebra.

The third form (27 June 2018) requests interventional treatment.

The form states that the elective revision surgery at L2, L3 and L4 was carried out, but the patient has developed ongoing/new neurology lower limbs, with decreased sensation and weakness. MRI scan shows post-operative fluid collection and indentation thecal sac.

'The clinical question: guided biopsy/aspirate for CSF, seroma, blood, debulk pressure on dura.'

The information given on this form is of a very satisfactory standard. It should highlight to an interventional radiologist that there is a problem of a neurologic nature related to surgery or the post-operative phase. This should make the radiologist or team review all imaging modalities, both MRI scan and plain x-rays.

The radiologist, in my opinion, should not only look at the spinal cord and sac, but should also look to see what is causing the compression, whether it be haematoma or other problems such as misplaced metalware (related to surgery) that could be causing compression as well.

The quality of the relevant clinical history and requests given on each of the radiologic forms, are of a very good standard. In particular, the notation that there is ongoing neurology or indeed new neurology post surgery should have been a 'red flag' for a practising radiologist that they would need to look at all parts of the x-ray scans and review the metalware placement.

In summary, I would state that the standard of Radiology reporting in [Mrs B's] case has not been satisfactory.

The information provided on the request forms by the Orthopaedic Department personnel provided a very good description of what was wrong and what was requested. In particular, the highlighted note of ongoing or new neurology should have acted as a 'red flag' for a reporting radiologist. All parts of the x-rays and metalware should have been reviewed and reported, either verbally or in writing back to the Orthopaedic Department.

I am unable to state whether these concerns about the quality of radiologic reporting on [Mrs B's] case indicate a systemic issue in the [the DHB] Radiology Department.

I hope this is of some help.

Yours faithfully

Bruce F. Hodgson
Consultant Orthopaedic Surgeon"

Appendix B: Independent clinical radiology advice to the Commissioner

The following expert advice was obtained from a radiologist, Dr Gregory Hunt:

> "I have been asked to provide an opinion to the Commissioner on case number 19HDC00316. I have read and agree to follow the Commissioner's Guidelines for Independent Advisors.
>
> I am a vocationally registered Diagnostic Radiologist and have been routinely reporting general hospital orthopaedic imaging since 1989. I am a Consultant Radiologist and Senior Medical Officer of Lakes District Health Board at Rotorua Hospital and also work in private practice for Hamilton Radiology Ltd, where I am a partner. My qualifications are MB ChB (1981), Otago University and I am a Fellow of the Royal Australian and New Zealand College of Radiologists.
>
> I have reviewed the following documents provided by courier and email:
>
> 1. Letter of complaint dated 19 February 2019.
> 2. [Dr A's] response dated 20 March 2019.
> 3. [Dr A's] letter to ACC dated 25 July 2018.
> 4. [The DHB's] response dated 6 March 2020 and relevant radiology policies and protocols.
> 5. [Dr A's] response dated 5 February 2020.
> 6. Statement from [Dr E].
> 7. [Dr D] radiologist's report.
> 8. Radiology reports dated 19, 26, 27 and 28 June 2018.
>
> I have also studied the relevant image intensifier, plain film, CT and MRI imaging from [the public hospital], provided on a CD.
>
> **Expert Advice Requested**
>
> Thank you for your blind reports you provided. Please review the enclosed documentation and advise whether you consider the care provided to [Mrs B] by [the DHB] was reasonable in the circumstances, and why.
>
> Please note we have engaged another expert to provide advice on the orthopaedic care provided so we would appreciate if you can please limit your advice to the radiology care.
>
> In particular, please comment on:
>
> a. The standard of the radiology reports on 19, 26, 27 and 28 June 2018 and whether the findings/conclusions were reasonable;
>
> b. Any other matters in this case that you consider warrant comment.
>
> For each question, please advise:
>
> c. What is the standard of care/accepted practice?

d. If there has been a departure from the standard of care or accepted practice, how significant (mild, moderate or severe) a departure do you consider this to be?

e. How would it be viewed by your peers?

f. Recommendations for improvement that may help to prevent a similar occurrence in future.

If you note that there are different versions of events in the information provided, please provide your advice in the alternative. For example, whether the care was appropriate based on scenario (a) and whether it was appropriate based on scenario (b).

