IN THE CORONERS COURT
OF VICTORIA
AT MELBOURNE

Court Reference: COR 2020 0832

FINDING INTO DEATH WITHOUT INQUEST

Form 38 Rule 63(2)
*Section 67 of the **Coroners Act 2008***

Findings of:	Caitlin English, Deputy State Coroner
Deceased:	Ann Leah Jones
Date of birth:	14 April 1932
Date of death:	14 February 2020
Cause of death:	1(a) Pulmonary artery rupture complicating pulmonary artery catheter insertion in a woman with severe ischaemic heart disease <u>Contributing factors</u> Aortic rupture complicating balloon pump insertion during resuscitation for cardiac arrest
Place of death:	The Valley Private Hospital, 1 Blanton Drive, Mulgrave, Victoria

INTRODUCTION

1. On 14 February 200, Ann Leah Jones was 87 years old when she died while undergoing a medical procedure. At the time of her death, Mrs Jones lived at Officer.

THE CORONIAL INVESTIGATION

2. Mrs Jones's death was reported to the Coroner as it fell within the definition of a reportable death in the *Coroners Act 2008* (**the Act**). Reportable deaths include deaths that are unexpected, unnatural or violent, or result from accident or injury.

3. The role of a coroner is to independently investigate reportable deaths to establish, if possible, identity, medical cause of death, and surrounding circumstances. Surrounding circumstances are limited to events which are sufficiently proximate and causally related to the death. The purpose of a coronial investigation is to establish the facts, not to cast blame or determine criminal or civil liability.

4. Under the Act, coroners also have the important functions of helping to prevent deaths and promoting public health and safety and the administration of justice through the making of comments or recommendations in appropriate cases about any matter connected to the death under investigation.

5. As part of my investigation, I obtained statements from the hospital and Mrs Jones's treating medical practitioners. I also obtained advice from the Coroners Prevention Unit about the medical care Mrs Jones received immediately before her death.

6. This finding draws on the totality of the coronial investigation into Mrs Jones's death, including evidence. Whilst I have reviewed all the material, I will only refer to that which is directly relevant to my findings or necessary for narrative clarity. In the coronial jurisdiction, facts must be established on the balance of probabilities.[1]

[1] Subject to the principles enunciated in *Briginshaw v Briginshaw* (1938) 60 CLR 336. The effect of this and similar authorities is that coroners should not make adverse findings against, or comments about, individuals unless the evidence provides a comfortable level of satisfaction as to those matters taking into account the consequences of such findings or comments.

MATTERS IN RELATION TO WHICH A FINDING MUST, IF POSSIBLE, BE MADE

Identity of the deceased

7. On 14 February 2020, Ann Leah Jones, born 14 April 1932, was visually identified by her daughter, Belinda Jones.

8. Identity is not in dispute and requires no further investigation.

Medical cause of death

9. Forensic Pathologist, Dr Joanna Glengarry, from the Victorian Institute of Forensic Medicine (**VIFM**), conducted an examination on 18 February 2020 and provided a written report of her findings dated 17 April 2020.

10. Review of computed tomography images revealed was evidence of contrast leak in the region of one and/or two pulmonary artery branches on the left and right respectively. This implied that the blood vessel had been damaged and ruptured. Dr Glengarry explained that the pulmonary arteries are the outflow source of blood from the right side of the heart into the lungs, and injury to these may cause bleeding into the lungs and symptoms of coughing up blood. The examination showed bleeding within the lung as a consequence of the pulmonary artery rupture.

11. Clinically, it was suspected that vascular injury had occurred as a consequence of insertion of a Swan-Ganz pulmonary artery catheter (**PAC**) (a long vascular line used to monitor pulmonary artery pressures during the operation). Dr Glengarry agreed this would appear to be the most likely explanation.

