



OFFICE OF THE STATE CORONER

NON-INQUEST FINDINGS OF INVESTIGATION

CITATION: **Investigation into the death of SG**

TITLE OF COURT: Coroners Court

JURISDICTION: Brisbane

FILE NO(s): 2012/1386

DELIVERED ON: 1 September 2014

DELIVERED AT: Brisbane

FINDINGS OF: John Lock, Deputy State Coroner

CATCHWORDS: Coroners: investigation, health care related, central venous line arterial puncture, vascular complication

Introduction

SG was a 68 year old married woman. On 21 April 2012 she died after a health procedure at Greenslopes Private Hospital.

She had a history of diverticulitis and a previous Hartmann's procedure from which there were considerable postoperative complications.

SG was admitted to hospital for a laparotomy, reversal of the Hartmann's procedure/stoma, hernia repair and cholecystectomy. The operation was expected to be a long one, however while the anaesthetist was inserting a central line, the right subclavian artery in the neck was punctured.

The line was removed and a vascular surgeon was called in. The abdominal procedure was abandoned. A neck dissection and exploration of the carotid artery was performed. During this procedure SG's vital signs deteriorated and she had a cardiac arrest. CPR was commenced. Another surgeon performed an urgent sternotomy to get better access to the bleeding artery. A cardiac thoracic surgeon attended to the sternotomy and assisted in the closure of the sternal wound. The puncture in the subclavian artery was identified and repaired.

The estimated blood loss throughout surgery was 1360 millilitres. A massive transfusion was activated and Heparin was commenced for anticoagulation.

Resuscitation continued and SG was stabilised and then was transferred to the Intensive Care Unit. Approximately four hours later she had an episode of ventricular tachycardia and resuscitation was commenced. CPR continued for 50 minutes but she could not be revived.

Autopsy results

An external and full internal autopsy examination was performed. The medical charts of Greenslopes Private Hospital, Logan Hospital and GP records were also reviewed.

The examination found two sutured lacerations (4mm and 3mm) of the right subclavian vein. In addition, another un-sutured 3mm laceration was found in the same artery. There was evidence of marked soft tissue haemorrhage in the right side of the neck. There was 520mls of blood in the neck drain in addition to the 1060mls of estimated blood loss throughout surgery.

There is no evidence of major coronary artery disease, acute myocardial infarction or sepsis at autopsy. The heart was mildly to moderately enlarged, probably due to chronic hypertension.

The primary cause of death was considered to be a cardiac arrest secondary to blood loss following right subclavian artery lacerations. Subsequent chest and neck surgery had been performed as potentially life-saving procedures.

The investigation

Statement of anaesthetist

The anaesthetist Dr E and the surgeon, Dr NL agreed that a central venous line was necessary due to the long duration of the surgery; issues of unknown blood loss and fluid management; and SG's description of difficult intravenous access from previous hospital admissions. The anaesthetist felt it was the safest and most appropriate action to ensure she was adequately protected from those risks during surgery. The only other option available was an insertion of a Peripherally Inserted Central Catheter (PICC line); however she had a DVT associated with a PICC line in a previous admission.

Dr E stated the risk of inadvertent arterial puncture is a known complication of insertion of a central venous catheter and can happen in the best of hands.

Dr E's statement in paragraphs 14 to 17 describes what happened:

14. *I was responsible for the insertion of the central venous line. I determined together with Dr L that a central venous line was necessary due to the long duration of the surgery, issues of unknown blood loss and ongoing fluid management and SG describing difficult intravenous access from a previous hospital admission.*
15. *Initially I used a high approach on the right internal jugular but I was unable to feed the catheter over the medial. I had, however, located the plane with a 23 gauge seeker needle. I requested a Sonosite, however this was not available. As a result I utilised a low approach, medial to the lateral head of the SCM muscle, at the apex of the triangle. I got a venous flashback with the seeker needle. I then utilised a larger 20 gauge needle and thread the 18 gauge cannula over the needle without issue. At this stage I disconnected the syringe and withdrew the 20 gauge needle. There was dark red blood dripping from the cannula, indicating I had achieved venous access. At this time there was no arterial flashback. I easily fed the wire, checking for ventricular ectopics.*
16. *I nicked the skin with a scalpel and then dilated up the vein with the dilator. When I removed the dilator there was a bright red flashback which spattered on my wrist. This indicated I had arterial involvement.*
17. *I removed the wire, put pressure on the site and altered the position of the operating table so that SG's head was in the up position on the operating table. I advised Dr L that there was an issue with the surgery and I thought I had punctured and dilated the artery. Dr L immediately contacted a vascular surgeon, Dr G to assist.*

Following this event Dr E has altered her practice regarding insertion of central venous catheters. She now uses an ultrasound assisted technique to visualise the structures prior to insertion. She also uses a high approach on

the right and then left internal jugular. If neither of those approaches is successful she then uses a subclavian approach.

