Neutral Citation: [2017] EWHC 1900 (QB)

Case No: A90BM164

IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
BIRMINGHAM DISTRICT REGISTRY

Before :
MR EDWARD PEPPERALL QC
SITTING AS A DEPUTY HIGH COURT JUDGE

- -

Between :

SUZANNE LANE

Claimant

- and -

(1) WORCESTERSHIRE ACUTE HOSPITALS NHS TRUST
(2) UNIVERSITY HOSPITALS BIRMINGHAM NHS FOUNDATION TRUST

Defendants

- -

Dr Simon Fox QC (instructed by **Anthony Collins Solicitors LLP**) for the **Claimant**
Mr John Coughlan (instructed by **Bevan Brittan LLP**) for **the Defendants**

Hearing dates: 16, 17, 18 & 19 January, 4 & 5 April and 5 May 2017

Judgment provided in draft: 15 June 2017
Judgment handed down: 24 July 2017

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Approved Judgment

I direct that pursuant to CPR PD39A para 6.1 no official shorthand note shall be taken of this judgment and that copies of this version as handed down may be treated as authentic.

MR EDWARD PEPPERALL QC:

1. On 30 September 2010, Mrs Suzanne Lane suffered a myocardial infarction due to a blocked right coronary artery. She was treated by a rescue angioplasty at the Queen Elizabeth Hospital in Birmingham ("the QE") before being transferred back to the Alexandra Hospital in Redditch ("the Alexandra") during the morning of 1 October 2010.

2. During the early hours of Saturday 2 October 2010, Mrs Lane developed ischaemia (a restriction in blood supply) to her right arm. This condition was correctly diagnosed by Dr Dobson, a medical registrar at the Alexandra, at 02:30, but she was not transferred back to the QE until about 08:50. The consultant vascular surgeon, Mr Phil Nicholl, performed a brachial and radial thrombectomy (a surgical procedure to clear the clots that had formed, in this case in Mrs Lane's brachial and radial arteries) under local anaesthetic at 21:10 in order to reperfuse the limb.

3. Unfortunately, the clot in the radial artery recurred and, despite further surgery on 13 October, Mrs Lane developed dry gangrene. Her right arm was subsequently amputated above the elbow on 9 November 2010.

~~4.~~ By this clinical negligence claim, Mrs Lane originally complained of negligence by both the Worcestershire Acute Hospitals NHS Trust and the University Hospitals Birmingham NHS Foundation Trust in respect of the treatment of her ischaemic limb at the Alexandra and the QE respectively. In his helpful written closing submissions, Dr Fox QC identified the three allegations of negligence that are now pursued by the Claimant:

   4.1 First, Mrs Lane alleges that the advice given by the cardiology registrar at the QE at 02:30 on 2 October 2010 was negligent.

   4.2 Secondly, she alleges that Mr Nicholl was negligent in not taking her to theatre at 12:40 on 2 October and in delaying surgery until 21:00.

   4.3 Thirdly, she alleges that Mr Nicholl was negligent in not carrying out thrombectomy of the ulnar artery and completion angiography.

5. Accordingly, there is no longer any criticism of the doctors at the Alexandra in following the advice given by the QE's cardiologist at 02:30. Indeed, in the course of his oral closing submissions, Dr Fox confirmed that he did not pursue the case against the Worcestershire Trust. Further, the pleaded allegations of a negligent failure to carry out angiography before surgery and of the failure to perform a fasciotomy have been abandoned.

6. The QE denies negligence. In short, it responds that Mrs Lane was seriously ill and that her cardiac condition remained unstable. It argues that it was reasonable to seek to optimise Mrs Lane's medical condition before transferring her to the QE and then before carrying out surgery. While accepting that the ischaemia was a medical emergency that required vascular surgery, the Trust contends that Mrs Lane presented a significant surgical risk

and that it had to prioritise *"life over limb."* As to the operation, the QE argues that it was reasonable not to carry out completion angiography, especially in a seriously ill cardiac patient, and that it is not standard vascular practice to clear the ulnar artery upon successful thrombectomy of the radial artery.

THE LAW

STANDARD OF CARE

7. Inevitably, one must start any analysis with reference to McNair J.'s classic statement of the law in the course of his directions to the jury in Bolam v Friern Hospital Management Committee [1957] 1 W.L.R. 583, at 587:

> "[A doctor] is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a responsible body of medical men skilled in that particular art … Putting it the other way round, a man is not negligent, if he is acting in accordance with such a practice, merely because there is a body of opinion who would take a contrary view."

8. To similar effect, Lord Scarman said in Maynard v West Midlands Regional Health Authority [1984] 1 W.L.R. 634, at 639:

> "… a judge's 'preference' for one body of distinguished professional opinion to another also professionally distinguished is not sufficient to establish negligence in a practitioner whose actions have received the seal of approval of those whose opinions, truthfully expressed, honestly held, were not preferred. If this was the real reason for the judge's finding, he erred in law even though elsewhere in his judgment he stated the law correctly. For in the realm of diagnosis and treatment, negligence is not established by preferring one respectable body of professional opinion to another. Failure to exercise the ordinary skill of a doctor (in the appropriate speciality, if he be a specialist) is necessary."

9. In Bolitho v City & Hackney Health Authority [1998] A.C. 232, the House of Lords considered whether the Bolam test required a judge to accept the views of a truthful body of expert professional opinion even where he was unpersuaded of its logical force. Lord Browne-Wilkinson (with whom all other law lords agreed) accepted, at 241G:

> "the court is not bound to hold that a defendant doctor escapes liability for negligent treatment or diagnosis just because he leads evidence from a number of medical experts who are genuinely of opinion that the defendant's treatment or diagnosis accorded with sound medical practice."

10. As Lord Browne-Wilkinson pointed out, McNair J. spoke of a *"responsible body"* of medical opinion (at p.587) and of a *"competent reasonable body of opinion"* (at p.588) in Bolam. Equally, in Maynard, Lord Scarman referred to a *"respectable"* body of professional opinion. Accordingly, Lord Browne-Wilkinson concluded, at p.241H:

> "The use of these adjectives – responsible, reasonable and respectable – all show that the court has to be satisfied that the exponents of the body of opinion relied upon can demonstrate that such opinion has a logical basis."

11. Lord Browne-Wilkinson was not seeking to depart from Bolam but to explain that, on a proper application of the Bolam test, a judge might find a body of opinion not to be responsible, reasonable or respectable if it could not withstand logical analysis. This does, however, require some care. While one might expect a highly eminent, respectable and responsible expert only to express reasonable opinions that withstand logical analysis, this does not necessarily follow. Accordingly, such an expert's opinions are not to be accepted by the court without proper analysis. Equally if, unusually, such an expert expresses a view that cannot withstand analysis, he or she is not to be branded as no longer respectable or responsible.

12. I therefore agree with the observations of Green J. in C v North Cumbria University Hospitals NHS Trust [2014] EWHC 61, at [25](vi)-(vii):

> "(vi) Responsible/competent/respectable: In Bolitho Lord Browne-Wilkinson cited each of these three adjectives as relevant to the exercise of assessment of an expert opinion. The judge appeared to treat these as relevant to whether the opinion was 'logical'. It seems to me that whilst they may be relevant to whether an opinion is 'logical' they may not be determinative of that issue. A highly responsible and competent expert of the highest degree of respectability may, nonetheless, proffer a conclusion that a court does not accept, ultimately, as 'logical'. Nonetheless these are material considerations …
>
> "vii) Logic/reasonableness: By far and away the most important consideration is the logic of the expert opinion tendered. A judge should not simply accept an expert opinion; it should be tested both against the other evidence tendered during the course of a trial, and, against its internal consistency."

13. As I explain below, this case turns on the proper weighing of the risks and benefits of surgery in an unstable patient. Lord Browne-Wilkinson considered such a case in Bolitho at p.242A:

> "… in cases involving … the weighing of risks against benefits, the judge before accepting a body of opinion as being responsible, reasonable or respectable, will need to be satisfied that, in forming their views, the experts have directed their minds to the question of comparative risks and benefits and have reached a defensible conclusion on the matter."

14. Lord Browne-Wilkinson therefore accepted that there are cases in which the court might properly find negligence even where a body of professional opinion sanctioned the doctor's practice. He considered that such cases would be rare. To that end, he observed at p.243B:

> "In the vast majority of cases the fact that distinguished experts in the field are of a particular opinion will demonstrate the reasonableness of that opinion. In particular, where there are questions of assessment of the relative risks and benefits of adopting a particular medical practice, a reasonable view necessarily presupposes that the relative risks and benefits have been weighed by the experts in forming their opinions. But if, in a rare case, it can be demonstrated that the professional opinion is not capable of withstanding logical analysis, the judge is entitled to hold that the body of opinion is not reasonable or responsible.
>
> "I emphasise that in my view it will very seldom be right for a judge to reach the conclusion that views genuinely held by a competent medical expert are unreasonable. The assessment of medical risks and benefits is a matter of clinical judgment which a judge would not normally be able to make without expert evidence. As the quotation from Lord Scarman [in Maynard] makes clear, it would be wrong to allow such assessment to deteriorate into seeking to persuade the judge to prefer one of two views both of which are capable of being logically supported. It is only where a judge can be satisfied that the body of expert opinion cannot be logically supported at all that such opinion will not provide the benchmark by reference to which the defendant's conduct falls to be assessed."

15. In the recent case of Muller v King's College Hospital NHS Foundation Trust [2017] EWHC 128 (QB), [2017] P.I.Q.R. P10, Kerr J. put the Bolitho point thus, at [79]:

> "I must not, therefore, reject Dr Foria's view unless I am persuaded that it does not hold water, in the senses discussed in Lord Browne-Wilkinson's speech in Bolitho and developed in other cases: that is to say, if it is untenable in logic or otherwise flawed in some manner rendering its conclusion indefensible and impermissible."

16. There was some argument before me as to the rarity of what has often been referred to as the Bolitho exception. In my judgment, such argument is sterile. No doubt counsel saw some forensic advantage in seeking to persuade me that a Bolitho finding is rare (as Mr Coughlan emphasised) or rather more common since 1998 (as Dr Fox suggested), but my task is properly to apply the Bolam test as further explained in Bolitho to this case without worrying about whether that approach leads me to a commonplace conclusion. That said, there are undoubtedly examples in the law reports of a so-called Bolitho finding, although judges have repeatedly emphasised the rarity of such conclusion: most obviously, Lord Browne-Wilkinson (above) in Bolitho itself, but see also, for example, Brooke L.J. in Wisniewski v Central Manchester Health Authority [1998] P.I.Q.R. 325, at 336.

17. It follows from this analysis that Dr Fox correctly submits that a doctor cannot avoid liability simply by calling evidence from a respectable expert supporting his practice. To do so would be to delegate the court's decision to the expert. The court must, as Dr Fox argues, go further and consider whether the practice supported by such defence expert is reasonable, responsible and logical.

18. Equally, Mr Coughlan is right to submit that a logical basis for an expert's opinion is sufficient. Bolitho is not a licence for a judge to prefer one expert's logical opinion over another. The question is not whether Mrs Lane could have received a better standard of care or whether, with hindsight, things could have been done better, but whether the treatment given by these doctors is or is not supported by a responsible body of medical opinion that withstands logical analysis.

19. In my judgment, the correct approach to considering the expert evidence in this case is that helpfully set out by Green J. in the North Cumbria Case, at [25].

SPECIALIST TREATMENT

20. Counsel also addressed me as to the appropriate standard of care in respect of specialist treatment. It was common ground that the law focuses on the activity rather than the identity of the actor. An argument to the contrary was rejected by Mustill L.J. in Wilsher v Essex Area Health Authority [1987] 1 Q.B. 730, at 750E-751D. As Mustill L.J. observed in that passage:

> "it would be a false step to subordinate the legitimate expectation of the patient that he will receive from each person concerned with his care a degree of skill appropriate to the task which he undertakes, to an understandable wish to minimise the psychological and financial pressures on hard-pressed young doctors."

21. Accordingly, a doctor undertaking vascular surgery is held to the reasonable standard of the vascular surgeon. If a medic or a surgeon who specialises in a different area of surgery attempts vascular surgery, he or she cannot be heard to say that the patient cannot expect the level of care to be expected of the averagely competent vascular surgeon.

22. In Wilsher, it was the defendant health authority that sought a lower standard for a junior doctor. In this case, the issue arises because one of the experts, Mr Collin, differentiated in his evidence the standard that he would expect in a district general hospital from the higher standard that he expected in a teaching hospital such as the QE.

