STATE
CORONER
VICTORIA

Case No: 1987/98

FINDINGS

The death of Peter Sullivan occurred on 6th July 1998 at the Box Hill Hospital from 1(a) Pulmonary Thromboembolism 1(b) Bilateral calf deep venous thromboses 1(c) Immobilization following nail-gun injury to left thigh.

The nail gun incident

Mr. Sullivan, aged 42, was a self-employed carpenter at the time of his death. On Friday 3rd July 1998 he was working for Oriete Homes Pty. Ltd. renovating a house in Raymond Street, Ashwood when inadvertently injured by a nail gun that he was using. He received an injury to the left thigh when the nail gun discharged.

Oriete Homes is owned by two brothers Sam Murarotto and John Murarotto. Apparently, about eighty percent of Sullivan's work was for Oriete Homes.

Apparently, according to Mr. Neil Gillespie, a labourer working with Sullivan the incident occurred as follows:

`Around 11 .45 a.m. sometime just before lunch we were still working at the rear of the house putting up weather boards we were both standing on the ground. I was working behind Peter, I was cutting weatherboards to the correct measurement and Peter was nailing them on. Peter was using a T-nailer gun. The T-nailer gun belonged to Peter and I had seen him use it on a regular basis. The T-nailer gun Peter was using had a sensitive trigger, I had used this gun before and when using it, it only required a small amount of pressure to be applied before it released the nail. The T–nailer gun has a safety latch which prevents it from firing. I have used framing and fixing guns before and they need a greater amount of pressure to be applied before they would release the nail, I remember Peter was holding the T–nailer in his right hand he turned around and the gun was around chest height he then lowered it to around knee height, I believe he must have brushed the side of his leg and the gun has gone off. The only way the gun could have fired was due to Peter having finger on the trigger.'

Mr. Sullivan was transported by Sam Murarotto to the Highbury Road Medical Clinic and then by ambulance to the Box Hill Hospital where he was operated on to remove the nail.

The WorkCover incident report was prepared by WorkSafe Inspector Mr. Barry Lupton. In his report he indicated that the nail gun was a Hitachi Model NT 65 AB (Serial Number 160022). The gun is operated pneumatically. Apparently the gun is:

`trigger guarded with a spring loaded device which is required to be pushed home so as to allow the trigger to be activated. The loading on the trigger interlock guard is quite light and this allows operators to "bounce" the gun from one nail insertion to the next without releasing the trigger.'

The WorkCover inspector also indicated the most likely possibilities as being:

- *That the injured person caught the trigger guard on his clothing and with his finger depressing the trigger, firing off a nail.*
- *That the injured person slipped and depressed the trigger guard onto his leg - firing off the nail.*
- *That the injured person was, in some way, holding back the trigger guard and when he accidentally depressed the trigger, fired off a nail.*
- *That the trigger guard was in some way locked and when the injured person accidentally depressed the trigger a nail was fired off.*

In evidence, Mr. Lupton said that over time, when using a nail gun, the spring will potentially weaken. Also the force used for the operation of the plate will sometimes vary from unit to unit depending on manufacturer.

It appears likely that the nail gun discharged in the circumstances as described by Mr. Gillespie.

Medical Management at the Hospital

The operation

At the Hospital late in the afternoon of 3rd July 1998 Mr. Robert Carey, Orthopaedic Surgeon, operated on Sullivan to remove the nail. The operation took about 15 minutes and the patient was under the anaesthetic for about 55 minutes.[1]

Other than the note on the medical file `RIB' (Rest in Bed) there were no documented management procedures, post operatively, for Mr. Sullivan. The note was placed on the file by an Orthopaedic Registrar, Dr. Holland. A physiotherapist visited Mr. Sullivan just before he collapsed to arrange crutches for him as he was leaving the Hospital. Other than that visit there were no arrangements for a physiotherapist to attend him following the operation.

There was nothing to indicate that Mr. Sullivan had any particular risk factors prior to the operation.