On reflection she stated there was no action, which she would alter in her involvement in her care. She conveyed her sympathy to the family.

Statement of Surgeon Dr L

Dr L also provided a statement. He noted that he first saw SG on 19 March 2012 and noted her complicated medical history. Dr S, hepato-biliary and general surgeon, was considering repairing a large incisional hernia, and she was referred to Dr L for consideration of the possible reversal of her stoma.

After a first consultation, Dr L performed a colonoscopy on 30 March 2012.

He subsequently saw SG on 10 April 2012 and discussed the planned surgery. She consented to the laparotomy, adhesiolysis, ureteric catheters, reversal of Hartmann's, cholecystectomy and hernia repair. It was explained that the hernia repair may need to be done at a later date.

On 17 April 2012 she attended a pre-admission clinic where various tests were performed.

Dr L was not closely observing Dr E when she inserted the central venous line. It became apparent that the line was placed in an artery and Dr E promptly removed the catheter. She immediately sought the telephone advice of Dr G, (vascular surgeon) who suggested applying pressure to the area for 15 min, advising that should be sufficient in the circumstances. Given there was considerable bruising Dr L telephoned Dr G again and he attended at the operating theatre. Dr G and Dr L explored the right neck but during this exploration SG went into cardiac arrest. Cardiac compressions were commenced immediately and Dr S and Dr G performed a sternotomy. Dr G repaired a through-and-through hole in the right sub-clavian artery.

A cardiothoracic surgeon was called and assisted in stabilisation. Some two hours later her chest was closed but SG was suffering from atrial fibrillation and she was shocked twice before her heart reverted to sinus rhythm.

A cardiologist performed a trans-oesophageal echocardiogram, which revealed moderate systolic dysfunction and moderate pulmonary hypertension. SG was transferred to the ICU.

Around 12 midnight she suffered an asystolic cardiac arrest and CPR was commenced. Dr L arrived in the ICU but resuscitation was unsuccessful.

Dr L advised that he was at a loss to explain the specific cause of her death. He considered the puncture artery had been successfully repaired by Dr G, and the patient stabilised. The trans-oesophageal echocardiogram only revealed moderate systolic dysfunction and moderate pulmonary hypertension.

With respect to the injury to the subclavian vein he considered the anaesthetist handled the situation well after the injury occurred.

Dr L considered his preoperative workup of the patient was comprehensive. Upon reflection if presented again with a similar clinical scenario, he would not alter his preoperative care, treatment and advice that was provided.

Statement of Dr G

Dr G was the Vascular Surgeon who attended on 20 April 2012. He was first contacted by telephone at approximately 3pm by Dr E. He was informed that whilst inserting a right internal jugular central venous catheter that arterial bleeding had been noted on removing the dilator. He advised Dr E to commence pressure on the neck region. He was informed they had initially appeared to have control of bleeding.

He then attended the operating theatre urgently. The patient was haemodynamically stable however a moderate haematoma in the neck was noted as well as in the supraclavicular region. He commenced surgical exploration of the right carotid artery and internal jugular vein to repair the injury. After commencing the initial exploration he could find no puncture of the initial carotid artery but noted extensive bleeding from the lower neck and supraclavicular region. He was informed by Dr E that the patient had become more haemodynamically unstable and has progressed to a hypotensive cardiac arrest.

With other surgeons in assistance including Dr S and Dr L as well as Dr M commenced an urgent midline sternotomy. He noted there was no blood within the pericardium and he commenced the dissection of the neck and subclavian artery. He noted this had a superior and anterior laceration consistent with a through-and-through puncture of the subclavian artery and a puncture into the subclavian vein. He repaired the artery and vein lacerations with the suture. This obtained adequate vascular control and no further arterial or venous bleeding was noted.

A massive transfusion protocol had been activated by the anaesthetist. Dr P, cardiothoracic surgeon was asked to attend. The patient remained haemodynamically unstable with atrial fibrillation and evidence of congestive cardiac failure with pulmonary oedema noted. After a long period of a number of hours of attempted stabilisation Dr P felt that she was stable enough for closure of the sternotomy and this was undertaken.

The central line wire was removed and had no impact on resuscitation or haemodynamic events.

Dr G believes that the advice he had given Dr E was followed correctly.