23. There is some support in Wilsher for the notion of a higher standard where a unit offers a highly specialised service. At p.751C, Mustill L.J. referred to the standard of *"the averagely competent and well-informed junior houseman … who fills a post in a unit offering a highly specialised service."*

24. Mr Coughlan submitted that here the specialised service was that of vascular surgery and that the law did not impose a higher standard of care upon vascular surgeons working in teaching hospitals than it did upon their colleagues in district general hospitals. Dr Fox submitted that a unit might offer expertise in a sub-specialty such that doctors working in such a unit might owe a higher standard of care. He conceded, however, that there was no

evidence before the court that Mr Nicholls' vascular team at the QE had some discrete specialism in thrombectomy that called for the imposition of a higher standard of care. Accordingly, in my judgment, the argument based upon Mr Collin's evidence on this point fell away and I hold Mr Nicholls to the standard of the averagely competent vascular surgeon undertaking upper-limb thrombectomies.

CAUSATION

25. Mrs Lane claims that but for the QE's negligent management of her ischaemic arm, amputation would have been avoided. There is, as I shall set out below, evidence of a number of cumulative causes of amputation; some of which, it is common ground, were not negligent and others which it is said arose by reason of the QE's negligence.

26. When faced with multiple possible causes of injury, the Court must first consider causation on the balance of probabilities (see Waller L.J. in Bailey v Ministry of Defence [2008] EWCA Civ 883, [2009] 1 W.L.R. 1052, at [46]). Accordingly, the question in this case is whether, on the balance of probabilities, Mrs Lane would have avoided amputation but for the QE's negligence:

26.1 If so, Mrs Lane will have proved her case on causation and can recover damages even if there were other additional non-negligent causes of amputation.

26.2 Equally, if, on the balance of probabilities, the arm would still have been amputated because of the non-tortious causes and without the negligent management then Mrs Lane will have failed to establish liability.

27. In most cases, the issue of causation will be answered on this basis. Indeed, while arguing for opposite results, both counsel urged me to the view that causation could be determined on the balance of probabilities. In the alternative, Dr Fox argued that if, because of the limitations of medical science, the Court cannot determine causation on the balance of probabilities then it may find causation established on the basis of a finding that the QE's negligence made a material contribution to amputation. I do not analyse this submission further because, for reasons that will become apparent below, I find myself able to answer the causation issue on ordinary "but for" principles.

THE EVIDENCE

28. I heard from a number of doctors who had treated Mrs Lane on 1-2 October 2010. First, I heard from three doctors at the Alexandra:

28.1 Dr Dzifa Abban was a consultant cardiologist who saw Mrs Lane at the Alexandra during the morning of 1 October 2010.

28.2 Dr Donna Best was then a second-year core trainee in Acute Internal Medicine. She was working as on-call medic at the Alexandra when she saw Mrs Lane at 23:30 on 1 October and again at around 00:40 on 2 October.

28.3 Dr Chris Dobson was then a final-year specialist registrar in General Internal Medicine and Gastroenterology but has since been appointed as a consultant gastroenterologist in Truro. He was working as the on-call medical registrar at the Alexandra when he saw Mrs Lane at 02:30 on 2 October and diagnosed ischaemia.

29. I also heard from four doctors at the QE:

29.1 Dr Yogesh Raja was then a final-year specialist cardiological registrar but has since been appointed as a consultant interventional cardiologist in Sunderland. He was working on-call at the QE during the night of 1-2 October when he was consulted by the doctors at the Alexandra.

29.2 Dr (now Professor) Russell Smith is a consultant cardiologist. He remains in clinical practice but has since been appointed to an honorary chair in cardiology. He was the consultant responsible for Mrs Lane's coronary care upon her transfer back to the QE on 2 October.

29.3 Mr Kai Leong was then an ST8 specialist registrar in general surgery. He has since completed his surgical training and currently works as a post-CCT fellow. He was the first surgeon to see Mrs Lane upon her transfer back to the QE.

29.4 Mr Phil Nicholl is a consultant vascular surgeon. As already recounted, he carried out the thrombectomy at around 21:15 on 2 October.

30. I then heard from expert witnesses in three different fields of medicine. In each case, I heard the experts in each field back to back. First, I heard the cardiological experts:

30.1 The Claimant's expert, Dr John Caplin, is a consultant interventional cardiologist. He qualified in 1976 and has been a consultant cardiologist since 1990. He retired from NHS practice in 2012 but continues to see patients on a private basis in Hull in addition to his medico-legal practice. As an experienced interventional cardiologist, Dr Caplin has significant experience of carrying out the PCI procedure for acute myocardial infarctions.

30.2 The Defendants' expert, Dr Tim Cripps, is a consultant cardiologist and former Lead Doctor at the Bristol Heart Institute. He qualified in 1980 and has been a consultant cardiologist since 1994. He has a broad cardiological practice but a particular interest in electrophysiology (heart rhythm disorders).

31. I then heard briefly from the anaesthetists:

31.1 The Claimant's expert, Dr Basil Matta, is a consultant in anaesthesia and neuro-critical care at Addenbrooke's Hospital in Cambridge and an associate lecturer at Cambridge University. He has been a consultant since 1996 and is past President of both the Neuroanaesthesia Society of Great Britain & Ireland and the International Society of Neurosurgical Anaesthesiology & Critical Care. He is widely published on neuroanaesthesia.

31.2 The Defendants' expert, Dr Andrew Mortimer, is a consultant in anaesthesia, critical care and acute pain management at the University Hospital of South Manchester. He qualified in 1973 and has been a consultant since 1987. He is a former elected member of the Council of the Royal College of Anaesthetists and the Chairman of the North West Region Speciality Committee in Anaesthesia.

32. Finally, I heard from the vascular experts:

32.1 The Claimant's expert, Mr Jack Collin, qualified in 1968. He is a professorial fellow at Trinity College, Oxford and was a consultant vascular surgeon at Oxford's John Radcliffe Hospital between 1980 and 2010. He has been widely published across a broad range of surgical issues. Much of his career has been academic and general surgical, but increasingly he gravitated towards clinical work and a specialism in vascular surgery.

32.2 The Defendants' expert, Professor Jonathan Beard, qualified in 1979 and has been a consultant vascular surgeon at Sheffield Teaching Hospitals since 1990. He is an honorary professor of surgical education at the University of Sheffield and is widely published on vascular surgery.

33. In reviewing the expert evidence, it is necessary to distinguish between evidence upon which I can make findings of fact such as, for example, the cardiologists' evidence as to the severity of Mrs Lane's cardiac problems, and evidence as to the proper management of this case, which I must approach on a Bolam / Bolitho basis.

ISSUE 1: DELAYED TRANSFER

THE ORIGINAL INFARCTION

34. Mrs Lane was born on 18 July 1953. In September 2010, she had multiple risk factors for ischaemic heart disease, being then a morbidly obese 57-year-old ex-smoker with a family history of premature ischaemic heart disease who suffered both hypertension and elevated cholesterol.

35. At 07:30 on 30 September 2010, Mrs Lane suffered sudden central crushing chest pain. After first attending her GP, Mrs Lane was admitted to the Alexandra at around 15:00. A 12-lead electrocardiogram ("ECG") timed at 15:09 showed clear and significant elevation of the ST segment leading to the diagnosis of inferior ST elevation myocardial infarction.

36. Mrs Lane was immediately treated by thrombolysis (a non-invasive treatment to break down blood clots by administering intravenous drugs). Thrombolysis was not effective and accordingly Mrs Lane was transferred to the QE for emergency interventional cardiac treatment. On admission at the QE, Mr Ludman, a consultant cardiologist, performed a rescue percutaneous coronary intervention ("PCI"), involving the removal of thrombus (blood clots) from the occluded right coronary artery and the insertion of stents to keep the artery open. This procedure involved the insertion of a catheter into

the radial artery at Mrs Lane's wrist, which was then passed up the arm through the brachial artery and into her coronary arteries.

37. Upon Mrs Lane's return to the Coronary Care Unit at the QE, a further ECG at 19:54 showed that the ST elevation had reduced to 4 mm. A note taken by a senior house officer at 21:00 recorded that Mrs Lane had been free of pain since the PCI. A good right radial pulse and good capillary refill were noted in the right hand.

38. There was no significant difference between the cardiologists as to the original infarction:

38.1 Drs Caplin and Cripps agreed, and I find, that the ECG taken before the rescue angioplasty showed ST elevation of 7 mm in the inferior leads and that this was a significant myocardial infarction. Dr Cripps described the ECG as *"horrible"* and vividly explained the seriousness of the ECG findings which, he said, cardiologists would describe as *"tombstone ST elevation."*

38.2 I accept Dr Caplin's evidence that, while one would hope to see a reduction in ST elevation after a PCI, the ECG would often not return to normal immediately. Further he said, and I find, that the expectation was that the elevation would diminish over a few days of a successful intervention, but that any increased elevation would be a matter of concern.

38.3 I also accept Dr Cripps' evidence that this was a partially successful PCI. The distal end of the right coronary artery was still blocked and the ECG remained abnormal. While there might yet be further improvement, Dr Cripps observed, and I find, that these were not favourable markers.

38.4 The two experts agreed, and I accept, that the continuing ST elevation was a sign of damage having been caused, rather than of any continuing cardiac event.

1 OCTOBER 2010

39. On the morning of 1 October, Mrs Lane was transferred back to the Coronary Care Unit at the Alexandra. An ECG at 10:47 showed ST elevation of 2-3 mm. Although I heard from Dr Abban, the consultant cardiologist who saw Mrs Lane that morning, there was not, at that time, any significant new development.

40. An echocardiogram was performed. It reported some historical hypertrophy (thickening) of the left ventricle. The inferior and basal mid-posterior walls of the left ventricle were noted to be hypokinetic (i.e. not moving as they should). The report suggested elevated left ventricular end diastolic pressure ("LVEDP").

41. Matters started to deteriorate through the night of 1-2 October 2010. The evolving medical emergency was dealt with by Dr Best and her registrar, Dr Dobson, who were the key witnesses from the Alexandra. I was impressed by

both doctors. They were clear witnesses who presented as conscientious and competent doctors. I accept their evidence as reliable. They each made detailed and accurate notes of their attendances during the night of 1-2 October. That said, I accept Dr Dobson's observation that it is not always practical to make a full note of every aspect of a patient's condition. Medical notes made by busy on-call doctors in the midst of a medical emergency and with responsibility for dozens of other patients cannot descend to every detail. They must record the essential findings and are designed to be read by fellow medical professionals rather than pored over in a court room by lawyers with all the leisurely pace of a High Court trial. Accordingly, medical notes may well fail to spell out something that would be obviously implicit to the informed reader.

42. The first evidence of deterioration was a further ECG at 22:37. ST elevation had worsened and was back up to 4 mm. The ECG was also annotated to record that Mrs Lane was *"clammy +++ and restless",* but not in pain. The nursing staff called for a medical opinion and Dr Best saw Mrs Lane at about 23:30.

43. Dr Best confirmed the contents of her clear note. She noted the worsening ST elevation on Mrs Lane's ECG and also recorded that Mrs Lane was feeling hot and *"clammy ++"*. There was no chest pain or shortness of breath, but Mrs Lane was disorientated in place. Her pulse was 60 bpm and her blood pressure was 105/50 mmHg. Dr Best discussed the patient with Dr Dobson, the on-call medical registrar at the Alexandra, and with Dr Raja, the on-call cardiology registrar at the QE. Dr Raja recommended a GTN infusion and asked Dr Best to fax the ECG to him. He advised that since there was no chest pain, Mrs Lane was *"not for immediate transfer"* but that a repeat ECG should be taken in 10-15 minutes and faxed over to the QE.

44. Dr Raja gave brief evidence about his involvement at 23:30 and sought to justify his recommendation that Mrs Lane be given a GTN infusion. In fact, it is now common ground that Mrs Lane was not actually given a GTN infusion. Accordingly, both Dr Raja's justification and Dr Caplin's criticism of Dr Raja's advice about the infusion are irrelevant. In fairness to Dr Raja, it is, however, appropriate to record that he fully accepted that GTN would be contraindicated in a hypotensive patient. The short point that he made was that there was no hypotension at 23:30 and the recommended prescription might have assisted in reducing the ST elevation.

45. Dr Cripps explained, and I accept, that the echocardiogram indicated a diseased left ventricle that was not functioning properly, and that the heart was struggling to deal with fluid balance. If this got worse, Dr Cripps said that there was a risk of pulmonary oedema (the lungs filling with fluid). In addition, the echocardiogram reported some involvement of the right ventricle. Dr Cripps explained that there was some right ventricular involvement in 30% of cases of inferior myocardial infarction.