Factual Summary

[Mrs B] had spinal fusion surgery performed in 1991. She was referred to the orthopaedic service for back and hip pain in 2017 and an MRI scan revealed severe spinal stenosis at the L2–L3 level.

On 19 June 2018, [Mrs B] underwent surgery with [Dr A], orthopaedic consultant, to remove the previous metalware and for decompression and instrumented fusion of L2 to L4.

Subsequently, it was discovered that there was low positioning of the right L4 pedicle screw, causing injury to the right L4 nerve root.

[Mrs B] received imaging during and following her surgery on 19, 26, 27 and 28 June 2018. However, the scan reports did not comment on or identify the issue with screw positioning.

Review Process

Initially, the HDC provided me with a copy of [Mrs B's] [public hospital] imaging from 19–28 June 2018 along with the relevant radiology request forms. They requested me to provide 'blind reports' of the studies, to simulate the process of the original reporting radiologists.

After I had submitted the requested blind reports of the relevant radiologic procedures, copies of the documents listed above were sent to me. I have reviewed all of these and re-examined the imaging in the light of the new information available.

I subsequently sought peer review by presenting anonymised images and clinical information to a panel of seven other specialist radiologists convened for the purpose of peer review at Rotorua Hospital. Experience of these colleagues ranges from one to more than thirty years in specialist radiology practice; three of them are experienced in interventional procedures and one has a recognised subspecialty interest in musculoskeletal imaging.

Interoperative Lumbar Spine Screening — 19 June 2018

The provided clinical details describe the operative procedure of intervertebral disc fusion at the L3–4 level of the spine. Although the necessary removal of the pre-existing metalware was not mentioned in the clinical details, this would have been clear to the reporting radiologist from review of the prior imaging. Overall, the provided clinical history is satisfactory for the purposes of imaging and interpretation.

Two screening images from the procedure were captured and saved to the radiology PACS for radiologist review. These are of generally good quality although I note that the AP view does not identify which side of the patient is which.

My blind report is as follows:

Indication:

Lumbar spine fusion at L3–4.

Technique:

Interoperative image intensifier views.

***Findings**:*

Fusion plates have been removed from the lower lumbar spine since [the CT scan] from 5/12/2017. A single residual screw is visible in the left side of the sacrum.

Current views show pedicular screws bilaterally at L2, L3 and L4, with disc cages at L2–3 and L3–4. Alignment appears satisfactory and no complication is visible on the images obtained.

Conclusion:

Interoperative fusion views from L2–L4. No significant findings.

Dr Greg Hunt
Radiologist.

While it is my practice to issue a 'standard' report on these studies, with a full description of the findings, radiologist opinions and practices vary considerably on the need to issue a detailed report for image intensifier images obtained in theatre. By the time the images are presented to a radiologist, the surgeon has used the images for the purpose required, the procedure has been completed and the patient has long since left the operating theatre.

Accordingly, some hospitals do not issue any form of radiologist report for these procedures and there is some literature support for this. In my view, it is appropriate for all such studies to be reviewed by a radiologist. This allows for quality control of the work done by the medical imaging technologist in theatre with respect to patient positioning, image quality and screening time. A richly worded and formatted report is

only strictly necessary in the case of images which show a problem which may have been overlooked.

The report issued by [the radiologist] summarises the procedure performed and lists the screening time (of radiation exposure). There is no mention of the metalware implanted or any visible complication, although many radiologists do not consider this to be necessary in the absence of major visible complication.

No significant findings were identified by me in my blind report, or by other colleagues on peer review.

[The radiologist's] report therefore is reasonable and satisfies the widely-held view of acceptable practice, supported by peer review.

The inclusion of a side marker on the images captured would have made no difference to the interpretation of the study or the outcome for [Mrs B], but may be a practice to consider for general quality control purposes.

MRI Lumbar Spine — 26/06/2019

The referral details provided for this study describe the timing and nature of the recent surgery and the statement 'ongoing neurology'. This implies persistence of neurologic findings that were present before the operation, with no new findings alerted.

A high quality MRI study of the spine has been performed on what appears to be a state-of-the-art MRI scanner. There is inevitable image distortion from the implanted metalware. This is entirely as expected. Typically, this 'artifact' from metal prevents confident assessment of the screws and rods themselves and slightly limits detail of immediately adjacent normal tissues. It is widely agreed that MRI is not a useful technique to evaluate possible complications of implanted screws.