12. The examination also revealed severe ischaemic heart disease as documented during life.

13. Sequelae of resuscitation were significant and one particular complication was considered contributory to death but was not the cause of death. Dr Glengarry noted that Mrs Jones was *in extremis* with life-threatening pulmonary haemorrhage due to the pulmonary artery rupture, requiring extensive resuscitation measures. One of these measures was the insertion of an aortic balloon pump. Dr Glengarry explained that this is a device inserted into the aorta used to support a critically low blood pressure and is used when the patient's condition is critical. Due to the markedly fragile nature of Mrs Jones's aorta (an underlying predisposition due to severe cholesterol and calcium build-up in the wall that commonly occurs in the aged), the balloon pump subsequently caused a rupture of the aorta wall (the aorta is the main artery

exiting the heart and supplying the body with blood). This caused bleeding into the chest (which was noted during resuscitation).

14. Dr Glengarry provided an opinion that the medical cause of death was *"1(a) Pulmonary artery rupture complicating pulmonary artery catheter insertion in a woman with severe ischaemic heart disease"* with a contributing factor of aortic rupture complicating balloon pump insertion during resuscitation for cardiac arrest.

15. I accept Dr Glengarry's opinion.

Circumstances in which the death occurred

16. Mrs Jones's medical history included ischaemic heart disease,[2] hypertension,[3] atrial fibrillation,[4] reflux, gout,[5] type two diabetes (diet-controlled), transient ischaemic attack,[6] hyperlipidaemia,[7] hearing impairment and she had a permanent pacemaker.[8]

17. She was scheduled to undergo elective off-pump coronary artery bypass surgery[9] for worsening angina[10] and cardiac-related[11] exertional breathlessness.[12] It was reported that Mrs Jones could only walk about 30 metres and was unable to go shopping and it was hoped the procedure would allow a return of some impendence.

[2] A disease characterised by ischaemia (reduced blood supply) of the heart muscle.
[3] Elevated blood pressure.
[4] Atrial fibrillation is the most common cardiac arrhythmia, whereby disorganised, erratic, and rapid electrical signals cause the atria heart chambers to contract irregularly. Symptoms can include palpitations, dizziness, shortness of breath, tiredness and low blood pressure. An increased risk of ischaemic stroke in AF is caused by the possible formation of blood clots (emboli) resulting from blood stasis due to improperly contracting chambers of the heart. These emboli can be conveyed through the vasculature, commonly becoming lodged in the brain, and resulting in localised ischaemia. Patients with atrial fibrillation are usually prescribed a blood-thinning agent such as warfarin to reduce the risk of such a stroke.
[5] A form of arthritis that occurs when uric acid builds up in blood and causes joint inflammation. Acute gout is a painful condition that typically affects one joint.
[6] Transient ischaemic attacks are more commonly known as a 'mini stroke'. They have identical symptoms to a stroke although these last for less than 24 hours and are followed by a full recovery, due to a transient episode of neurologic dysfunction caused by ischemia (loss of blood flow) – either focal brain, spinal cord or retinal – without acute infarction (tissue death).
[7] Abnormally elevated levels of any or all lipids and/or lipoproteins in the blood.
[8] A surgically implanted device used to control heart rate in people with an abnormal heart rhythm when medication has failed.
[9] Coronary artery bypass surgery or CABG is heart surgery in which the rib cage is opened and venous grafts (harvested from elsewhere in the body) are placed over the occluded arteries to bypass the narrowing or blockage, to enable improved blood flow to the heart.
[10] Angina is pain or discomfort caused by the heart not receiving enough blood and oxygen.
[11] Worsening ventricular function caused by coronary ischaemia.
[12] Mrs Jones could only walk about 30 metres and hoped the surgery would improve her quality of life and regain her physical independence.

18. Mrs Jones stopped taking her Pradaxa (dabigatran)[13] for her atrial fibrillation five days prior to surgery, as planned with the cardiothoracic surgeon.

19. On the afternoon of 13 February 2020, Mrs Jones was admitted to The Valley Private Hospital (now Mulgrave Private Hospital) in anticipation of the surgery to be carried out the next morning.