46. Drs Cripps and Caplin agreed that there was some sort of active cardiac event during the night of 1-2 October:

46.1 Dr Caplin said that it was difficult to say whether it was an acute myocardial infarction or further evidence of coronary ischaemia. He made the point that, by contrast with the position on admission on 30th, Mrs Lane was not suffering chest pain. He agreed with the treating doctors that, at this stage, this was a case for conservative management.

46.2 Dr Cripps disagreed with Dr Caplin that there was any significance in the fact that Mrs Lane was not suffering chest pain whereas she had on 30th. In Dr Cripps' view, it was likely that Mrs Lane was suffering an extension of her myocardial infarction. In cross-examination, he did not distinguish between an extension and re-infarction. He agreed that it was almost impossible to differentiate between a further infarction and ischaemia, but said that the deterioration of Mrs Lane's condition and her subsequent drop in blood pressure indicated that this was an extension of the infarction and not just ischaemia.

47. Whatever the precise mechanism, I accept the clear evidence that Mrs Lane was suffering some further cardiac event from about 22:30.

2 OCTOBER: THE ALEXANDRA

48. At 00:40 on Saturday 2 October, Dr Best discussed the case again with Dr Raja who had, in turn, discussed Mrs Lane with Dr Smith, the on-call consultant cardiologist at the QE. The cardiologists at the QE had reviewed the angiogram and ECGs. They recommended conservative management only.

49. Dr Dobson saw Mrs Lane at 01:00 but, finding her asleep, left her to rest. On his return at around 02:30, Dr Dobson found the patient to be mildly confused, drowsy and restless, but noted that she had been given diamorphine and zopiclone (a sleeping tablet). Mrs Lane was complaining of a heavy right arm and was generally clammy and cold. Dr Dobson could not record the blood pressure in her right arm but noted that it was 91/47 "at best" in the left arm. Her pulse had fallen to 47 bpm, and was not palpable in the right radial and brachial arteries. Her oxygen saturation (the percentage of oxygen-saturated haemoglobin relative to total haemoglobin in the blood) was low at 91% (normal being 95% or higher). Further, Dr Dobson noted her unstable ECG.

50. There is no doubt, and I find, that Dr Dobson's examination at 02:30 identified a number of significant medical findings:

50.1 Mrs Lane was bradycardic (i.e. her heart rate was unusually slow).

50.2 She was hypotensive. Systolic pressure (the maximum pressure exerted when the heart beats) was less than 100 mmHg; diastolic pressure (the minimum pressure between beats) was also low but Drs Caplin and Cripps explained that the systolic was more important in this situation.

50.3 Oxygen saturation levels had fallen below normal.

50.4 There was evidence of some ongoing cardiac event, as evidenced by the worsening ECG and by Mrs Lane's presentation as clammy and cold.

50.5 There was evidence of right arm ischaemia.

51. Dr Dobson discussed the patient with an unnamed cardiology registrar at the QE. Although he did not give any evidence about the 02:30 advice, I am satisfied that the registrar was Dr Raja:

51.1 It was Dr Raja who had discussed Mrs Lane's case with Dr Best earlier in the night.

51.2 Dr Raja was working on-call at the QE until 09:00 on 2 October.

51.3 There would have been only one cardiological registrar on-call at the QE that night.

52. While I do not have evidence from Dr Raja about the advice that he gave, I do have the benefit of Dr Dobson's note and of Dr Dobson's own evidence on the issue. The note recorded that Dr Raja advised that dissection usually occurred at the time of cannulation of the artery. Dr Dobson's note of his recommendation read:

"Suggests ↑ intravascular volume. If still ↓ pulse then for CTA here"

53. Accordingly, Dr Raja first expressed an opinion as to the likelihood of the PCI being responsible for the formation of thrombus. Whether that view was right or wrong is not, in my judgment, material. The issue was about how to manage this acutely ill cardiac patient with an ischaemic arm rather than establishing the precise mechanism that had led to the vascular problem.

54. Turning to the recommended management of this patient, Dr Dobson explained that the advice was concerned with monitoring the pulses in Mrs Lane's right arm with a view to her being transferred to the QE for a CT angiogram if they remained low. While I acknowledge that Dr Dobson's note of the cardiological advice does not specifically refer to an improvement in right-arm pulses, this is, in my judgment, an example of a note catching the essence of a conversation between two experienced registrars rather than descending into a point of detail that they might regard as obvious. Dr Dobson had found and recorded that there were no pulses in the right arm and it is reasonable to infer that the CT angiogram would have been required to visualise the arteries in the ischaemic arm. Accordingly, I accept that the relevant pulses were those in Mrs Lane's right arm.

55. Having correctly diagnosed ischaemia in the right arm, I find that Dr Dobson recognised that the limb presented a surgical emergency and would require Mrs Lane's ultimate transfer back to the QE (there apparently being no facility for vascular surgery at the Alexandra). Although not formally recorded, I am satisfied that Dr Dobson's treatment was focused on optimising her cardiac condition so that her subsequent transfer would involve less risk. Given her cardiac status, I am in no doubt that Dr Dobson acted appropriately by seeking, and then following, cardiology advice from the QE. As I have already indicated, the cardiological advice is said to have been negligent, but Dr Dobson is rightly no longer criticised for following it.

56. In an effort to increase the intravascular volume in accordance with Dr Raja's advice, Dr Dobson prescribed an intravenous infusion of volplex (a colloidal fluid that gives a bigger fluid boost than a simple saline infusion). The first 500-ml infusion was given between 03:00 and 03:30, and a further 500 ml was given between 04:45 and 05:15. Finally, a 1-litre saline infusion was given between 07:10 and 08:10. The observation chart recorded that the oscilloscope showed a junctional rhythm (i.e. the sinus node, the heart's natural pacemaker, had shut off and there was no P wave).

57. Dr Fox cross-examined the clinicians at the Alexandra as to their failure to document any diagnosis of RVI (right ventricular involvement in Mrs Lane's myocardial infarction). I agree with Mr Coughlan that it is not obvious where this allegation took Dr Fox. There is no pleaded allegation of an alleged failure properly to diagnose and treat RVI at the Alexandra; indeed the case was not pursued against the Worcestershire Trust by the time of closing submissions.

58. Dr Fox asserted that a diagnosis of RVI was important because it was necessary to ensure adequate preload (i.e. fluid) in a patient with RVI. Indeed, he referred me to a paper "Right Ventricular Infarction – Diagnosis & Treatment" by Haji and Movahed published in Clinical Cardiology in 1999. The paper concludes that recognition of RVI is important because it is associated with considerable immediate mortality. Proper management includes volume loading to maintain adequate right ventricular preload.

59. In cross-examination, Dr Dobson accepted that he had not recorded a diagnosis of RVI. He rejected, however, the suggestion that that was because RVI was not in his mind. He responded, with appropriate caution given that that RVI was not recorded in his notes, that that was probably not correct given that he was aware of right-sided involvement from the angiogram and right-sided leads were being used on the ECG. In any event, Dr Dobson responded that his management, namely increasing Mrs Lane's intravascular volume, was the standard management for RVI.

60. I accept that, on the balance of probabilities, Dr Dobson was aware of RVI, but regard the issue as immaterial. All that I draw from the academic paper is that Dr Raja was right to advise that attempts be made to increase Mrs Lane's intravascular volume and, secondly, that Mrs Lane was a high-risk patient.

61. Dr Dobson made a further long retrospective note at 07:30. He noted that there was no blood pressure response to volplex. The observation chart recorded blood pressure as low as 75/30 at 05:00 and 80/60 an hour later and a pulse of 43-44. Plainly, Mrs Lane remained both hypotensive and bradycardic.

62. Dr Dobson discussed the case first with Dr Barbar, the consultant on-call physician, who recommended an angiogram of the ischaemic limb by CT scan. He next spoke to a consultant radiologist who advised that a CT angiogram could not be done of the arm. Dr Dobson discussed matters again with Dr Barbar who referred him for cardiological and vascular opinion.

63. Dr Dobson spoke to a vascular registrar at the QE who recommended a transfer into the QE for vascular review. He then discussed the patient again with Dr Raja who expressed concern that Mrs Lane was not filled enough and that the transfer of a hypotensive patient was a risk. Dr Dobson recorded that, whilst speaking to the cardiologist, the nursing staff informed him that the right arm was now *"blue and mottled."* Dr Dobson examined the arm and confirmed this finding and that this was a new development since 06:30. Dr Raja asked for a surgical review.

64. The next entry recorded the surgical assessment. The reviewing surgeon found a mottled right forearm and hand with blue fingertips. The right arm was markedly cold compared to the left and no radial or ulnar pulse could be felt. Grip power remained present but was reduced in the right arm.

65. Dr Dobson made a further note at 08:10 recording that Mrs Lane had now been accepted for transfer to the QE, but the cardiologist wanted a medical consultant to approve the transfer. Dr Dobson discussed the patient again with Dr Barbar, who agreed that Mrs Lane was safe for transfer. Asked whether the cardiological registrar was the only person putting a hold on the transfer process, Dr Dobson disagreed explaining that the clinical picture was putting a hold on transfer. He said that the patient needed to be stabilised and that if she had been pushed into acute left ventricular failure, he does not think that she would have survived.

66. Ambulance records show that the ambulance was called at 08:15. The ambulance arrived minutes later and left the Alexandra at around 08:50. It is common ground that there was a paramedic on board, but no doctor.

67. Dr Cripps said, and I accept, that from the point when Mrs Lane's blood pressure dropped at about 01:00, she was in cardiogenic shock, which he defined as a drop in blood pressure caused by a patient's cardiac status. Dr Cripps considered the onset of cardiogenic shock to be a significant development. Further, he explained that hypotension was the clinical manifestation of RVI. In cross-examination, Dr Caplin accepted that there was evidence of cardiogenic shock.

THE CASE FOR TRANSFER

68. Against these findings of fact, I turn to consider the expert evidence on this first issue.

The cardiological evidence

69. Dr Caplin considered that transfer back to the QE for vascular surgery was mandated following the diagnosis of an ischaemic right arm at 02:30. He told me in his oral evidence that Mrs Lane's cardiac status was *"precarious",* but that she was nevertheless fit for transfer. Of the contrary view, Dr Caplin added:

> "It is unreasonable to argue that there was a concern of 'life over limb.' Mrs Lane was not in chest pain and she remained haemodynamically stable, and the potential risk to Mrs Lane's limb which subsequently occurred, should have been considered in any risk vs. benefit analysis."

70. Dr Cripps disagreed. He observed, at paras 23 and 31 of his report, that Mrs Lane was haemodynamically unstable, bradycardic, hypotensive and with low oxygen saturations. He considered that appropriate treatment had been given for RVI and added:

> "In my opinion a reasonable body of opinion would agree, in view of the diagnosis of right ventricular infarction, with treatment for a few hours until the morning with intravenous fluids in the hope that improved blood pressure would restore flow to the arm."

71. In the joint report, Dr Cripps added that transfer at 02:30 carried a significant risk of life-threatening deterioration. He said that the advice to try increasing the intravascular volume before considering transfer was reasonable and logical in view of the chance that such treatment might restore blood flow to the arm, the fact that it was in any event the correct treatment for RVI and the risk of immediate transfer.

72. Dr Cripps suggested that there was a range of approaches. Specifically, it would have been reasonable to have arranged for an immediate transfer, as Dr Caplin insisted. Equally, Dr Cripps considered that it was also reasonable to seek to improve Mrs Lane's cardiac condition in order to make both transfer and subsequent surgery safer. While insisting that immediate transfer was mandated, Dr Caplin accepted in cross-examination that increasing the fluids could help stabilise the patient for transfer. Further, he accepted that it was possible that she had only been as fit for transfer as she was on the morning of 2 October because she had been given fluids in the small hours.

73. The two experts agreed that the cardiologist's insistence that Dr Dobson should seek a surgical review before transfer was not necessary. Dr Cripps agreed in cross-examination that Mrs Lane plainly required to be transferred at that point and that there was no logical basis for requiring this local surgical view. That said, he pointed out that any delay was short. Dr Cripps did not, however, consider it unreasonable that the registrar had suggested to Dr Dobson that he should have a consultant medical view given the risks involved in this transfer. Furthermore, this simply required a phone call and would not have introduced any delay.