My blind report is as follows:

Indication:

Postop. lumbar decompression and fusion at L2–3 and L3–4. Ongoing neurology at seven days. Technique:

Sagittal T1, T2, STIR; axial Ti, T2; coronal T1.

Moderate image artefact from metallic rods and screws.

Comparison with 5/09/2017.

Findings:

The low lumbar plates have been removed since previous MR imaging with a residual S1 screw fragment in situ on the left. There is a mature interbody fusion at L4–5 and

the spinal canal is widely patent at L4–5 and L5–S1. Allowing for image artefact, there is no foraminal narrowing or neural compression at L4–5 or L5–S1.

In addition to the previous laminectomies at L3 and L4, there has been a new bilateral laminectomy at L2 with posterior rod fusion bilaterally from L2 to L4 and disc cages at L2–3 and L3–4.

An irregular fluid collection lies in the laminectomy defect from mid-L2 to mid-L4 with a vertical height of 65 mm and maximum axial dimensions of 31 x 24 mm. This indents the thecal sac behind the L3 vertebral body, without significant compression, but the sac is tightly compressed at the L2–3 disc level, due to a combination of the collection and a possible 5 mm isointense nodule which may be a remnant of the left ligamenturn flavum (Series 6: Image 18).

There is a disc bulge at L1–2 with a mild spinal stenosis but there is no significant thecal or nerve root compression above L2. No significant bone marrow signal abnormality. The cones terminates normally at T12–L1.

Conclusion:

Fluid collection in the laminectomy defect, which is likely to be a seroma, but an infected collection or CSF leak could not be excluded. Compression of the thecal sac at the L2–3 disc level due to a combination of this collection and a possible ligament remnant on the left side.

Dr Greg Hunt
Radiologist.

The report issued by … includes a little more clinical detail than listed on the provided referral form, possibly following direct discussion with the responsible clinicians, but there is no hint of any new neurologic findings.

The formal report is otherwise very similar in content to the blind report that I generated. No other findings were observed on peer review of selected images of the postoperative fluid collection and screws in the L4 vertebra.

[The] report is considered to be of a good standard, with no departure from accepted standard of care.

If referral details had referred to the presence of any new neurologic findings which might suggest complication of screw position, this would have probably prompted a closer inspection of the screws on the scan, but as above, no screw complication is visible on this scan or expected to be shown with MRI.

CT Guided Lumbar Aspiration — 27/06/2019

Provided clinical details once again describe the timing and nature of [Mrs B's] surgery. A mention is also made of 'ongoing/new' neurology, but the nature of the new findings

has not been detailed. If detail of the 'new' neurologic finding had been available, this might have been a trigger for close inspection of screw position on the images.

In preparation for drainage of the postoperative collection in the spine, high-quality CT images have been obtained. As expected, there is image artefact from the metalware, but this is less troublesome than on MRI and screw position is shown. Further images reveal satisfactory needle placement for fluid drainage which allowed completion of the required procedure.

Also included with this study is a series of sagittal images, reconstructed with an algorithm to enhance bone detail. These images would not have been available to the radiologist at the time of the drainage procedure. They would have been created from source data by the medical imaging technologist, maybe only after [Dr A] had subsequently become concerned about screw placement on clinical grounds.

They may or may not have been present when the study was presented to the radiologist for reporting some time after the completion of the procedure.

My blind report is as follows:

Indication:

Postop. lumbar decompression and fusion at L2–3 and L3–4. Ongoing sensory and motor neurology, with fluid collection on MRI and indentation of the thecal sac at L2–3. For fluid sampling and decompression.

Technique:

Non-contrast prone imaging for localisation and needle placement.

Findings:

Preliminary images confirm satisfactory placement of the spinal fixation. There is interbody fusion at L4–5 and the L5–S1 facet joints are fused.

The sampling needle tip has been placed just medial to the left L2–3 facet joint, close to the edge of the postoperative fluid collection shown on yesterday's MRI.

Conclusion:

Satisfactory placement of the sampling/drainage needle, laterally in the postoperative fluid collection demonstrated on MRI.

(NB: Comments on the ease of needle placement, patient comfort and symptomatic response cannot be made from images only)

Dr Greg Hunt
Radiologist

My belief, supported by the comments of my colleagues is that during the planning and performance of the drainage procedure, all attention would have been directed toward the target fluid collection and its safe drainage. Any specific attention to screw position would be secondary and not addressed at the time of the procedure.