20. At approximately 7.30am on 14 February 2020, standard intra-venous and intra-arterial lines for the cardiac surgery – including a pulmonary artery Swan-Ganz PAC[14] – were inserted under local anaesthetic by Dr John Lau, anaesthetist. Mrs Jones remained clinically stable throughout the procedures, including normal pulmonary artery pressures.[15] Dr Lau stated that Mrs Jones remained fully conscious until the induction of anaesthesia. She did not complain of feeling unwell or mention blood in her mouth. She did not cough or complain of any chest pain.

21. At approximately 8.50am, upon anaesthetic induction[16] (following arrival of the surgeon in operating theatre) and just prior to intubation,[17] a moderate amount of blood was observed in Mrs Jones's oral cavity. The endotracheal tube was inserted successfully, however high peak inspiratory (airway) pressures were noted. Ventilation became extremely difficult, and Mrs Jones developed hypoxia[18] and then hypotension,[19] as the amount of bleeding increased. It was unclear whether the bleeding was from the airway or the oesophagus.

22. By approximately 9.00am, Mrs Jones had become increasingly clinically unstable and progressed to a pulseless electrical activity[20] cardiac arrest. Cardiopulmonary resuscitation was commenced (and a Code Blue[21] initiated), with multiple emergency medications and blood products administered. A double lumen endotracheal tube was inserted, alternatively

[13] An oral anticoagulant medication.
[14] A pulmonary artery catheter is inserted for both blood pressure / cardiac output monitoring and to facilitate the administration of intravenous medications. It is a common element of anaesthetic and post-operative care in cardiothoracic surgery. The PAC is inserted via a large vein (usually in the neck) and passed through the right atrium and right ventricle of the heart to lie in a pulmonary artery (the blood vessel that conveys blood from the right side of the heart to the lungs).
[15] The pressure generated from the right side of the heart pumping blood to the lungs before returning to the left side of the heart.
[16] Administration of anaesthetic agents (typically a combination of sedation, narcotic analgesia, and muscle relaxant medications) to insert the endotracheal tube to enable mechanical ventilation.
[17] Endotracheal intubation is a procedure by which a tube is inserted through the mouth down into the trachea (the large airway from the mouth to the lungs) to enable ventilation.
[18] Reduction of oxygen supply to a tissue below normal physiological level.
[19] Low blood pressure.
[20] An organised heart rhythm without sufficient mechanical contraction to produce a palpable pulse or measurable blood pressure. This is a medical emergency and requires initiation or continuation of cardiopulmonary resuscitation.
[21] An emergency call for assistance in the management of patients who are having or are anticipated to have a cardiorespiratory arrest. A Code Blue facilitates near immediate review by senior medical and intensive care doctors and nurses with the intention of attempting to resuscitate the patient.

isolating each lung while suctioning blood from the other, with no significant improvement in ventilation. A bronchoscopy[22] was performed, but the bleeding was so profuse despite continuous suctioning, no point of origin could be identified. Multiple anaesthetists attended to assist.

23. An intra-aortic balloon pump (**IABP**)[23] was subsequently inserted and a gastroscopy[24] and transoesophageal echocardiogram[25] were performed, with bilateral intercostal catheters[26] inserted (two litres of blood was drained from the right chest) at a late stage in the resuscitation.

24. After consultation between the resuscitation team, the medical/ intensive care director, and the anaesthesia lead, and following discussion with Mrs Jones's son, the prolonged resuscitation attempt was discontinued, and Mrs Jones was pronounced deceased at 11.14am.

FURTHER INVESTIGATION INTO MRS JONES'S MEDICAL CARE

25. I note that at the time of anaesthetic induction, a moderate amount of blood was observed in Mrs Jones's oral cavity. The presence of haemoptysis[27] or blood in the oral cavity is a known clinical sign of pulmonary artery perforation or rupture in the setting of PAC insertion[28] (though it can also be due to other causes). It was unclear when pulmonary artery rupture was initially considered as a potential cause of the blood pooling in Mrs Jones's mouth and whether definitive investigation and treatment of such a life-threatening emergency (via either thoracic surgery or angioembolisation[29]) was considered prior to her cardiac arrest. I therefore requested the Coroners Prevention Unit (**CPU**) to review Mrs Jones's medical care.