The anaesthetic evidence

74. The anaesthetists expressed contrary views as to the likely effectiveness of administering intravenous fluids. Dr Mortimer concluded that the administration of fluids was a *"reasonable initial treatment"* while Dr Matta considered such treatment to have been *"extremely unlikely"* to have improved either cardiac condition or blood flow to the ischaemic limb. Ultimately, the vascular benefit is a question for the vascular experts. Dr

Matta added that, if this had been the objective before transfer, then the proper treatment was to have started inotropes, inserted a pacing wire and, perhaps, even instituted mechanical ventilation.

75. The anaesthetists agreed that transfer at or about 02:30 involved some risk to Mrs Lane's cardiac status, but that if the decision had been made to operate at any time after 02:30, Mrs Lane could have been transferred and anaesthetised with appropriate support and monitoring. Their respective positions on transfer are best summarised by the following passage in their second Joint Report:

> "Dr Matta is of the opinion that Mrs Lane could have been transferred if the decision was for her to have surgery. If needed, she could have had supportive treatments such as pacing wire (or external pacing pads), inotropes and even ventilation (if she was hypoxic). There are always risks to transferring patients, but on balance, the risk of further limb ischaemia outweighed any potential risk of the transfer."
>
> "Dr Mortimer is of the opinion that Mrs Lane was not sufficiently stable, but if she had been supported with [a] pacing wire (or external pacing pads), inotropes and even ventilation (if necessary) she could have been transferred. However, this would have converted her nursing care from level 1 (ward based) to level 3 (critical care) and the need for an intensive care bed."

The vascular evidence

76. Mr Collin and Professor Beard each referred to the rough rule of thumb that was put to the clinical witnesses that surgery within 6 hours of the onset of total ischaemia should save a limb but that, after a delay of 12 hours or more, it becomes likely that there will be a loss of some tissue or amputation. They explained that this rule was actually derived from experience of lower-limb ischaemia. They agreed that upper limbs could tolerate ischaemia for longer periods but that there was no published data to assist with assessing the length of time. As their evidence developed, it was evident that one of the reasons for the difference is that there is a rich collateral blood supply around the shoulder and the elbow such that there is often some blood flow into the forearm even when the brachial artery is blocked.

77. Mr Collin considered that there had been a *"prolonged delay"* from the point of occlusion of the brachial artery to surgery. He said that, from 02:30 onwards, the need for emergency vascular surgery should have been apparent to any doctor and that surgery should have been performed within 6 hours in order to prevent irreversible ischaemic injury. Against this, Professor Beard considered that it would not have been appropriate to have attempted a brachial embolectomy at Redditch, and presumably still less to transfer Mrs Lane for such surgery at the QE. In his view, improving Mrs Lane's life-threatening cardiac condition was clearly the priority.

Analysis

78. Since the criticism is made of Dr Raja's cardiological advice, I start with, and principally focus upon, the cardiological evidence. I was generally impressed

by both cardiologists. In each case, I reject many of the criticisms made of the two experts. Specifically, I reject many of the points that Mr Coughlan made in a sustained attack upon Dr Caplin's evidence:

78.1 I reject the suggestion that Dr Caplin had inappropriately rushed to criticism of Dr Raja's advice to give a GTN infusion to Mrs Lane. Such infusion was contra-indicated in a patient with RVI and led the Claimant to plead the administration of the infusion as a central plank of the case at paras 24(a)-(f) of the original Particulars of Claim. In cross-examination, Dr Caplin explained that he had not originally had the drug charts and had assumed that the recommended GTN infusion had been given to Mrs Lane. In my judgment, it was not unreasonable to have assumed that the recommended GTN infusion had been administered and then to withdraw the allegation when it became clear that it had not.

78.2 I do not consider that the criticism that Dr Caplin had changed his position on the importance of hypotension when he learnt that the GTN infusion had not been given is made out on the papers before me.

78.3 I cannot properly assess Mr Coughlan's argument that Dr Caplin's late criticism of the fluid management (first raised about a fortnight before trial) was wrong in principle. Since I did not allow late re-amendment of the Particulars of Claim to plead a new case on the basis of inadequate fluid management, I have neither had the evidence nor the argument that would have been required to determine whether the allegation was sound.

78.4 I reject Mr Coughlan's alternative argument that, even if right, the fluid-management point should have been identified from the start. As to this, Dr Caplin said, and I accept, that he had only been alerted to the fluid charts by Mrs Lane's legal team shortly before the point was taken.

78.5 I am not in the slightest concerned by Dr Caplin's recitation of a form of words that was plainly derived from the Bolam and Bolitho cases. There can be no objection to counsel asking an expert to apply a particular legal test, and I am quite satisfied that the opinions expressed by Dr Caplin remained entirely his own.

78.6 I was not troubled by the modest errors made by Dr Caplin in quoting medical entries. Such errors did not, in my judgment, affect the substance of Dr Caplin's opinion.

78.7 I reject the suggestion that Dr Caplin fell into the trap of becoming an advocate in the Claimant's cause. Both counsel had robust exchanges in cross-examination with the other's cardiological and vascular witnesses and, like others, Dr Caplin firmly defended his own expert opinion.

78.8 I reject the criticism that Dr Caplin failed to offer a range of opinion. Dr Caplin confirmed that he understood that he was bound to offer a range of opinion where appropriate, but explained that there would not, in his view, be a range of opinion among interventional cardiologists in respect of the issues in this case. While I might, on analysis, reach a contrary conclusion, I accept that this was Dr Caplin's professional view.

79. On the other side of the balance sheet, I reject many of Dr Fox's criticisms of Dr Cripps:

79.1 I do not consider that Dr Cripps' particular expertise in electrophysiology undermined his expertise to give evidence in this case, or that I should favour Dr Caplin for his greater experience in interventional cardiology. Both men are enormously experienced consultant cardiologists and are very well qualified to give expert evidence on the relatively straightforward cardiac issues in this case.

79.2 In the absence of a documented diagnosis of RVI at the Alexandra, Dr Fox criticised Dr Cripps' assumption that the clinicians were treating RVI. Pressed on the point, Dr Cripps memorably suggested that some things are so obvious that they are not recorded by busy clinicians. For example, Dr Best recorded an increase in ST elevation. Dr Cripps explained that the implicit diagnosis, which would not need to be spelt out to be understood by medics, would be of an inferior myocardial infarction. Equally, the clinical manifestation of RVI is hypotension. That taken with the recorded fact that right-sided leads were being used on the ECG indicated, I accept, that the doctors probably realised that they were now dealing with RVI, even if they failed to record that conclusion.

79.3 I reject Dr Fox's complaint that Dr Cripps' approach to the RVI issue somehow undermined either his credibility or his respectability. Dr Cripps' position was rooted in the practical realities of note taking for the benefit of fellow medical professionals. He effectively reached the conclusion that I have reached after hearing Dr Dobson.

79.4 In any event, I do not consider that the specific criticism in respect of the unrecorded but implicit diagnosis of RVI gets the Claimant anywhere given that there is no pleaded allegation that the management of her cardiac condition at the Alexandra was negligent. Indeed, on the contrary, Dr Caplin accepted that increasing the intravascular volume was a reasonable treatment plan to stabilise Mrs Lane's condition, albeit that he maintained that she required immediate transfer.

79.5 I also reject the criticism that Dr Cripps wrongly inferred that the treatment at 02:30 was with a view to transfer. Again, Dr Cripps regarded this as obvious. Any doctor would know that an ischaemic limb would require surgery if blood flow was not restored by increasing intravascular volume and boosting the patient's blood pressure. In any event, Dr Cripps' inference was subsequently justified by Dr Dobson's evidence, which I accept, that his management was all about stabilising Mrs Lane for transfer.

79.6 I am not troubled by the suggested inconsistency between Dr Cripps' report, which indicated that Mrs Lane was suffering a re-infarction on 1 October, and his oral evidence in which he spoke about an extension of the original infarction. As to this, Dr Cripps said, and I accept, that re-infarction and an extension are used as synonyms in clinical practice, although it was more logical to talk of an extension.

79.7 Dr Cripps described the 02:30 treatment plan as having been formulated by both doctors. In cross-examination, he accepted that it was not documented that any plan had been jointly formulated. I do not, however, regard this as material since I find that Dr Dobson would

not have followed a recommended treatment plan that he did not accept.

79.8 I reject the suggestion that Dr Cripps had based his opinion on a case that was not established by the evidence, namely that delay was justified because the Alexandra:

(a) was stabilising Mrs Lane for transfer;

(b) had put in place a treatment plan formulated by Dr Dobson; and

(c) was treating RVI.

I have dealt with each of these issues. Contrary to Dr Fox's argument, I have accepted that the plan at the Alexandra, formulated by Dr Raja and adopted by Dr Dobson, was to stabilise Mrs Lane for transfer (see para. 55 above). Further, intravascular volume was being increased in part to treat RVI (see paras 59-60 above). In any event, Dr Cripps responded, and I accept, that Mrs Lane needed fluids and was given them. Thereafter, Dr Cripps considered that it was reasonable to wait to see if her condition improved before arranging her transfer.

79.9 Further, I do not accept that Dr Cripps made unreasonable assumptions in favour of the defendant trusts or that his opinion was not balanced.

80. Mr Coughlan was, however, right to observe that Dr Caplin focused heavily on the ischaemic arm rather than Mrs Lane's cardiac status:

80.1 Surprisingly, Dr Caplin's report scarcely offered an opinion as to the evolution of what, in his oral evidence, he described as Mrs Lane's *"precarious cardiac status."* It was only during Dr Caplin's cross-examination that I learnt his views as to the severity of Mrs Lane's original heart attack and the seriousness of her on-going cardiac symptoms.

80.2 While in cross-examination, Dr Caplin conceded that Mrs Lane's haemodynamics were deranged, at para. 8 of his report he had described her as haemodynamically stable. Dr Caplin sought to explain that her condition was not changing rapidly and that she was not therefore unstable. If, however, his opinion was that her haemodynamics were stable albeit at a deranged level then it would have been better that he had explained that properly in his report. A simple statement of stability underplayed the seriousness of Mrs Lane's fragile health on 2 October 2010.

80.3 Again, it was only in cross-examination that Dr Caplin conceded that Mrs Lane had been in cardiogenic shock. This was a significant conclusion that ought to have featured in the written evidence of a cardiological expert, especially given that the treating clinicians recorded a diagnosis of cardiogenic shock and the issue had been discussed when Dr Cripps had referred to cardiogenic shock in the experts' joint discussions.

81. I also find that Dr Caplin was not consistent in his position in two respects:

81.1 In the Joint Report, Dr Caplin had criticised the cardiological registrar at the QE for having expressed an opinion on transfer without having

seen Mrs Lane. Such criticism had not been made in the original report and was rightly withdrawn in cross-examination.

81.2 At para. 14 of his report, Dr Caplin had criticised delay by the vascular surgeon. Such criticism was subsequently directed at the cardiologists in the Joint Report by his answers to questions 7, 9 and 10.

82. Further, I do not consider that Dr Caplin was right to assert, as he did in his response to question 5 in the Joint Report, that there had been no treatment plan at 02:30. The plan was plainly to increase intravascular fluids and monitor Mrs Lane with a view to her transfer for angiography.

83. Generally, I was more impressed by Dr Cripps' evidence. Like Dr Caplin, he largely avoided becoming an advocate for the defence while robustly rebuffing challenging cross-examination. I do, however, find that occasionally Dr Cripps strayed over the line. Indeed, his answer to Dr Fox's suggestion that he had become an advocate was to make a comparative observation between his own broader approach and Dr Caplin's narrower approach. Ironically, in doing so, it sounded as if he were making a submission. This is to be balanced by, for example, Dr Cripps' readiness to criticise Dr Raja's insistence on a further surgical review at 06:30.

84. If I were simply deciding which cardiological opinion I prefer, I would, for the reasons set out above, have found that in general I preferred the evidence of Dr Cripps to that of Dr Caplin.

85. For good reason, counsel did not embark on a similarly close analysis of the anaesthetists' positions. They confirmed that transfer at 02:30 posed a risk that could have been managed by various interventions. The question of the possible benefit of fluids to the ischaemic arm was not really a question for them.

86. As between the vascular surgeons, for reasons that I will set out more fully later in this judgment when considering the vascular allegations, I have no hesitation in preferring the evidence of Professor Beard over that of Mr Collin. Accordingly, I accept Professor Beard's vascular view that the immediate priority was to stabilise Mrs Lane's cardiac condition before she could be transferred.

87. Like Drs Caplin and Cripps, I accept that a reasonable body of cardiologists might properly have recommended Mrs Lane's immediate transfer back to the QE. However, I reject Dr Caplin's view that that was the only reasonable management plan.