Mr. Carey, considered that Sullivan was in the low risk group of patients for Deep Vein Thrombosis (DVT) and acknowledged that one of the factors in assessing DVT is the time extent of the operation. He noted that surgery on the lower limbs does have an increased risk of DVT. However, Dr. Carey indicated that the operation was a relatively small operation as far as interfering with circulation of the limb. He anticipated that the length of the operation was up to 30 minutes, but would have been surprised if it was longer than 15 minutes. It was a minor operation. He did not consider prophylaxis necessary for the length of time of this particular operation.

Mr. Carey considered that, where a patient falls into the moderate or high risk category, he would normally document the post operative management procedures. However, where a patient is in the low risk group he would rely on the general hospital management procedure. He agreed that in borderline cases, it might be appropriate to consider that the clinician document the post operative management procedures.

Mr. Carey accepted that exercise gives the patient the best chance of avoiding the risk of DVT. He thought that it would have been possible for Sullivan to have walked, although the wound would have been sore. In summary Carey said that there was *`no reason for him (Sullivan) to rest in bed he could have been up and about.'*

Mr. Carey also suggested elevation of the leg as another one of the potential management procedures. He noted that even though `Rest in Bed' was ordered - bed exercises would be normal.

Mr. Carey noted that, in summary, potential management procedures following an operation to reduce the risk of blood stasis (apparently these procedures are a normal part of nursing training) are:

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[1] The time of procedure from the anaesthetic procedure records 9145 to 2040. Mr. Sullivan was recorded as being awake at 2100.

- elevation of foot of bed;
- exercising;
- deep breathing and coughing exercises; and/or
- where there is a considered significant risk, compression stockings.

As indicated Mr. Carey considered that Sullivan fell into the low risk category as far as DVT was concerned. He said that he would have looked at the history provided by patient as part of his risk assessment.

It is noted that Mr. Carey was not aware of specific hospital guidelines (the 1997 Hospital Guidelines were not brought to the attention of Mr. Carey prior to 20th November 2002). Mr. Carey considered that the age figure is not hard and fast also have to take into consideration factors involving the individual.

Mr. Carey also noted that the Hospital's guidelines have not, to his knowledge, been discussed by members of the orthopaedic group who operates at the Hospital.

Mr. Simon Holland, (at the time of Sullivan's operation a Registrar at the Hospital) considered that it was not the `implied' policy of the `orthopaedic unit' for anticoagulation therapy `to be used in low risk patients.' He was unaware of the Hospital's written policy as it was not distributed to orthopaedic registrars (he worked in the Hospital in 1998). However, Holland noted that only in one or two of the hospitals where he has worked has he seen a written policy on anticoagulation therapy.

Mr. Holland considered that Sullivan was a low risk patient. He opined that management of the low risk would be to include deep breathing and in bed exercises, elevation and walking. He wrote `Rest in Bed' in the medical file. He indicated in effect, that nursing staff generally knows the need for exercises. Holland saw Sullivan both Saturday and Sunday, but made no notes. He stated that his normal routine is to mention exercises, but cannot specifically recall discussing it with the patient or the nursing staff on this occasion.

Mr. Holland did not consider that much would be changed in management of Sullivan. He noted that the bleeding risk is a real risk in operations, but DVT is less likely. However he also noted that consequences are far greater in DVT.

Mr. Holland considered, in effect, that exercises following an operation would be fundamental nursing management on the ward. He considered that any problems would have been mentioned by the nursing staff. He also noted that physiotherapy was generally used in more high risk patients.

Mr. Holland referred to the successful use of mechanical compression stockings which were routinely used during operations in Hospitals in Tasmania to reduce the risk of DVT.

Mr. Holland had seen Sullivan earlier in the morning of his death. He noted that Sullivan was quite happy that he was going home. Holland examined both legs and did not detect anything unusual. On the arrest call, Holland, who was working in theatre, considered that the most likely cause was a pulmonary embolus and treatment was instituted accordingly.

Dr. Peter Sloan, Medical Director, Latrobe Regional Hospital, (former Medical Director of Box Hill) gave evidence about the Hospital's procedures. He noted that, *`although the outcomes for high risk patients have improved immeasurably, he could not think of a way to prevent this type of event from happening again'.*

Dr. Sloan noted that there was *`no absolute cut off point (age) for anticoagulation'* therapy. He considered that there was no definitive statement to be made in this case towards improvements in practice.