26. The CPU is staffed by healthcare professionals, including practising physicians and nurses. Importantly, these healthcare professionals are independent of the health professionals and

[22] Technique of visualising the inside of the airways for diagnostic and therapeutic purposes. An instrument (bronchoscope) is inserted into the airways, usually through the nose or mouth, or occasionally through a tracheostomy. This allows the practitioner to examine the patient's airways for abnormalities such as foreign bodies, bleeding, tumors, or inflammation.
[23] A catheter with a balloon is inserted into the aorta and used to augment critically low blood pressure and relieve the workload of the heart. The catheter is usually inserted via the femoral artery and sits in the thoracic segment of the descending aorta (the main blood vessel in the centre of the body carrying oxygenated blood away from the heart).
[24] To investigate for bleeding in the oesophagus and stomach using a long, thin, flexible tube with a camera. No bleeding in the stomach and oesophagus was identified.
[25] To investigate for pericardial effusion (excess fluid in the membranous sac that envelops the heart) by placement of an ultrasound probe in the oesophagus. No pericardial effusion was identified.
[26] Flexible plastic tube that is inserted through the side of the chest into the pleural space. It is used to remove air (pneumothorax), fluid (pleural effusion, blood, chyle), or pus (empyema) from the intrathoracic space.
[27] Coughing up blood.
[28] Sirivella, Gielchinsky & Parsonnet, 2001, "Management of catheter-induced pulmonary artery perforation: A rare complication in cardiovascular operations", Annals of Thoracic Surgery, Vol. 72, pp. 2056-2059.
[29] Minimally invasive interventional radiology procedure to occlude bleeding vessels.

institutions under consideration. They draw on their medical, nursing, and research experience to evaluate the clinical management and care provided in particular cases by reviewing the medical records, and any particular concerns which have been raised.

Presence of known or emerging risk factors

27. Before proceeding to advise whether Mrs Jones's case was reasonable, the CPU explained the complications that Mrs Jones encountered, and which contributed to her death.

Pulmonary artery rupture secondary to pulmonary artery catheter insertion

28. The post-mortem examination confirmed that *PAC was in situ, with the tip of the catheter sited at the pulmonary trunk branching into left and right arteries. The PAC had correctly traversed the right atrium and ventricle of the heart, without causing damage to either heart chamber.*[30]

29. The CPU noted that pulmonary artery rupture, a known rare complication of PAC insertion, has a mortality rate of 30 to 70 per cent.[31] I note that a search of the National Coronial Information System on 12 November 2020 of previous pulmonary artery rupture deaths caused by or possibly caused by a PAC in Victoria revealed five other cases.

Intra-aortic balloon pump balloon rupture

30. *The CPU noted that* there was longitudinal rupture of the IABP balloon along its lateral edge in the area of the aortic rupture.

31. *The CPU explained that IABP balloon rupture is a known rare complication of IABP, which is generally considered to be caused by the balloon inflating and deflating against abrasive calcified plaque lining the aorta wall.*[32] *Mrs Jones was found to have severe build-up of plaque lining her aorta during the post-mortem examination.*

[30] To insert the PAC through the right heart into the pulmonary artery, the clinician inflates a small balloon at the tip of the catheter and, assisted by blood flow, advances (or 'floats') the catheter through the right side of the heart until it is seated within the pulmonary artery.
[31] Weinhouse, 2019, "Pulmonary artery catherization: Indications, contraindications, and complications in adults", Up To Date, accessed online 17 November 2020, Version 25.0.
[32] Laham & Pinto, 2020, "Intraaortic balloon pump counterpulsation", Up To Date, accessed online 17 November 2020, Version 26.0.