88. In my judgment, Dr Cripps is an obviously competent, responsible and respectable expert cardiologist. I accept his opinion that, faced with this unstable cardiac patient who was in the midst of some further cardiac event and who was bradycardic, hypotensive and in cardiogenic shock and who had just presented with an ischaemic arm, a reasonable and responsible body of

cardiologists would seek first to stabilise the patient by increasing her intravascular volume while monitoring her progress with a view to subsequent transfer for vascular surgery.

89. I find that such opinion can be supported in logic:

89.1 Mrs Lane was a seriously ill and unstable patient. Immediate transfer without attempting first to stabilise her condition therefore carried some risk of a downturn in her fragile cardiac condition and, even, death.

89.2 The fluid challenge prescribed might well have stabilised her blood pressure and, more generally, her cardiac status thereby reducing the risks of transfer.

89.3 Further, an improvement in blood pressure, had it been achieved, might well have helped to restore blood flow to the ischaemic arm.

89.4 While an ischaemic arm is a surgical emergency, I do not accept that Mrs Lane required immediate surgery, or at least surgery within 6 hours, without first seeking to stabilise her condition. Such rule of thumb may be appropriate in cases of lower-limb ischaemia, but it is clear from the vascular evidence that an ischaemic arm can be tolerated for somewhat longer without irreversible consequences.

90. Accordingly, I dismiss the allegation that the cardiological advice at 02:30 was negligent.

91. This leaves a further issue. As recounted at para. 73 above, Drs Cripps and Caplin agreed that Dr Raja's insistence that Dr Dobson should seek a surgical review before transfer was not necessary and that Mrs Lane plainly required to be transferred at that point. Dr Fox also criticised Dr Raja's request for a consultant medical view before transfer.

92. I accept the evidence of the expert cardiologists that there really was no need for a surgical review before transfer, but I do not consider that the Claimant has established that it introduced any significant further delay in this case. I reject the criticism that the medical consultant's review was not required. It was, in my judgment, perfectly reasonable for the registrars to seek consultant approval for the transfer of this unstable cardiac patient. In any event, it took no time at all for Dr Dobson to speak to and obtain Dr Barbar's approval for the planned transfer.

93. There is of course a difference between saying that an additional precaution was unnecessary and that it was negligent. Indeed, there is no specific pleaded criticism of the delay for such further reviews. In any event, I consider that there is much to be said for Dr Dobson's view that it was not so much Dr Raja who put a hold on transfer but the clinical picture. Accordingly, I reject the suggestion that Dr Raja was negligent in seeking the surgical and consultant review before finally agreeing Mrs Lane's transfer. Even if I am wrong, the delay introduced by these additional reviews was, in my judgment, minimal.

ISSUE 2: DELAYED SURGERY

2 OCTOBER: 09:30-21:00

94. The records show, and I find, that the ambulance arrived at the QE by around 09:30. Mrs Lane was seen by Dr Bowater, a cardiological registrar, at 10:15. The attendance is recorded in Dr Bowater's 11:00 note. After setting out the history, she recorded that Mrs Lane complained of a painful right hand but no chest pain or shortness of breath. She was oliguric (very low urine output). On examination, Mrs Lane was in pain and clammy. Her pulse remained low at 48 and her systolic blood pressure remained low at 90-100. Again, the monitor showed a junctional rhythm. The right hand and wrist were cold with no radial pulse, markedly reduced capillary refill and a weak brachial pulse.

95. Arterial blood gases were taken and Dr Bowater noted acidosis (increased acidity in the blood). She discussed matters with the vascular registrar who agreed to review Mrs Lane. She prescribed gelofusine (a colloidal infusion to increase her fluid balance) and atropine (in order to increase the heart rate), and sought advice from the renal team and from her own consultant, Dr Smith.

96. Dr Smith first reviewed Mrs Lane at 11:45. Asked why he had not seen Mrs Lane earlier, Dr Smith explained that the nurses would have been assessing and re-establishing the patient within the Coronary Care Unit. Furthermore, he was able to rely on Dr Bowater, who he described as having been a very experienced and capable final-year registrar.

97. Dr Smith was an impressive and authoritative witness. It was, in my judgment, entirely reasonable for him to have relied on his experienced and trusted cardiological registrar to assess Mrs Lane and to set the initial treatment plan. Not only do I not consider it a proper criticism of Dr Smith that he did not personally see Mrs Lane before 11:45, but I am surprised that anyone would suggest otherwise.

98. Dr Smith noted the history and referred Mrs Lane for a vascular opinion. In his evidence, he described her as *"extremely unwell with complications from her right coronary infarct that had developed since the initial treatment … [including] right ventricular involvement and a junctional bradycardia along with the perfusion issues of her right arm."* I accept this clinical assessment.

99. Dr Smith said, and I accept, that the plan was to optimise Mrs Lane's cardiac condition so that the vascular surgeons could operate. He said that if she had not been so unwell, then she would have been a vascular case.

100. Mrs Lane was carefully reviewed before mid-day by Mr Leong, the vascular surgical registrar. He then wrote up his note at 12:00, recording the history and noting bradycardia (30-40 bpm), hypotension (89/60 mmHg) and poor urinary output. On examination, he found the right arm to be cold with dusky

fingers. He found no pulse in the radial, ulnar and brachial arteries. There was no sensation in the right hand and a reduced (2/5) grip power. By contrast, the left arm was warm and power was 5/5.

101. Mr Leong recorded his plan that Mrs Lane needed imaging and perhaps thrombolysis. He discussed the case with his cardiological colleague and noted that the patient was now for pacing. He left a voicemail for the on-call consultant vascular surgeon, Mr Silverman, and noted that Mrs Lane was currently unstable and that she needed optimisation *"first."* I heard from Mr Leong who explained that he was obviously contemplating vascular surgery and that he had meant that Mrs Lane's medical condition needed to be optimised before surgery. I accept his evidence on these issues.

102. At 12:40, Mr Leong spoke to Mr Nicholl. He explained in his oral evidence that he would have had a full discussion with Mr Nicholl presenting not just the vascular picture but also a general account of Mrs Lane's cardiac status. He recorded the consultant's decision, with which he agreed, that Mrs Lane was then unstable for any procedure. Once her condition had been optimised by the cardiologists, they were to contact the vascular team for reassessment with a view to proceeding to surgery. Mr Leong recorded that he informed the cardiological registrar of the position.

103. Mr Nicholl also gave evidence about the 12:40 decision. He was a slightly diffident witness. That is perhaps understandable since he was the principal doctor alleged to have been negligent in this case. He faced criticism not just for the delay in getting Mrs Lane to theatre but also in respect of his surgical competence. His evidence was, however, no less impressive for his diffidence. He gave measured evidence, engaged properly with questions, made appropriate and fair concessions and resisted the temptation to argue his case from the witness box. I found him to be an honest and reliable witness, and I accept his evidence.

104. As to the 12:40 decision, Mr Nicholl explained that Mr Leong had discussed matters with Drs Bowater and Smith. He accepted that he had not himself sought a cardiological or anaesthetic assessment. He dismissed, however, the suggestion that the question of fitness for surgery was not for him and Mr Leong. He confirmed, and I accept, that the decision at 12:40 to delay surgery was his. It was, I find, a considered decision reached after discussion with the cardiologists and proper consultation between vascular consultant and registrar. The plan was therefore to defer surgery while the cardiologists sought to optimise Mrs Lane's condition and to await further requests for review.

105. Dr Smith saw Mrs Lane again at 13:00. A temporary pacing wire was inserted in order to establish a regular heartbeat. Dr Smith recorded that Mrs Lane looked better, but that her systolic blood pressure was still 80-90. He noted that an angiogram should be performed when Mrs Lane had been resuscitated, thereby confirming, in my judgment, that she was not for immediate surgery. Further, a nursing note at 13:00 recorded that Mrs Lane

was to be monitored until she was stable and that thereafter she was to be reviewed by the vascular team.

106. At 14:45, Dr Bowater noted that Mrs Lane remained oliguric despite a further 1,000-ml infusion of gelofusine. She prescribed the inotropic drugs dopamine and dobutamine (in order to stimulate the heart's contractions) together with a saline drip. Dr Bowater referred the patient for further review by the vascular registrar.

107. Dr Smith confirmed in his evidence that his team was treating the right ventricular involvement by the prescription of fluids, atropine and, from 14:45, dopamine and dobutamine. He said that other than fluids, these treatments had not been tried before arrival at the QE. He explained, and I accept, that his team adopted a stepwise and logical approach to Mrs Lane's cardiac resuscitation. In any event, no criticism is pleaded in respect of the QE's management of her cardiac condition.

108. Dr Bowater's 14:45 note includes a record of her discussion with Mrs Lane's family. Dr Bowater explained that Mrs Lane had had a large heart attack, that her heart still required support from fluids and a pacing wire, that she remained *"very poorly"* and that she was *"not out of danger yet."* While Dr Bowater did not give evidence, as I have already observed, Dr Caplin expressly agreed with her assessment. I therefore accept it to be accurate.

109. A nursing entry at 16:00 recorded that Dr Bowater had contacted the vascular registrar. A further nursing note at 16:15 recorded deterioration of the right arm and hand. An SHO was contacted whose 17:15 note recorded that the arm had become more blue and painful. The SHO spoke to the vascular registrar, but he was then busy in the Intensive Care Unit and agreed to review Mrs Lane as soon as he was free.

110. At 18:00, Dr Bowater noted that Mrs Lane was anuric (no urinary output) despite the administration of inotropes. This appears to have evidenced a worsening of her renal failure. Increasing discolouration of the right hand was observed. Dr Bowater also noted worsening metabolic acidosis. She referred Mrs Lane for an urgent vascular review and for an intensive care opinion.

111. Mrs Lane was then reviewed by Mr Rai, an on-call vascular surgical registrar. In a detailed note, he recorded a cold, cyanosed right hand with no sensation. He found no brachial, ulnar or radial pulse and recorded that she was still unstable with a mean arterial pressure of 48 mmHg (a measurement of average blood pressure, which falls rather nearer to diastolic than systolic pressure) and a systolic pressure of 70. Mr Rai recorded that it was unlikely that an attempted brachial embolectomy (a term that, for current purposes, was used interchangeably with 'thrombectomy' by some witnesses) or any procedure would make any difference to the right distal forearm and hand. In other words, he foresaw the futility of surgery. Having heard the expert evidence in this case, I find (as I shall explain later in this judgment) that Mr Rai's pessimism as to the result of surgery was more likely to have been based

on Mrs Lane's poor cardiac output which would make perfusion difficult to sustain than the delay in taking her to theatre.

112. Mr Rai then recorded a *"difference of opinion with cardiology SpR."* In evidence, Dr Smith suggested that it was unlikely that the cardiologist would have challenged Mr Rai's assessment as to the likelihood of successful surgery and that this was probably a difference of opinion as to Mrs Lane's fitness for surgery. While the contrary interpretation has been urged on me, for the reasons given by Dr Smith I find that this was a difference of opinion – apparently for the first time – as to fitness for surgery. In any event, Mr Rai spoke to Mr Nicholl who reviewed Mrs Lane at 19:15.

113. Meanwhile, the ITU registrar, Dr Glasson, reviewed Mrs Lane at 19:00. Dr Glasson recorded his impression of cardiogenic shock secondary to right ventricular failure and the ischaemic right arm. He confirmed that nothing more could be offered, observing that CVVH (continuous veno-venous haemofiltration, a form of dialysis for patients in acute renal failure) would be poorly tolerated haemodynamically. He queried whether a RVAD (a right-ventricular-assist device) might be an option.

114. When Mr Nicholl saw Mrs Lane at 19:15, he noted the history and decided to proceed to with a right brachial thrombectomy under local anaesthetic. He told me that the need for vascular surgery was a constant. Mrs Lane had had an afternoon of intensive cardiac treatment and there was nothing else to be done to improve her condition. He remarked that anuria was a very serious condition and that she remained hypotensive despite the inotropes.

115. In cross-examination, Mr Nicholl accepted that he made the decision to operate at 19:15 because that was when he saw Mrs Lane. He agreed that the same decision would be likely to have been made had he seen her one hour earlier or one hour later.

116. Drs Smith and Glasson further reviewed the patient at 19:30. Dr Smith noted that she was for theatre and then was to return for critical care. The temporary pacing wire was to be continued until she had re-established her own cardiac rhythm. He also noted that fluids were to be continued, but the inotropes had not been effective.

117. In cross-examination, Mr Leong accepted that an ischaemic limb is a surgical emergency. He agreed with the rough rule of thumb put to him, namely that surgery within 6 hours of the onset of total ischaemia should save the limb but that, after a delay of 12 hours or more, it becomes likely that there will be a loss of some tissue or amputation. He agreed that Mrs Lane would have been a high priority patient for the vascular team on 2 October, but understandably could not now say whether she had been the top priority.