Dr. Sloan gave evidence that there was no comprehensive policy on DVT at the Hospital and that the intention was to have policy on anticoagulation. On the question as to whether `the quicker for a patient to become mobile the better' Sloan considered that there was:

> *`No harm in transferring the issue of getting the patient up and exercising as soon as possible (as with the high risk group)...?'*

And in:

> *`Providing greater level of information on DVT to patients and families.'*

Dr. Lee Hamley, Director of Clinical Services, stated that the Hospital's 1997 Clinical Guidelines on `anticoagulation' referring to `patients receiving Prophylaxis' Mr. Sullivan was not administered any pharmacological Prophylaxis.

Nursing management

Associate Charge Nurse Deanne Dawe was Sullivan's primary carer at the time of his death. On 4th July she noted that he was *`very bright, talkative and cooperative'.* He had no complaints of pain and refused offers of analgesia. Dawe commented that Sullivan was *`very mobile in the bed hence his bed sheets needed regular straightening.'* She noted that although she could not *`specifically recall encouraging Peter to perform passive bed exercises, it is my usual practice with post-operative patients.'*

On the morning of 5th July Mr. Sullivan refused the offer of a bedpan and insisted on going to the toilet. He had no shortness of breath or pain. According to Dawe, he remained in bed over the weekend as per the *`post-operative orders'* which were *`rest in bed until Monday.'* There was no 'physiotherapy referral requested by medical staff.' Dawe noted that Sullivan was *`non-complaining, denying any pain and was looking forward to going home the next day.'*

Nurse Janice Berg made a statement in August 2001. That statement did not refer to Sullivan undertaking any exercises. She stated that *`throughout the weekend he appeared bright and cheerful. He talked about his family and joined in the general conversation in the ward...?'* Later, in a statement dated 10th December, she added the comment that the *`patient was encouraged to do deep breathing and coughing exercises and encouraged to move his feet and do leg exercises which is normal post operative practice.'*

Nurse Berg said the Physiotherapist told her Sullivan was fine when she got him up in preparation for him leaving the Hospital.

Nurse Berg said that the *`principles of bed rest are not getting out of bed.'* Exercises like deep breathing, coughing or wriggling toes are a normal part of management. Apparently, Sullivan did these exercises. It is not customary practice to write down the fact that the patient has exercised.

Nurse Berg noted that Sullivan was constantly moving in bed as his bedclothes were being picked up from the floor. She said, *`We joked about it.'*

Expert opinion on medical management

Mr. George Stirling, Consultant Cardiothoracic Surgeon, provided an opinion for the Coroner. Having reviewed the file, provided two reports and listened to all of the evidence, he opined that this was a:

> *`minor injury, what was done was appropriate with modern high standards of care.'*

However, Mr. Stirling also did consider that the *`ways which we assess the severity of injury may need reassessment?...'* He opined that one aspect of this case was not properly considered (in hindsight). He thought that the 'force of injury' may need reviewing. The forces:

> *`transmitted may be very significant ... ?external appearances may believe the severity of injury ... ?energy diffused ... ?could be damage was done to veins in calf or thigh...?'*

Accordingly Mr. Stirling considered that this type of injury may require anticoagulation therapy. And he thought that, with *'more wisdom we would say it was a major injury?...'*

Mr. Stirling also was of the view that stimulation to the legs was also undertaken during Mr Sullivan's operation to reduce the incidents of DVT.

Conclusion

Mr. Sullivan, aged 42, having been injured in the thigh during an incident with a nail gun, received surgery at the Box Hill Hospital to remove the nail and died from a pulmonary embolus a few days after the operation having developed a DVT.

Mr. Sullivan was assessed as being in a low risk group of patients and as such was not managed with drug therapy, pressure stockings or an intensive exercise regime following his operation. However, although Sullivan was ordered to 'Rest in Bed' he was required to undertake exercise in bed. There is nothing in the evidence to indicate that, in light of the current standards for managing the risk of DVT, his management at the Hospital was not inappropriate.

The safety systems on the Hitachi nail gun for preventing accidental discharge, when the plate operation became light, appear problematic. It appears likely that the nail gun was able to be fired when the trigger was depressed without any fail-safe systems to prevent accidental discharge.