Aortic rupture secondary to the intra-aortic balloon pump balloon

32. *The CPU noted that the post-mortem examination confirmed the* IABP was in situ. There was rupture of left lateral thoracic aortic wall (7 x 4 cm tear) at the location of the IABP balloon, in the setting of brittle severe atherosclerosis of the aorta[33] with markedly friable aortic wall tissue.

33. *The CPU noted that Mrs Jones was 161cm tall and advised that the selection of the 30cc IABP catheter by the perfusionist was appropriate for her height.*[34]

34. The CPU explained that insertion of the IABP catheter was complicated by initial poor position of the catheter and balloon, so it was removed from the left femoral vein and inserted in the right femoral vein, resulting in improved augmentation (cardiac support). There were five attempts to insert the IABP correctly in total.

35. *Aortic dissection*[35] *is a known rare complication in IABP.*[36] *At post-mortem examination, a small aortic dissection only was present at the edge of the aortic wall rupture, however the aorta was noted to be "brittle, fragile and readily fractures through the severe atheroma present throughout its length".*

Assessment of health care diagnosis/ treatment/ follow-up

36. As part of my review of Mrs Jones' medical care, I obtained statements from Mrs Jones's treating medical clinicians – Dr Lau and Associate Professor Philip Hayward, cardiothoracic surgeon.

Statement from Dr Lau

37. In his progress notes, Dr Lau documented that the PAC was inserted under ultrasound guidance and the balloon tip was 'floated'[37] uneventfully into the pulmonary artery. The PAC

[33] The main artery exiting the heart and supplying the body with blood.
[34] Teleflex 2017, "Arrow Intra-Aortic Balloon Catheter Options". Accessed online 17 November 2020, <https://www.teleflex.com/usa/en/product-areas/interventional/cardiac-assist/intra-aortic-balloon-catheters/Arrow-IAB-Catheters-Brochure-MC-000164-Rev-2.pdf>.
[35] Aortic dissection is a tear or partial tear in the lining of the largest blood vessel in the body, the aorta. This tear allows blood (and the pressure of the blood flow) to penetrate the arterial wall. Over time, this continuous flow can cause the aorta to rupture - a condition that most people do not survive.
[36] De Augustin et al, 2014, "Aortic dissection caused by intra-aortic balloon pumping", European Heart Journal", 35(26), p. 1718.
[37] To insert the PAC through the right heart into the pulmonary artery, the clinician inflates a small balloon at the tip of the catheter and, assisted by blood flow, advances (or 'floats') the catheter through the right side of the heart until it is seated within the pulmonary artery.

was not 'wedged'[38] and there was an unremarkable initial pulmonary artery pressure of 35/20mmHg (later increasing to an extremely high 88/40mg, which was greater than the systolic blood pressure[39]).

38. Mr Lau stated that between 8.00am and 8.49am and while waiting for the surgeon to arrive, Mrs Jones's pulmonary artery pressure began rising with corresponding mild systolic hypertension. This prompted him to urgently request inhaled pulmonary vasodilator from the intensive care unit and expedite induction of anaesthesia, which occurred at about 8.50am, to enable intervention and treatment of the increasing pressure. At this time, he first noticed bleeding in the mouth.

39. Dr Lau stated that when blood was identified in Mrs Jones's oral cavity, his primary diagnosis was pulmonary artery injury causing airway bleeding. A differential diagnosis of localised/pharyngeal trauma was ruled out upon direct laryngoscopy and immediately post intubation, high airway pressure, and ongoing airway bleeding

40. In his statement, Dr Lau noted that he has since reflected in his use of PAC insertion in particular for high-risk patients *"despite PAC routinely being used and expected for most cardiac surgery in the state of Victoria".* He has also modified my practice so as to float the PAC for high-risk patients only after a sternotomy has been performed, so as to possibly ease resuscitation effort should a PA injury be encountered again.