118. Mr Nicholl was also cross-examined about the 6/12-hour rule of thumb for treating an ischaemic limb. He did not agree and observed that such

timescales were generally quoted for ischaemic lower limbs. As became apparent when I heard the expert vascular evidence, Mr Nicholl was right in this assertion. In any event, Mr Nicholl readily agreed the general principle that one should operate as soon as possible to remove a blockage and that the longer the delay, the greater the risk of tissue loss and amputation.

119. It was suggested that Mr Nicholl could have operated at any time under local anaesthetic. He rejected this explaining that, on the information that he had been given, any procedure that involved taking Mrs Lane out of the Coronary Care Unit, even for a short time and even under local anaesthetic, posed too great a risk to her life. He confirmed that it was his decision whether to operate but that, where there is a cardiac issue, he would discuss fitness for surgery with the cardiologists and anaesthetists.

THE EXPERT EVIDENCE

The cardiological experts

120. In his written evidence, Dr Caplin criticised the delay, which he put at 105 minutes, between re-admission to the QE and assessment by the consultant cardiologist, Dr Smith, at 11:45. In fact, the perceived delay was somewhat longer since, on the evidence, I find that Mrs Lane was re-admitted to the QE at about 09:30. Dr Caplin said that such delay in assessing a clearly unwell patient was *"unacceptable."*

121. Dr Cripps correctly observed that Mrs Lane would first have had to be established back on to the Coronary Care Unit by the nurses. Thereafter, she was assessed at 10:15 by Dr Bowater. Dr Caplin realistically accepted in cross-examination that it had not been unreasonable for Dr Smith to have relied on his experienced cardiological registrar to make the initial assessment. Further, he accepted, as again I consider he had to, that Dr Bowater's note evidenced an extensive and good quality medical examination. Indeed, Dr Caplin described Dr Bowater's treatment plan as *"good."*

122. Dr Caplin accepted that it was reasonable to prioritise life over limb but that, in his view, it was possible to save both. Indeed, Dr Caplin considered that Mrs Lane was fit for surgery upon arrival at the QE. He reported that there was no clinical assessment of fitness for surgery under local anaesthetic. Further, he said that the temporary pacing wire alleviated what he regarded as the small risk of bradycardia. Since fitting the wire takes 15 minutes, he suggested that it could have been done while the theatre was being prepared.

123. Against this, Dr Cripps reported that Mrs Lane was *"extremely sick with cardiogenic shock, recent if not on-going acute myocardial infarction, acute renal failure and compensated metabolic acidosis"* and suggested that fitness for surgery was a matter for the anaesthetists.

124. Dr Caplin accepted that Dr Smith's stepwise approach was appropriate. Further, as I have already indicated, he accepted the way in which Dr Bowater

had put matters to the family, thereby accepting that Mrs Lane had remained very poorly and that she was not out of danger.

125. Drs Caplin and Cripps offered alternative explanations for acidosis. Dr Caplin said that Mrs Lane was becoming acidotic because the arm muscles were hypoxic (deprived of an adequate oxygen supply). In cross-examination, Dr Caplin accepted that acidosis could also be caused by worsening cardiogenic shock and renal failure. Dr Cripps attributed the acidosis to renal failure. Asked whether the ischaemic arm might be a factor, he deferred to the vascular surgeons but added that the degree of acidosis in this case was consistent with the extent of renal failure and that he would not have been looking for another cause.

The anaesthetic experts

126. The anaesthetists agreed that there was no *"significant delay"* in assessment at the QE, noting that Mrs Lane was seen by the cardiologist at 10:15, referred by 11:20 and reviewed by the surgical SpR by 12:00. They also agreed that Mrs Lane was treated appropriately with the insertion of the pacing wire and the prescription of inotropic drugs and fluids. Dr Matta criticised, however, the delay in treatment, saying that it all took *"far too long."* Ultimately, however, the issue of the proper cardiac treatment of this patient is a matter for the cardiologists.

127. The anaesthetists also agreed that Mrs Lane could have undergone general anaesthesia. They added:

> "Dr Matta feels that she was stable, and supportive measures could have been instituted should she have deteriorated during the surgery.
>
> Dr Mortimer feels that she was not sufficiently stable at the time, but if she had received sufficient support in the form of pacing wire, inotropes and even ventilation if necessary, she would have been able to undergo general anaesthesia.
>
> The risk associated with general anaesthesia included worsening of her cardiac function as a result of the cardiac depressant effects of anaesthetic drugs."

128. In his oral evidence, Dr Matta told me that he would himself have offered any of local, regional or general anaesthesia in this case, although he would have first needed to have explained the risks of general anaesthesia to Mrs Lane.

129. Dr Mortimer was asked about the pre-operative anaesthetic assessment undertaken by Dr Pierson in advance of the thrombectomy. Dr Mortimer agreed that there was nothing in the assessment to indicate that Dr Pierson was concerned about Mrs Lane's cardiac status. Indeed, Dr Pierson had not entered an ASA score for the anaesthetic risk (a scoring system developed by the American Society of Anesthesiologists to score a patient's health status, and therefore anaesthetic risk, from 1-5).

The vascular experts

130. The vascular experts agreed that there had been a two-hour delay before Mrs Lane had been reviewed by the vascular registrar at the QE. Mr Collin said that Mrs Lane should have been seen by 11:00 and the surgery should have been performed as an emergency within one further hour. Against this, Professor Beard considered that the delay was reasonable given the time required by the cardiologists and nursing staff to admit, review and stabilise Mrs Lane on the coronary care unit. He also pointed to the fact that the hospital would not have been fully staffed on a Saturday.

131. Mr Collin considered that the 12:40 assessment that Mrs Lane was then unstable for any procedure was simply wrong. After insisting that surgery should have been undertaken immediately, Mr Collin added:

> "I have seen no evidence to support the view that any resuscitative measures that were undertaken between 12:00 and 21:00 hours on 2nd October 2010 many any substantial difference to the ability of the Claimant to safely undergo the operation of thromboembolectomy under local anaesthesia."

132. Professor Beard noted Mr Nicholl's conclusion that Mrs Lane was too unstable for surgery. He reported, at para. 4.3:

> "Given her medical problems I agree with his decision, because I do not think that she was fit for any form of vascular intervention around the time of her transfer back to [the QE]. Therefore it was reasonable for Mr Nicholl to defer revascularisation in the hope that her cardiac condition could be improved, on the basis of 'life before limb.' Therefore, I do not believe that the delay in her brachial embolectomy until the evening of 2 October 2010 represents a breach of duty."

133. Professor Beard said that when Mrs Lane's cardiac output did not improve with treatment and her metabolic acidosis worsened, Mr Nicholl then decided to proceed to surgery. He explained that the surgeon would have been concerned that persistent severe acute limb ischaemia might cause systemic toxicity, but acknowledged in cross-examination that this was his interpretation rather than something that Mr Nicholl had recorded.

134. Mr Collin reported that the medical records did not record that any appropriate assessment had been made of Mrs Lane's fitness for surgery under local anaesthesia. Professor Beard responded that the cardiologists were the most appropriate specialists to assess fitness for any procedure that required Mrs Lane's removal from the Coronary Care Unit.

135. The vascular experts agreed that there was a delay in taking Mrs Lane to theatre. As to this key point, their respective positions can be taken from their Joint Report:

135.1 Mr Collin reported:

> "… embolectomy under local anaesthetic is a trivial systemic insult that is unlikely to affect the cardiac function of those with even the most

severe cardiac disease. Whether the Claimant's cardiac function was likely to have been or was in fact substantially improved by cardiac intervention are matters of opinion for the cardiac specialists to provide and for the Court to decide. From the perspective of a vascular surgeon, embolectomy was probably no more or less safe when it was in fact performed than it would have been at any other time after the brachial artery occlusion occurred."

135.2 By contrast, Professor Beard reported:

"… this was a reasonable delay. Dr Smith inserted a pacing wire at 13:00 and left instructions that she required monitoring for a period of time until stable, then for further vascular review. At 14:45 inotrope infusions were commenced as she remained hypotensive and oliguric despite pacing and fluid resuscitation, but she remained in cardiogenic shock. The situation was discussed with the vascular registrar at 16:15 because the CCU staff were concerned about the worsening colour of her hand, and Mr Nicholl subsequently made the decision to take her to theatre once it became clear that her cardiac condition could not be improved. Brachial embolectomy is not a 'trivial procedure' because it carries a significant risk of adverse periprocedural events, including cardiac arrest. This is a particular risk at the time when an ischaemic limb is reperfused, because of the toxins that are washed out into the circulation. It would have been unwise, and possibly reckless, for a surgeon to remove an unstable patient from the coronary care unit, which was the best place to look after her, until the cardiologists were happy that her condition had been stabilised and optimised. To do otherwise risked the claimant's life, and would breach a general principle of treatment, which is 'life before limb.'"

136. Professor Beard told me that it would have been *"crazy"* to have taken Mrs Lane to theatre until the cardiologists had got her as well as they could. He added that she might well have died, as she nearly did in the following days when she when into asystolic arrest. He conceded, however, that Dr Bowater had waited from 14:45 until 18:00 for a vascular review. He responded that that was perfectly reasonable in a busy hospital at the weekend.

137. Professor Beard interpreted the documented difference of opinion between the registrars to be in respect of the futility of surgery. On this, as I have already indicated, I prefer Dr Smith's view. Professor Beard accepted that it was clear that the cardiologists were not preventing the surgeons from taking Mrs Lane to theatre.

138. Mr Collin accepted that the effect of thrombectomy would be to release toxic metabolytes back into the blood stream. He suggested that the effect would be minimal but accepted that a relatively toxic bolus could make its way back to the heart. Professor Beard explained that this was the reason why surgeons in wartime often moved straight to amputation.

ANALYSIS

139. The resolution of this issue turns largely on the view that I take of the vascular experts. In my judgment that question cannot be answered in isolation without also analysing their respective views in respect of Mr Nicholl's surgery.

ISSUE 3: THE STANDARD OF SURGERY

THE VASCULAR SURGERY

140. Mrs Lane was taken to theatre at 21:05. Mr Nicholl administered a local anaesthetic. The right brachial artery was exposed and transverse arteriotomy (an incision in the arterial wall) was performed. A balloon catheter was then passed up through the brachial artery. The operation note recorded that thrombus and intima (arterial lining) were retrieved on 3-4 passes until a good down bleed was achieved. Mr Nicholl then turned to the radial artery. Multiple passes were required and significant thrombus was retrieved before achieving good back bleeding. The arteriotomy was then closed. In his statement, Mr Nicholl confirmed that after the procedure Mrs Lane's hand was *"pink and perfused"*.

141. In cross-examination, Mr Nicholl confirmed that achieving a good down and back bleed would usually be sufficient to re-vascularise the arm. He was as sure as he could be that a good flow had been restored into the hand. Although he accepted that he had not recorded it, he said that he would have checked for and found a radial pulse. He said that he was not in the habit of doing half a job and that he would not have closed the arm up if he had not found a radial pulse.

142. Again, I accept Mr Nicholl's evidence. Specifically, I find that that he achieved a good down and back bleed by the end of the surgery. If he had not, then I do not consider that he would have recorded the same. Equally, I do not accept that he would have closed up the arteriotomy without completing the thrombectomy.

143. Further, I accept Mr Nicholl's evidence that he found a radial pulse at the end of the procedure and that the hand pinked up, even though neither of these facts were recorded in his operation note as, in my judgment, they ought to have been. I consider that these findings are supported by the independent evidence that a capillary refill time of 2 seconds was noted a few hours after the thrombectomy. Further, I consider that these conclusions are supported by the expert vascular evidence, as I shall seek to demonstrate below.

144. It was suggested that Mr Nicholl should also have cannulated the ulnar artery. He disagreed, explaining that normal vascular practice was only to clear one artery in the forearm. He said that was normally sufficient to reperfuse the hand. He added that cannulating the ulnar artery would have prolonged surgery and that he was not aware of any evidence that a better outcome was achieved by cannulating both the radial and ulnar arteries.

145. Mr Nicholl also rejected the suggestion that he should have carried out completion angiography. He said that he was confident that he had cleared the radial artery. Further, completion angiography takes time and requires the use of contrast agents that are renal toxic, and Mrs Lane was of course already in renal failure. In re-examination, Mr Nicholl told me, and I accept, that he had never performed completion angiography after an upper-limb thrombectomy.