Review of the sagittal bone reconstructions in particular reveals satisfactory placement of the left L4 pedicle screw, but the screw on the right is lower and passes through the right L4–5 neural foramen where it could be affecting the right L4 nerve root. I did not appreciate this when preparing my blind report.

The report issued by [the radiology consultant and radiology registrar] describes satisfactory performance of the drainage procedure, but makes no mention of screw placement.

When the procedure report was dictated, the additional bone reconstructions may or may not have been present. In either event, without any specific clinical question about screw position, close inspection of screw position on every image would probably not take place. Nevertheless, the diagnosis of a misplaced screw was possible at the time of reporting.

Accordingly I believe that the report issued by [the radiology consultant and radiology registrar] does depart from the standard of care to a mild degree. This is mitigated by the absence of referral data to suggest neurological findings that might imply suboptimal screw placement. It is also possible that the sagittal bone reconstructions may not have been provided for reporting.

I believe it would be good practice for bone reconstructions to be created in three planes in all cases of musculoskeletal intervention with CT. These should be available at the time of procedure reporting and radiologists should adopt the practice of systematically reviewing these before a report is issued.

X-Ray Lumbar Spine — 28/06/2019

Referral details provided for this study are identical to those provided for the MRI scan from two days before. They describe the timing and nature of the recent surgery and ‘ongoing neurology’. This implies persistence of neurologic findings that were present before the operation, with no new findings to suggest nerve root injury.

Satisfactory frontal and lateral plain film images have been obtained. Evaluation of the lumbosacral junction is not optimal but the new metalware is well shown and side markers are present.

My report is as follows:

> ***Indication:***
>
> *Postop. lumbar decompression and fusion at L2–3 and L3–4. Ongoing neurology at seven days.*

Technique:

Plain frontal and supine lateral views.

Findings:

Posterior rod fusion has been performed from L2 to L4 with disc cages in position at L2–3 and L3–4. The L3–4 disc space is slightly reduced, but overall alignment and appearances are satisfactory. There have been laminectomies from L2 to L5 and there is an old screw remnant at S1 on the left.

The lumbosacral junction has not been formally examined, but at other levels, bony alignment and density are normal. Disc and vertebral body height are preserved and no significant abnormality is shown. Incidental note is made of hypoplastic 12' ribs.

Conclusion:

Postoperative changes with no visible complication. No significant findings.

Dr Greg Hunt
Radiologist

The report issued by [Dr D] matches my blind report in all significant respects, but when this study was reviewed by seven specialist colleagues, four of them remarked on asymmetry of the placement of screws at L4 and one went on to confidently diagnose a misplaced screw on the right.

The majority view was that L4 screw asymmetry was worthy of comment to give the referring practitioner pause to consider the possibility of suboptimal screw placement.

Accordingly, the report for this study is a mild departure from the accepted standard of care, once again mitigated by the absence of any referral detail to suggest neurologic findings suspicious for a misplaced screw. Additional mitigation is that in most radiologists' experience, orthopaedic surgeons usually consider their own evaluation of metalware position to be more clinically relevant.

Conclusion

Based on the information and images provided, radiology reports provided for [Mrs B's] interoperative lumbar spine imaging from 19 June 2018 and subsequent MRI scan from 26 June 2018 are within the expected standard of care for these procedures. Reports for the procedural CT scan on 27 June 2018 and plain film examination from 28 June 2018 are mild departures from the expected standard of care, with mitigating factors as outlined.

The creation of three-plane bone reconstructions during interventional CT procedures and having them available at the time of radiologist reporting could lessen the chances of similar outcomes in the future, particularly if reporting radiologists are disciplined in reviewing all of these additional images.

Appropriate side markers on image intensifier studies would not have altered outcomes in this case, but should be considered as good practice. All such studies should be reviewed by a radiologist and reports generated as appropriate.

New clinical findings in a postoperative patient should prompt particular attention to placement and appearances of newly implanted devices, with a relatively low threshold for alerting the referrer to a possible complication. If new symptoms had been alerted in postoperative radiology referrals, the chance of early detection would have been increased.

Dr Greg Hunt, 20 June 2020."