Statement from Associate Professor Hayward

41. Associate Professor Hayward provided details of Mrs Jones's assessment for surgery, consent process, and risks associated with surgery.

42. He stated that when he entered the operating room, Mrs Jones was awake and not yet intubated. Almost immediately, she began to experience haemoptysis and her decline from there was very rapid, into massive haemorrhage, inability to ventilate or oxygenate, severe central hypoxia and then hypotension and loss of cardiac output (presumed due to coronary ischaemia secondary to hypovolaemia and central hypoxia). The immediate clinical suspicion was of pulmonary artery rupture.

[38] A pulmonary artery wedge pressure is recorded when the catheter tip is briefly wedged in the tapering branch of one of the pulmonary arteries. The reading provides an indication of left ventricle preload.
[39] Systolic blood pressure is the peak blood pressure in the body generated by the heart primarily due to the contraction of the left ventricle.

43. Associate Professor Hayward provided rationale for the insertion of the IABP at 10.15am (after about 75 minutes of cardiac massage at a time when cardiac output was briefly restored), and the difficulties associated with the insertion. He stated:

> *As Mrs Jones had been without cardiac output for more than an hour before this, in my opinion the aortic injury from the balloon pump, after already a prolonged unsuccessful attempt at resuscitation, was non-contributory or relevant to her death which was already in evidence.*

44. In response to a question as to whether other surgical interventions/options ought to have been considered, Associate Professor Hayward stated that other therapeutic interventions were not feasible or realistic options. He went on to provide a very detailed consideration of the suggested options proffered in the statement questions and provided support as to the rationale the suggested treatment options were not attempted.

45. Associate Professor Hayward also provided significant additional commentary in his statement in relation to the usage of PACs, treatment of pulmonary artery rupture, the haemodynamic monitoring, and post-mortem findings.

46. I also note that in his letter to Mrs Jones's general practitioner, Associate Professor Hayward, explained that chest surgery and cardiopulmonary bypass were options considered during the latter stages of the resuscitation, though the chance of survival was considered remote or non-existent, and the latter contraindicated due to the requirement for high dose anticoagulation.

Coroners Prevention Unit conclusion regarding medical care

47. The CPU advised that anaesthetists typically may administer some intravenous sedation for inserting central venous access lines in the setting of preparing for major surgery prior to the arrival of the surgeon. On this occasion Dr Lau administered 100mcg of intravenous fentanyl. It was likely due to this sedation that Mrs Jones did not alert the theatre staff of the blood pooling in her mouth, though how long the blood was pooling before it was identified is undetermined. Once the bleeding had been identified, it was appropriate to intubate Mrs Jones in an attempt to provide ventilatory support and maintain a patent airway.

48. Following the initiation of the Code Blue at approximately 9.00am on 14 February 2020, the protracted resuscitation attempt (including multiple procedural interventions) appeared to have been reasonable, despite the catastrophic iatrogenic injuries.

Hospital internal review

49. As part of my investigation, I obtained statements from Kay Hotker, Director of Clinical Services at Mulgrave Private Hospital.

50. Ms Hotkey explained that the circumstances of Mrs Jones's death were investigated by a root cause analysis internal investigation and subsequently presented at a morbidity and mortality committee meeting. Issues identified from the investigation were as follows:

    (a) there was a prolonged initial wait time in the operating theatre with Mrs Jones under sedation prior to intubation and planned commencement of the surgery. Following discussion between the anaesthetist and the Medical Advisory Committee anaesthetic representative, the anaesthetist will now ensure delay of anaesthesia commencement until the arrival of the surgeon in the theatre for such a case;

    (b) the PAC was inserted approximately 45 minutes prior to intubation. Following discussion between the anaesthetist and the Medical Advisory Committee anaesthetic representative, the anaesthetist will now wait to 'float' the PAC balloon until the patient is intubated and the sternotomy[40] has commenced;