146. Mr Nicholl roundly rejected the suggestion that he should have performed a fasciotomy (a cut in the fascia to relieve the pressure in the muscles). He said, and I accept, that fasciotomies are rarely performed in the forearm; indeed he has only performed the procedure in an upper limb once in his career. Fasciotomy would only be performed where the compartment pressures indicated the need. In any event, Mr Nicholl doubted whether he could have performed a fasciotomy under local anaesthetic and insisted that he would not have countenanced operating on Mrs Lane under general anaesthetic on 2 October 2010. He considered that she might well have died had he done so.

147. A nursing record at midnight noted that Mrs Lane's right hand was mottled and cold but that the capillary refill time (a measurement of the time taken for colour to return to an external capillary after pressure has been applied) in the right hand was 2 seconds. The vascular experts told me that this was a normal finding and is, of course, the finding that I referred to at para. 143 above.

148. On examination by the vascular registrar at 15:40 on 3 October, no right radial pulse was palpable although the hand was noted to be warm and not ischaemic. By 09:00 on 4 October, the capillary refill time in the right hand had deteriorated to a distinctly abnormal 8 seconds. Her hand was then noted to be painful and dusky.

149. Meanwhile, Mrs Lane remained very poorly. She remained dependent on the pacing wire for some days and her acute renal failure was treated by haemofiltration. Despite being paced, Mrs Lane collapsed a number of times on 4 October with the ECG flat-lining for a number of seconds (referred to by doctors as being asystolic). That evening, the ITU consultant, Dr Pouchet, advised Mrs Lane's daughter that she was at high risk of dying from her cardiac condition. Further, on 7 October, Mrs Lane was noted to have profound left-sided weakness. A cerebrovascular accident (known, more colloquially, as a stroke) was diagnosed.

150. Over the next few days, Mrs Lane's condition improved. On 12 October, Mr Edwards, a vascular surgeon, noted that she was a very high risk for any vascular procedure under general anaesthetic. On 13th, he performed a further embolectomy. Notwithstanding the two attempts to re-vascularise the arm, dry gangrene developed and, on 9 November 2010, the right arm was amputated above the elbow.

151. Meanwhile, testing established that Mrs Lane suffered heparin-induced thrombocytopaenia (abbreviated to HIT); a rare condition in which a reaction to heparin (an anti-coagulant commonly used in the treatment of myocardial infarctions) can itself lead to thrombosis (clotting).

THE EXPERT EVIDENCE

152. Mr Collin made five criticisms of Mr Nicholls' surgery:

152.1 First, a longitudinal arteriotomy would have provided better access.

152.2 Secondly, it was essential to have also cannulated the ulnar artery.

152.3 Thirdly, a patch suture should have been used in preference to direct suturing.

152.4 Fourthly, completion angiography should have been performed.

152.5 Fifthly, it was essential to perform a fasciotomy of the forearm and hand.

153. The first and third criticisms can be immediately discarded. Mr Collin never suggested that these failings were negligent and indeed they have never been pleaded. It would, in my judgment, have been better if such criticisms had not been made. They have no place in a clinical negligence case.

154. In his oral evidence, Mr Collin differentiated between:

154.1 the failure to cannulate the ulnar artery, which he made plain fell below the standard expected of vascular surgeons in general; and

154.2 the failure to perform completion angiography, which he said would be expected from a teaching hospital such as the QE but not necessarily a district general hospital.

The ulnar artery

155. Mr Collin did not disagree with the suggestion that a responsible body of vascular surgeons would not have cannulated the ulnar artery upon achieving a good bleed. Mr Collin considered, however, that Mrs Lane was at particularly high risk of re-thrombosis and it was therefore *"imperative"* that *"every proportionate effort should be made to ensure that the chances of a successful outcome were as high as they could be."* Of the various steps recommended in his original report, Mr Collin made clear that the essential additional intervention was the thrombectomy of the ulnar artery.

156. Challenged in cross-examination that this opinion was driven by hindsight, Mr Collin responded that the matter was clear-cut. He said that because of the very long delay in performing the brachial embolectomy, it was essential that everything was done to *"snatch success from the jaws of failure."* In his view, no reasonably competent vascular surgeon would have failed to cannulate the ulnar artery.

157. Professor Beard rejected the suggestion that clearance of the ulnar artery was essential. In his report, he explained that the radial artery is usually the dominant artery in the forearm and that most vascular surgeons would concentrate on it in preference to the ulnar artery. The ulnar artery is more difficult to expose because it branches off lower than the antecubital fossa. Furthermore, he said that it was a general principle of embolectomy that clearance of one artery to the foot or hand is adequate to restore perfusion because of the rich collaterals.

158. Mr Collin accepted that he could not point to any literature indicating a need to cannulate the ulnar artery in late-presentation ischaemia. He accepted that it was argument and assertion by him.

159. Mr Collin conceded that if the surgeon had achieved reperfusion of the limb after performing radial and brachial thrombectomy, no more needed to be done. He did not, however, accept that Mr Nicholl had achieved reperfusion and, accordingly, he considered the additional step of ulnar cannulation to be essential. However, in answer to the Claimant's question 9, the two vascular experts wrote:

> "We agree that the brachial artery was successfully cleared of thrombus. We agree that the radial artery was at the time of surgery cleared of thrombus. We agree that the thrombectomies performed secured some increase in the perfusion of the limb."

160. Further, in his oral evidence, Mr Collin said that he believed that a brachial pulse was briefly re-established. He also agreed that Mr Nicholl's failure to record the radial pulse was immaterial and that a pulse was probably present at the end of the operation, although it was not maintained.

161. Mr Collin was asked about the three separate pieces of evidence which support the QE's case that reperfusion was achieved, namely:

161.1 Mr Nicholl's record in his operation note that he had achieved a good down bleed (i.e. from the exposed brachial artery) and a good back bleed (i.e. from the radial artery);

161.2 Mr Nicholl's assertion in his statement (confirmed in his oral evidence) that the hand *"pinked up"* after the surgery; and

161.3 the nursing record at midnight of a normal capillary refill time in the right hand of 2 seconds.

162. Mr Collin doubted the accuracy of this evidence, while Professor Beard considered that this evidence indicated that the thrombectomy had been successful.

Completion angiography

163. As already indicated, Mr Collin clarified that the completion angiography allegation was made on the basis of the elevated or, as he called it in evidence, "gold standard" of care. However, Mr Collin conceded that a reasonable body

of vascular surgeons would disagree, and that most surgeons would not undertake completion angiography if they had achieved a good down and back bleed.

164. Professor Beard did not consider that completion angiography was mandated. Surgeons would generally judge success by reperfusion and achieving a good down and back bleed.

Fasciotomy

165. Mr Collin's original report stated that the failure to perform a fasciotomy fell below the standard *"expected from University of Birmingham NHS Foundation Trust."* This language sounded closer to the elevated standard applied in respect of the completion angiography allegation than the lower standard that he had applied to the ulnar cannulation point. In cross-examination, he denied that he was applying the elevated standard but added that he would certainly have expected this standard of care from the QE. Mr Collin volunteered that he would expect a reasonable body of vascular surgeons to disagree with him about the fasciotomy.

166. The experts agreed that fasciotomy is the treatment for a compartment syndrome, of which there was no evidence in this case. By trial, Mr Collin rowed back from his original position. It was, he said, essential that fasciotomy should have been *"considered."*

167. In cross-examination, Mr Collin didn't quarrel with Mr Coughlan's suggestion that it was rare to perform a fasciotomy in the upper limb and accepted that there were sound anatomical reasons for the rarity in the arm compared to the leg. He confirmed that he had personal experience of only two or three fasciotomies in the upper limb in his entire career. Professor Beard told me that he had never performed a fasciotomy for upper limb ischaemia and that the procedure was not indicated in this case.

168. Incidentally, the anaesthetists agreed that a fasciotomy could be performed under local anaesthetic. This view was controversial with at least two vascular surgeons; neither Mr Nicholl nor Professor Beard considered that the procedure could be undertaken under local anaesthesia. Ultimately, as will become clear, this difference of view is immaterial.

ANALYSING THE VASCULAR EVIDENCE

MR COLLIN

169. In his closing submissions, Mr Coughlan referred, accurately, to Mr Collin's *"wandering prolixity."* He was certainly a voluble witness, but I entirely dismiss the suggestion that his prolixity was deliberate or even diversionary. While Mr Collin contrasted with the more concise Professor Beard, I seek to peel away such superficial observations and focus instead on the substance of the two experts' evidence.

170. Like Dr Caplin, Mr Collin is criticised for having adopted a form of words that was plainly provided by the lawyers in order to encompass the Bolam and Bolitho tests. For the reasons already explained, I am not troubled by this.

171. As set out above, Mr Collin differentiated between the standard of care that he would expect in a district general hospital and a teaching hospital. Whether he was right to do so as a doctor, for the reasons already explained I reject the suggestion that Mr Nicholl is to be held to some higher standard of care. That is, however, a legal conclusion and I do not hold the issue against Mr Collin. I reject out of hand Mr Coughlan's suggestion that this was an invention from the witness box. Properly read, I consider that Mr Collin had always differentiated between the two standards. That said, I consider that he was somewhat muddled in the standard that he sought to apply to the fasciotomy allegation.

172. In my judgment, Mr Collin fell into the error of allowing hindsight to colour his thinking. For example, the passages set out above at para. 131 indicated a failure to look at matters prospectively. The question was not whether in fact Mrs Lane was better stabilised for surgery at 21:15 but whether a reasonable and responsible body of vascular surgeons would have accepted as proper the decisions made earlier in the day to delay surgery while attempting to stabilise this patient.

173. Mr Collin was prone to going off at tangents rather than answering the question asked. An egregious example was his repeated insistence that Mrs Lane's informed consent had not been properly obtained for the thrombectomy. No such allegation is pleaded and he was not asked about issues of consent, but he insisted that it was an important issue.

174. I was particularly concerned by Mr Collin's evidence that Mr Nicholl ought to have performed a fasciotomy. The clear evidence before me was that an upper-limb fasciotomy is vanishingly rare:

174.1 Mr Nicholl said as much without challenge.

174.2 In cross-examination, Mr Collin, confirmed that he had experience of only two or three in the upper limb in his entire career. In cross-examination, he didn't quarrel with Mr Coughlan's suggestion that the procedure was rare and accepted that there were sound anatomical reasons for the rarity in the arm compared to the leg.

174.3 Professor Beard reported that he had never performed fasciotomy for upper-limb ischaemia.

175. In any event, fasciotomy is the treatment for a compartment syndrome, and yet there is no evidence in this case of such condition. By trial, Mr Collin rowed back his position. It was he said essential that fasciotomy should have been *"considered."* Quite why it was essential to consider a vanishingly rare procedure that was not clinically indicated was not made clear, save for his observation that the surgeon would then be beyond criticism. Although the point was left there, a fasciotomy is no small matter and I cannot think that it

would be right to perform the procedure save where it is clinically indicated simply in order to be beyond criticism. Such a defensive approach to very rare surgery is neither in the best interests of patients nor required by the law.

176. To top it all, Mr Collin then volunteered that he would expect a reasonable body of vascular surgeons to disagree with him about the fasciotomy. If so, that of course indicates that there was a proper range of opinion on the point. Part 35 of the Civil Procedure Rules 1998 therefore required him to identify that point in his report, but he did not.

177. In the event, Dr Fox was wise not to cross-examine Professor Beard on the question of fasciotomy and the allegation was formally abandoned in closing submissions. That said, this was a late change of tack since Dr Fox had opened the issue to me at the outset of the trial and had already suggested to Mr Nicholl that he should have performed a fasciotomy.

178. In my judgment, it is clear that Mr Collin should never have made the criticism that it fell below the reasonable standard of care of a vascular surgeon to fail to perform a vanishingly rare procedure that was not, on the evidence, indicated and which, at least by the time of the Joint Report, did not appear to have any causative significance. The fact that he did so, taken together with my other criticisms of his evidence, makes me wary of relying upon his expert evidence. Indeed, taken as a whole, I was left with the uneasy impression that Mr Collin was straining to establish the QE's liability rather than simply giving his expert evidence to the Court.

PROFESSOR BEARD

179. Turning to Professor Beard, I reject Dr Fox's criticism that he failed properly to set out the Bolam and Bolitho tests. Just as I do not criticise the Claimant's experts for having been briefed by her lawyers as to the test and then for their recitation of the wording given to them, equally I was not troubled by the fact that Professor Beard chose to use his own words.