Dr G stated inadvertent puncture of arterial structures such as common carotid artery and subclavian artery are a well documented complication of central venous line catheter placement. Similar catastrophic outcomes have been reported worldwide, and are a known risk of this procedure. SG's

puncture of the subclavian artery was in a position low in her neck behind the clavicle and thus in the region where pressure on the neck in the common carotid region is unable to control such bleeding. Despite Dr E's pressure in the neck region over the presumed puncture site of a possible common carotid artery puncture, the region of the subclavian artery is unable to be controlled adequately with pressure. The specific site of SG's arterial puncture was not able to be adequately controlled with pressure and thus the appropriate major urgent arterial surgery to control this bleeding was required and was performed.

He considered that SG's demise after adequate vascular control and closure of the bleeding site is likely to be as a result of irreversible hypertensive shock from blood loss and the subsequent cardiac compromise and dysfunction after significant blood loss resulting in a hypotensive cardiac arrest.

Dr G opined he did not feel any other therapeutic management strategy would have changed the outcome or prevented SG's death after the subsequent puncture of the subclavian artery and vein.

Root cause analysis

A Root Cause Analysis was conducted and a copy of the report received. This found hospital processes and policy were followed and an escalation was appropriate. The complication was managed by appropriate and available specialists from anaesthetics, general surgery, cardiac surgery and vascular surgery.

The RCA noted the anaesthetist requested an ultrasound machine but this was not available. Those anaesthetists who have been trained to use ultrasound have the modality available. Those who used anatomic markers without ultrasound have equally good results.

Further improvements were identified including a review of current practice for inserting central lines including a discussion with an anaesthetist and vascular surgeon for the management of inadvertent puncture of the arteries.

Further the decision was made for there to be an increase in the number of ultrasounds that are available for usage by anaesthetists. Four ultrasounds were to be provided and purchased.

Independent expert evidence

Dr James Troup, the Deputy Director of the Department of Anaesthesia and Perioperative Medicine at the Royal Brisbane and Women's Hospital provided a report and answered a series of questions.

1. Was the procedure adopted by Dr E to insert the central venous line appropriate as well as the post puncture procedures as performed by the anaesthetist?

Dr Troup stated the description of her approach to the insertion of the central line described an appropriate method and decision-making.

He also stated that the post-puncture procedures performed were appropriate. It could be argued that, recognising that an artery had been punctured; Dr E could have left the guide wire in to try and block some of the bleeding. This would have had little effect as the dilator had been passed over the guide wire, resulting in a hole with a significantly larger diameter than the guide wire. Reintroducing the dilator would potentially cause more damage to the artery as the dilator is a fairly rigid device. Proceeding to insert the catheter into the artery would rarely be considered as that is one of the major complications that Dr E would have been trying to avoid. The decision of the surgeon to contact a vascular surgeon for advice was appropriate. The more specialised knowledge of the vascular surgeon was then brought into play. Dr E reports that she applied pressure over the puncture site which was a recommendation of the vascular surgeon.

2. Do you agree with the following views of Dr G?

- i) *That inadvertent puncture of arterial structures such as common carotid artery and subclavian artery are a well documented complication of central venous line catheter placement? Similar catastrophic outcomes have been reported worldwide, and are a known risk of this procedure*

Dr Troup stated that inadvertent arterial puncture occurs in approximately 3% of attempts at central venous catheter placement. Catastrophic outcomes including airway obstruction, haemothorax and cardiac tamponade are well documented and have been reported worldwide. Catastrophic outcomes are a known but very rare risk of this procedure.

- ii) *SG's puncture of the subclavian artery was in a position low in her neck, behind the clavicle and thus in a region where bleeding is unable to be controlled, despite pressure on the neck in the common carotid region*

Dr Troup stated he considers this to be anatomically correct. He had been unable to find any reports on the matter but an article in the Journal of Vascular Surgery suggests that pressure may not be the best treatment.

- iii) *Dr E's pressure in the neck region over the presumed puncture site of a possible carotid artery puncture, the region of the subclavian artery, was unable to be controlled adequately with pressure.*

Dr Troup agrees with this assertion.

3. Do you agree with Dr E's altered practice regarding insertion of central venous catheters?

Dr Troup stated that the use of an ultrasound technique to visualise the structures prior to insertion is considered current best practice. However, it does not completely preclude arterial puncture and consequent complications.

Dr Troup considered the decision to adjust her approach would decrease the risk of a similar puncture of the subclavian artery as happened with SG. The use of the subclavian approach still carries some risk of artery puncture. There is also an increased risk of puncturing the lung, causing a potentially life-threatening pneumothorax.