COMMENTS AND RECOMMENDATIONS

Work safety and nail guns

The need to warn industry

Over the last four and a half years there have been a number of injuries and one fatality (Mr. Sullivan) associated with apparent accidental discharge of nail guns. The WorkCover claims data from 1st July 1998 to 31st October this year indicates 94 traumatic injuries and 17 strain type injuries (in this material there was no indication of the compensation cost to WorkCover of these claims). There is no indication of the extent of injuries from this source in other States of Australia (Note: a recent search of the National Coroners Information System has not disclosed any other **accidental** fatality).

Some examples of the circumstances and injuries briefly described in the Victorian WorkCover claims include:

`Nail in knee from nail gun - laceration knee'
`Finishing off job attaching pole to fence, nail gun broke leg bone'
`While operating the nail gun, a plastic section hit his eye - loss of sight in his right eye'
`Using a nail gun, nail hit knot, flicking up into hand - lacerated right hand'
`Walking around pallet with nail gun, nail went into right knee.'
`Operating nail gun, nail missed pallet, penetrating left hand.'
`Using nail gun , miscalculated position of finger nail through finger.'

`Slipped and shot knee with nail gun.'
`Nailing timber nail gun double fired - puncture wound to right hand.'

Information is not provided on the brand of nail gun involved in each incident in the WorkCover injury records which were supplied to the Coroner.

Mr. Craig Newton, Compliance Coordination Branch WorkSafe, said that in relation to nail gun injuries, there had been no specific work by WorkSafe on prevention other than a visit following the report of the injury. He noted the need to alert users of the importance of *`maintaining nail guns to the manufacturer's standard in particular in relation to guarding mechanisms.'*

Also it is noted Mr. Holland indicated to the Court (through the Hospital's Barrister) that, in his experience over a one year period of work at Box Hill Hospital, there were five operations that resulted from nail gun injuries.

Clearly, the issue of nail gun injuries and safety is of concern. It may raise general issues of work practices, equipment design and maintenance, which require an industry wide review. Also, as part of a review, WorkSafe may need to identify the extent of the problem Australia wide.

Areas where nail gun injuries may occur include building and construction, furniture manufacture, packing and storage, etc.

Recommendation 1

That WorkSafe identify the various industries where nail guns are used and alert those industries of the risks (including case studies) and of the need to review work practices, training, equipment design and maintenance issues (WorkSafe may need to assist in the review of work practices).

WorkSafe may also need to ensure that its records provide more detail on the nature of circumstances and the brand of nail gun involved (if not already in the detailed records).

The need for a safe design review

As indicated, the number of apparent accidental injuries with nail guns is of concern. The number of injuries may lead to a need to review safety issues associated with the design of this type of equipment.

It is noted that the safety features of the particular nail gun used by Mr. Sullivan did not avoid the accidental discharge into his leg. Clearly, there may be a balance between a safe tool and an effective tool (as far as speed and efficiency of operation) is concerned. However, in this case it would appear that the potential for accidental discharge was not

alleviated by the safety feature of the need for contact and pressure on the plate before the trigger could be released resulting in discharge.

Ideally (to avoid accidental discharge) a nail gun may need an additional feature of a grip or palm safety (operating to prevent accidental release of the trigger mechanism - yet to allow it to be operated efficiently) combined with the need to press the plate on the surface before discharge is effected. Whilst this is only one suggested way of improving the safety design characteristics of nail guns there may be a number of other alternatives that should be considered.

Any review of design of nail guns may necessitate contacting and working with the various manufacturers of nail guns who may be based overseas. Also it may be necessary to review the relevant Australian Standards.

Recommendation 2

WorkSafe (in conjunction with the relevant manufacturers, industry groups and a University Engineering School) undertake a review of the design of the various nail guns used in industry, for the purpose of identifying the best practice in the design of (or alternative) safety features that may be appropriate.

The medical management of DVT - potential for improvement in the identification and management of the low risk group of patients

Mr. Sullivan, aged 42 was in the low risk group as far as DVT was concerned. He was appropriately managed in the Hospital. However, the family through Peter Sullivan's sister-in-law Ms. Adrienne Prior, emphasised that the sudden trauma of his death eventually resulted in the family, rather than focussing on blame, having a *`need to channel our energies into how we could make it better.'* For the family there was potential for improvement in the medical management of the low risk group of patients.