180. Equally, I reject Dr Fox's criticism that Professor Beard failed to present a balanced narrative of the facts and that his narrative was "spin" designed to favour the defence. It would have been better if Professor Beard had included all of the vascular entries between 14:45 and 18:00, but I do not accept that his failure to do so undermined his credibility as an independent and reliable expert.

181. Dr Fox was right to say that he failed to set out the substance of his instructions in breach of the requirement under rule 35.10 and PD35, para. 3.2. That said, this duty can be discharged in an anodyne way. Dr Caplin, for example, simply wrote:

> "You asked for my opinion with regard to breach of duty and causation in this case." [C2]

182. Professor Beard did not include an equivalent sentence but I note that the cover sheet for his report included the sub-title "Breach of Duty and Causation." I struggle to see how I am more enlightened by Dr Caplin's having converted such title into a sentence of prose. While the professor should therefore check that his future medico-legal reports comply properly with Part 35, I do not consider that this issue is of any relevance when weighing the value of his evidence. Of far greater importance is the fact that Professor Beard provided the appropriate declaration confirming his understanding of and compliance with his duty to the Court.

183. More significantly, Professor Beard made somewhat heavy weather of causation. First, he changed his mind about an important issue of causation (see para. 200) and there was some internal inconsistency in a passage in his written evidence (see paras 201-202). Dr Fox was also right to correct a passage about re-thrombosis (see para. 204).

184. While I take into account these imperfections, I was generally impressed by Professor Beard. He was rightly proud of the clear and concise way in which he writes his expert reports, although he has, no doubt, now learnt the lesson that he is obliged to set out the substance of his instructions. Given the myriad difficulties with Mr Collin's evidence, I have no hesitation whatsoever in preferring the professor's evidence.

ISSUE 2: CONCLUSIONS

185. I accept that some vascular surgeons might well have taken Mrs Lane to theatre significantly earlier, perhaps shortly after the 12:40 assessment. Indeed, I have been troubled throughout this case that Mrs Lane did not get to theatre sooner than she did.

186. However, I accept the expert opinion of the obviously competent, responsible and respectable Professor Beard. Accordingly, in my judgment, a reasonable and responsible body of vascular surgeons would have delayed surgery until Mrs Lane's cardiac condition had been stabilised, alternatively until it became clear that no more could be done.

187. I find that such opinion can be supported in logic:

187.1 Mrs Lane remained extremely unwell. As Dr Bowater advised that evening, and Dr Caplin accepted, she was not out of danger.

187.2 Indeed, while that assessment could only be made prospectively, the fact that she subsequently went into asystolic arrest and remained in danger for some days itself indicates that the vascular team might well have got this judgment call right.

187.3 Even though the anaesthetists would have been content to offer a range of anaesthetic options, it was logical not to remove Mrs Lane from the Coronary Care Unit until everything possible had been done to stabilise her condition.

187.4 For reasons that I will explain more fully when looking at causation, it was logical to conclude that little could be done to reperfuse Mrs Lane's arm until her blood pressure could be stabilised.

ISSUE 3: THE SURGERY

The failure to cannulate the ulnar artery

188. In my judgment, the clear and contemporaneous evidence of Mr Nicholl's having achieved a good down and back bleed, the evidence of the brachial pulse and Mr Collin's concession that, on the balance of probabilities, a radial pulse would also have been palpable, indicate that Mr Nicholl had probably achieved reperfusion. Such finding is supported by his evidence, which I accept, that the hand *"pinked up."* It is further supported by the independent evidence of a normal capillary refill time being noted a few hours post-surgery.

189. Accordingly, on Mr Collin's own evidence, I find that there was no need for Mr Nicholl to have cannulated the ulnar artery.

190. In any event, I preferred Professor Beard's evidence that there were a number of good reasons not to perform an ulnar thrombectomy:

190.1 First, it is logical that clearing one artery of thrombus is sufficient to restore blood flow to the hand.

190.2 Secondly, basic anatomy means that it is generally easier to cannulate the radial artery; it being larger and flowing straight on from the brachial artery.

190.3 Thirdly, performing a further procedure would have caused damage to the intima (lining) of an additional artery.

190.4 Fourthly, the basic principle of vascular surgery is to do the minimum necessary.

190.5 Fifthly, withdrawing the catheter and then introducing it into the ulnar artery risks causing damage to the arterial junction.

191. For these reasons, I am satisfied that a reasonable and responsible body of vascular surgeons would not have also carried out an ulnar thrombectomy upon achieving reperfusion through thrombectomy of the brachial and radial arteries. Further, for the reasons elaborated above, such body of opinion withstands logical analysis.

Completion angiogram

192. Completion angiography would have shown that the ulnar artery was thrombosed. Accordingly, it served no purpose unless the surgeon would then have been required to cannulate the ulnar artery.

193. I therefore consider that this allegation stands or falls together with the previous allegation. Since, on my findings of fact, Mr Nicholl had successfully

cleared the brachial and radial arteries and achieved reperfusion of the right hand, completion angiography would simply have confirmed those facts and that the ulnar artery was also thrombosed. Given Mr Collin's concession that there was no need to cannulate the ulnar artery if reperfusion had been achieved, completion angiography would not, in this case, have led to any further procedure.

194. In any event, I accept Professor Beard's evidence that on-table angiography is very rarely performed in upper-limb vascular surgery. He explained that it is rather easier to be confident that thrombus has been cleared all the way to the hand in upper-limb surgery than to the foot in lower-limb surgery. That is in part because lower-limb embolectomy is performed from the groin whereas in the upper limb, the incision is made at the elbow allowing the surgeon to be confident as to which distal artery has been entered.

195. Accordingly, I have no hesitation in finding that a reasonable and respectable body of vascular surgeons would not have carried out completion angiography, and that such body of opinion withstands logical analysis.

CAUSATION

THE EXPERT EVIDENCE

196. Professor Beard reported that the most likely cause of the ischaemia was dissection of the intimal lining of the brachial or subclavian artery at the time of the PCI. The delayed presentation of ischaemia indicated that the dissection had not severely narrowed or occluded the artery. Therefore, the narrowed artery only subsequently thrombosed because of reduced arterial flow caused by Mrs Lane's poor cardiac output.

197. Mr Collin asserted that if vascular surgery had been performed in good time and competently, irreversible ischaemic injury would have been avoided. He gave five reasons in his report for the eventual amputation of the arm:

197.1 Long delay in surgery.

197.2 The occlusion of the brachial, radial and ulnar arteries.

197.3 The failure to perform the surgery competently.

197.4 The poor cardiac output.

197.5 The inadequacy of the collateral blood supply.

198. In cross-examination, Mr Collin added two further factors, namely the effect of inotropes and HIT. Inotropes cause vasoconstriction. This effect is obviously useful in treating hypotension, but not in the treatment of limb ischaemia.

199. While ultimately the collateral blood supply might have been insufficient to sustain the limb, Mr Collin acknowledged that it had proved sufficient to prevent irreversible tissue injury for many hours after occlusion, and further that it had been adequate to prevent irreversible injury for many hours *"after*

the continuing occlusion of the radial and ulnar arteries following the effective thrombectomy of the brachial artery."

200. Professor Beard explained in evidence that his views had moved on from his original report. Initially, and focusing on the events of 2 October, he had considered that the amputation was largely caused by the delay (which he regarded as *"enforced"* and *"inevitable"* because of Mrs Lane's poor cardiac condition) in the thrombectomy. On further reflection and following a conference with the cardiologists and Mr Nicholl, he concluded that an earlier thrombectomy would have been no more successful.

201. On this issue, Professor Beard was cross-examined about a curious response to the Claimant's question 8 in the Joint Report. The answer went:

"[Professor Beard] agrees that the arm amputation was largely due to the delay in embolectomy but that an earlier embolectomy would not have been successful because her cardiogenic shock could not be reversed."

202. Dr Fox fairly suggested that this was internally inconsistent, and Professor Beard accepted that it was not happily expressed.

203. Professor Beard explained that the hand was reperfused at the end of the thrombectomy on 2 October, and yet it became ischaemic again. Professor Beard said, at paras 4.8-4.9 of his report:

> "On the balance of probability, this was due to the patient's continued poor cardiac output, hypotension and peripheral vasospasm caused by the inotropes required to treat her hypotension, rather than inadequate clearance of the thrombus or a failure to cannulate the ulnar artery at the time of the original embolectomy, as the Claimant's poor cardiac condition did not improve despite treatment. Therefore, on the balance of probability, even if the embolectomy had been done earlier in the day, the brachial and forearm arteries would have thrombosed again and the outcome would have been the same.
>
> Another complication that probably contributed to re-thrombosis of the brachial and forearm arteries was [HIT]. This would have led to platelet aggregates forming in the damaged arteries of the right arm and hand."

204. Professor Beard accepted that his reference to re-thrombosis of the brachial and forearm arteries was inaccurate:

204.1 First, the brachial artery remained clear.

204.2 Secondly, the ulnar artery had never been cleared and so did not re-thrombose.

204.3 Only the radial artery had re-thrombosed.

He accepted the correction, but observed that this was logical since the radial artery was more vulnerable to the effect of vasoconstrictors than the larger brachial artery.

205. Professor Beard accepted that there would have been secondary or propagated thrombus by the time of the procedure, but disagreed that this was the cause of re-thrombosis, adding:

> "Re-thrombosis was mainly due to the patient's continued cardiogenic shock, compounded by other pro-thrombotic factors including the embolectomy itself, which damages the anti-thrombotic endothelial cell lining of the arteries, vasospasm caused by the need for inotrope support, and the development of [HIT]."

206. Professor Beard was referred to Mr Rai's pessimistic conclusion. He offered the interpretation that Mr Rai believed that because of Mrs Lane's cardiogenic shock, any reperfusion would not be sustained. As he put it, you need the pump to be working to get the radiators to work.

207. Mr Collin had originally concluded that fasciotomy would have made it more likely than not that further ischaemic injury, and therefore amputation, would have been avoided. However, in his answers to the Claimant's question 5 and the Defendants' question 2 in the Joint Report, Mr Collin appeared to have abandoned any suggestion that a fasciotomy was essential. Furthermore, in his answer to the Claimant's question 11, Mr Collin agreed with Professor Beard that on the balance of probabilities the arm would still have been amputated even if a fasciotomy had been performed.

ANALYSIS

208. The ischaemia was plainly caused by the development of thrombus in the arteries of Mrs Lane's right arm. I am satisfied that Mrs Lane's brachial artery was narrowed, but not occluded, by dissection at the time of the PCI procedure. Such intimal damage made her susceptible to thrombosis, but, on the balance of probabilities, thrombus was only formed in this case because of a number of contributory factors:

208.1 First, Mrs Lane suffered profound and sustained hypotension. This of itself carried a risk of embolisation.

208.2 Secondly, the inotropic drugs rightly prescribed in order to treat Mrs Lane's hypotension had a vasoconstrictor effect which necessarily inhibited blood flow to the peripheries.

209. As I have already explained, I find that Mr Nicholl achieved successful reperfusion of the arm even though surgery was delayed until after 21:00. This is not therefore a case of failed delayed surgery but of surgery that, although initially successful, was unable to sustain blood flow to Mrs Lane's arm.

210. In my judgment, the arm re-thrombosed because cardiac output remained low. Specifically:

210.1 Mrs Lane remained in cardiogenic shock with low systolic pressure.

210.2 The inotropes that were necessary to treat her cardiac condition had the effect of further reducing peripheral blood flow.

210.3 Mrs Lane was unfortunate to suffer from undiagnosed HIT, such that the heparin prescribed to treat her infarction actually had a thrombotic effect.

211. In addition, I accept the evidence that the very fact of Mr Nicholl's surgery will itself have caused some damage to the anti-thrombotic lining of the brachial and radial arteries.

212. I therefore find, on the balance of probabilities, that Mrs Lane's arm would not have been saved even if Mr Nicholl had operated earlier. An earlier operation would no doubt have also led to the successful reperfusion of the arm, but, for the reasons already set out, such result would not have been sustained.

213. Accordingly, even if I am wrong to dismiss the allegations of delay and inadequate surgical technique in this case, I find that any such negligence did not cause the subsequent amputation.

214. In preferring Professor Beard's evidence on causation, I again acknowledge the problems with his evidence on this issue. Nevertheless, I am satisfied that he was right. Indeed, in my judgment, my conclusions flow logically from the finding of successful reperfusion.

OUTCOME

215. I therefore dismiss this claim against both defendants.

216. Mrs Lane will of course be disappointed in the result. Understandably, she has no recollection of these events. While some cardiologists might have transferred her immediately, and some vascular surgeons might have operated sooner, I hope that in time she takes comfort from knowing that earlier intervention would not have saved her arm.