The use of the internal jugular vein approach immediately prior to or during surgery is taught to minimise this risk. Positive pressure ventilation of the lungs used during many anaesthetics can exacerbate the size of a pneumothorax.

Central venous catheterisation will always carry some risk.

4. Comment on the adequacy of the improvements identified in the root cause analysis.

Dr Troup considered that a review of currency of practice for all anaesthetists needs to be approached cautiously. Lack of currency of practice does not mean inability to perform a procedure.

He considered that insertion of a central venous catheter always requires documentation. He would expect if an anaesthetist was performing the procedure this documentation would be in the anaesthetic record and complication should be included.

Dr Troup considered that increasing ultrasound machine access potentially enables patient care and understands the number has already been increased.

Dr Troup considered there would be many opinions on how to define competency criteria and he was not sure if consensus would be achieved. Protocols are prescriptive and it would be better to use guidelines wherever possible.

5. Opinion as to the appropriateness of the treatment provided.

Dr Troup stated the decision to insert a central venous catheter was appropriate and in this case there were valid reasons for the decision.

Dr E's decision to use a low approach after a high approach had failed was appropriate. The low approach is a well described technique. The alternative approach to use a subclavian vein catheter would have increased the risk of pneumothorax. As well, normal practice with subclavian central venous line insertion would include an immediate post procedure radiograph. This is difficult to perform in the operating theatre and in itself is a complicated and potentially risky procedure.

The decision to contact a vascular surgeon after recognising the arterial puncture was appropriate.

The decision to abandon the planned surgery to deal with the complications from the subclavian artery puncture was appropriate. The decision to explore the neck to look for the source of bleeding was appropriate.

SG arrested whilst the exploration of her neck was occurring. The differential diagnosis considered by Dr Troup would be:

1. Vagal response to pressure around the carotid sinus in the neck. This usually causes bradycardia, however he expected this to be concurrent with a drop in blood pressure, rather than be preceded by as seems to be indicated by the printout of the monitored observations. He would also expect a rapid recovery after appropriate treatment.
2. Major blood loss from the punctured subclavian artery. The treatment in this situation is to stop the bleeding and to decompress the pericardial. The decision to perform a sternotomy was appropriate in this context.
3. Cardiac failure due to intrinsic coronary artery disease or reduced cardiac muscle function. The request for a cardiologist to perform a trans-oesophageal echocardiogram helped exclude this as a major contributing factor. The only indication of pre-existing cardiac issues are the slightly enlarged heart noted on the preoperative chest or x-ray. The autopsy report also indicates a larger than normal heart.

6. Any other issues?

- Dr Troup considered that the overall treatment provided to SG was appropriate. The subclavian artery puncture is an infrequent complication. On recognising the puncture, the decisions made were targeted toward fixing the puncture and preventing further problems. In the presence of a significant puncture of a major blood vessel, the working diagnosis of major haemorrhage was followed and treated.
- Dr Troup suggested that a contemporaneous anaesthetic record documented by the anaesthetist should have occurred. If this was not done throughout the anaesthetic and crisis management could have been done post facto.
- The management of SG's arrest and subsequent instability was complex. Introducing extra opinions into such a complex situation can be problematic. However, considering how long the resuscitation took before SG was stabilised enough to leave the operating theatre, it might have been helpful to seek early input from an intensive care specialist.

Conclusions

I am in a position to make findings about how SG died. It is evident there are risk factors and complications of the procedure adopted in this case. In general, Dr Troup is not critical of the process adopted in this case or the overall care once the complication occurred.

I do not believe that any further essential information would be obtained by holding an inquest. It is unlikely that useful recommendations about what is essentially a complex clinical scenario could be made. There may be a number of clinical 'learnings' that should be considered and that may be best obtained by referring any findings to the Royal College of Anaesthetists. Any findings are also sent to the hospital, the doctors involved, the Patient Safety Unit within Queensland Health and also to the Health Quality and Complaints Commission (now the Health Ombudsman).

After consultation with the family, a de-identified finding will be published in the public interest in accordance with s. 46A of the *Coroners Act 2003*.

Findings required by s. 45

Identity of the deceased – SG

How she died –

SG died during a medical procedure when a central venous line was being inserted, and the right subclavian artery in the neck was punctured. Despite emergency procedures to recover the position she died as a result of massive blood loss.

Place of death –

Greenslopes Private Hospital QLD

Date of death–

21 April 2012

Cause of death –

- 1(a) Haemorrhage
- 1(b) Right subclavian artery lacerations
- 1(c) Insertion of central venous catheter
- 1(d) Diverticular disease (previously surgically treated)

John Lock
Deputy State Coroner
Brisbane
1 September 2014