Also in the submission by the legal representative of the family it was emphasised that the *`family are concerned about the catastrophic consequences that flow, not only to this family but to any other family in future?...'*

The family pointed to the fact that Mr. Sullivan's case was an emergency therefore there was no chance of a pre-operative work-up. It is noted that there was a physiotherapist at the Hospital but the management concentration was evidently on higher risk patients.

The submission of the family raised the following areas of potential improvement for serious consideration of those working in the health sector:

- The documentation of a patient's exercising regime and compliance is important.

- Provision of information on DVT to patients and family. Family knowledge of the issue can assist by encouraging the patient to exercise (pamphlets may be appropriate).

- Clinicians should be aware of hospital policy. The family considered that it is necessary to develop and refine an overall hospital policy (taking the policy beyond the issue of anticoagulation therapy to exercise, etc.) and to deliver sections of the policy to the various sectors working in the Hospital (i.e.: nurses; physiotherapists; clinicians)

Effectively, the family of Mr. Sullivan considered that management of the low risk group should have a *`primary focus on mobility'* following an operation (it is noted by the Court that there may be circumstances where the clinical indicators are that some caution should be taken relating to exercise).

The family also suggested that, as lower injuries to the limbs have a greater risk, they may need to be treated differently - perhaps by the provision of compression stockings.

It is also noted that some evidence of concern was given about the nature of the injury to Mr. Sullivan's leg, and whether that raises additional questions (evidence of the expert Mr. Stirling). That is, as it was an *`impact injury',* should this lead to a different classification system and the taking of these types of injuries outside the low risk classification?

This case is illustrative of the fact that the potential consequences of a failure to maximise management techniques in the area of DVT can have a tragic outcome. That is not to be critical of management actually undertaken at the Box Hill Hospital, as it apparently followed normal methodology, and even if the patient had been exercising outside his bed rest regime, there was no certainty the outcome would have been any different. However, there still may be areas where, with practical and relatively inexpensive changes, there is potential to improve outcomes even in the low risk group.

It appears, from a coroner's perspective, that there may be some additional clues potentially demonstrating a need for re-consideration of the elevation of the category for the management of risk, in patients who are normally classified as of lower risk. These potential clues are that the patient is:

- on the boarder line of the category between low and moderate risk;
- it is a lower limb operation;
- occurred as a result of an emergency - therefore with no opportunity of a pre-operation work up;
- the injury is a result of an impact (i.e.: as a result of some considerable force causing damage to surrounding blood vessels).

It is noted that none of the orthopaedic clinicians, involved in the management of Mr. Sullivan, who were working at the Box Hill Hospital were aware of the Hospital's own guidelines for the management of DVT. Although nothing turned on this issue **in this case** (as the procedures actually followed were similar to the Hospital guidelines) the **apparent lack of communication of the guidelines could potentially have consequences in other circumstances.** This issue needs to be drawn to the attention of all Medical Directors of Hospitals.

The Clinical Liaison Service at the Coronial Services Centre should review cases of pulmonary embolism and identify whether or not there are common features in "low risk" patients that have died from pulmonary embolism.

Recommendation 3

That the Victorian Quality Council and the relevant Colleges consider the issues raised by Mr. Sullivan's family (and the Coroner) with a view to identifying practical improvements in the identification of risk features and the management of the group of patients who are, at the moment, thought to be at low risk of developing DVT.

Recommendation 4

That the Clinical Liaison Service at the Coronial Services Centre consider (with the assistance of the Department of Human Services and the relevant Medical Colleges) undertaking a research project, using coronial files on the issue of DVT in order to help identify improvements in risk management procedures and practices.

Recommendation 5

That Box Hill Hospital incorporates into their "Operation Report" form a provision for specific orders for DVT prophylaxis so that instructions in future cases are unambiguous.
(It may be useful for all hospitals to review Operation Report and DVT management protocols in the light of this recommendation).

Graeme Johnstone
State Coroner
29th November 2002

Mr. Neville Bird for the Box Hill Hospital (as from 20th November 2002)
Mr. Jim Dounias for the family
Senior Constable Jeffery Stewart, Assisting the Coroner