    (c) there were initial subtle changes in Mrs Jones's haemodynamic parameters (pulmonary artery pressure change, blood pressure decline, carbon dioxide level increase) prior to her rapid clinical decline. Following discussion between the anaesthetist and the Medical Advisory Committee anaesthetic representative about being more aware of subtle changes in patient parameters (in particular, increase in carbon dioxide and pulmonary artery pressure), and investigate causes and implement preventative measures earlier; and

    (d) anaesthetic nursing staff assessing subtle changes in Mrs Jones' haemodynamic parameters. The Practice Development Unit facilitated training sessions for anaesthetic nursing staff are to ensure they escalate concerns to the anaesthetist if they become aware of changes in a patient's haemodynamic parameters.

51. In relation to the noted subtle haemodynamic changes with increased pulmonary artery pressures, increased blood pressure and increased carbon dioxide levels, Ms Hotker stated:

[40] Type of surgical procedure in which a vertical inline incision is made along the sternum, after which the sternum itself is divided, or 'cracked'. This procedure provides access to the heart and lungs for surgical procedures such as congenital heart defects surgery or coronary artery bypass surgery.

Outcomes from the Root Cause Analysis and discussion at the next Medical Advisory Committee post this incident, recommended changes in practice including delaying in proceeding with indication of anaesthesia, until surgeon is present in the theatre and ready to proceed and to delay floating of the Swan Ganz balloon catheter until surgical intervention of sternotomy has commenced.

Report to Safer Care Victoria

52. Ms Hotker provided the Court with a copy of the final report to Safer Care Victoria, which contained two recommendations as follows:

    (a) that the hospital purchases an intubation practice simulation model and conduct training with the anaesthetic nursing team to increase the skill level related to a patient's haemodynamic parameters during anaesthetic. The intubation practice simulation model has since been purchased and education sessions have been conducted and completed into escalation of concerns to the anaesthetist if there are changes to the patients' haemodynamic parameters; and

    (b) delay of anaesthesia until the surgeon arrives in the operating theatre. Ms Hotker confirmed that there will be a delay in anaesthesia until the surgeon is in the operating theatre, therefore decreasing the wait time and possibility of prolonged sedation. Additionally, the pulmonary artery balloon pump will be inserted but not 'floated' until the patient is intubated, and sternotomy commenced.

Family meeting

53. Ms Hotker also noted that the surgeon and anaesthetist had met with Mrs Jones's son immediately after her death to explain what had transpired (open disclosure) and that the suspected cause of the airway bleeding was pulmonary artery rupture caused by insertion of the PAC.

Response from the manufacturer of the intra-aortic balloon pump

54. Ms Hotker also advised that the hospital identified Getinge (the manufacturer) of the ruptured IABP balloon. However, as rupture was not suspected at the time of the incident, it was not retained for the purpose of return to Getinge for evaluation.

Guidance and usage of pulmonary artery catheters in high-risk cardiothoracic surgery

55. In their statements, Dr Lau and Associate Professor Hayward both discussed the usage of PAC in cardiothoracic surgery.

56. To further assist my investigation, I sought commentary from the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (**ANZSCTS**) in relation to the guidance and usage of PACs in high-risk cardiothoracic surgery. The statement questions were addressed by cardiothoracic surgeon Emily Granger, Vice President, ANZSCTS as follows:

(a) Is the usage of pulmonary artery catheters (Swan-Ganz) for cardiac output monitoring during cardiothoracic surgery the current best practice? Ms Granger stated:

> *Use of SGC [Swan-Ganz catheters] varies from institution to institution and is usually dependent upon the nature of the case being undertaken ... Most cardiac cases will have a SGC inserted as routine monitoring for their operation, but this is also highly influenced by the nature and risk of the surgery.*
>
> *...*
>
> *In summary, for certain operations and patients a SGC to monitor cardiac output and pulmonary pressures may be part of best practice for that patient, however a SGC is not critical for every case.*

(b) Are pulmonary artery catheters (Swan-Ganz) the only option for cardiac output monitoring during cardiothoracic surgery? Ms Granger provided detail other options to the Swan Ganz catheter however state that the Swan Ganz catheter was the most accurate as can help the anaesthetist to pre-empt the unstable patient by monitoring the cardiac output and detecting an early decline;

(c) In regard to high-risk patients, are there additional risks in the usage of PACs and what step ought to be taken to minimise risk? Ms Granger provided detail of the risks associated with PAC placement, including pulmonary artery rupture and stated:

> *Of course, patients with fragile tissues (elderly, steroids, immune suppression, pulmonary hypertension, lung disease) are specifically at higher risk for these complications. Anaesthetists placing these catheters use careful technique on all patients, but in these concerning groups greater caution is always used.*

(d) Should the first 'floating' of the Swan-Ganz catheter be performed after a sternotomy, is this current practice? Ms Granger explained that the catheter is usually floated immediately after the sheath is inserted. This is usually just prior to prepping and draping. Further in the statement, Ms Granger provided scenarios where the floating of the catheter may be either delayed or when the surgery is completed.

COMMENTS

Pursuant to section 67(3) of the Act, I make the following comments connected with the death.

57. Due to her advanced age and cardiac / cardiovascular disease, avoiding the need for surgery was appropriately attempted with a trial of medical therapy[41] to relieve Mrs Jones's debilitating cardiac symptoms. However, this was unsuccessful, and so after two consultations and lengthy discussions about the surgical risks with Associate Professor Hayward, Mrs Jones consented to undergo coronary artery bypass surgery.

58. Pulmonary artery rupture – with its high mortality rate and the delayed identification – was the cause of Mrs Jones's death. The aortic rupture caused by the IABP was a catastrophic complication of the attempted resuscitation and contributing factor in the death.

59. After a review of the materials obtained during my investigation and consideration of the advice from the CPU, I am satisfied that pre-operative assessment for surgery, consent, and plan for surgery was appropriate. Resuscitation attempts were appropriate. The necessity for Swanz-Ganz catheter was appropriate. Unfortunately, pulmonary artery rupture, which a known rare complication of PAC insertion, has a mortality rate of 30 to 70 per cent.[42]

FINDINGS AND CONCLUSION

60. Pursuant to section 67(1) of the Act I make the following findings:

(a) the identity of the deceased was Ann Leah Jones, born 14 April 1932;

(b) the death occurred on 14 February 2020 at The Valley Private Hospital, 1 Blanton Drive, Mulgrave, Victoria, from pulmonary artery rupture complicating pulmonary artery catheter insertion in a woman with severe ischaemic heart disease with a

[41] Multiple cardiac and cardiac-related medications.
[42] Weinhouse, 2019, "Pulmonary artery catherization: Indications, contraindications, and complications in adults", Up To Date, accessed online 17 November 2020, Version 25.0.

contributing factor of aortic rupture complicating balloon pump insertion during resuscitation for cardiac arrest; and

(c) the death occurred in the circumstances described above.

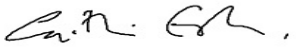
I convey my sincere condolences to Mrs Jones's family for their loss.

Pursuant to section 73(1A) of the Act, I order that this finding be published on the Coroners Court of Victoria website in accordance with the rules.

I direct that a copy of this finding be provided to the following:

Belinda Jones, senior next of kin
Mulgrave Private Hospital
Safer Care Victoria
Australian & New Zealand Society of Cardiac & Thoracic Surgeons
Australian Society of Anaesthetists
Senior Constable John Hughes, Victoria Police, reporting member

Signature:



Caitlin English, Deputy State Coroner

Date: 15 March 2022

NOTE: Under section 83 of the ***Coroners Act 2008*** ('the Act'), a person with sufficient interest in an investigation may appeal to the Trial Division of the Supreme Court against the findings of a coroner in respect of a death after an investigation. An appeal must be made within 6 months after the day on which the determination is made, unless the Supreme Court grants leave to appeal out of time under section 86 of the Act.