Worcestershire Acute Hospitals NHS Trust

Bone Cement Implantation Syndrome

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Policy Overview:
Bone Cement Implantation Syndrome Policy

Latest Amendments to this policy::
17th January 2019 – Document reviewed with no changes required by Dr Lucy Leong January 2023 - Document approved with no changes February 2026 – added DNACPR considerations, identifying high risk patients and how to manage BCIS if it occurs. Dr J Mackie.

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1. Introduction

The purpose of this document is reduce the risk from cemented hemiarthroplasty by encouraging joint decision making, team work and attention to detail.

The National Patient safety Agency (NPSA) has issued an alert in the past and subsequently Anaesthetic Sprint Audit of Practice (ASAP) collected prospective information on bone cement implantation syndrome (BCIS). This audit revealed evidence of cardiovascular compromise in some patients undergoing cemented hemiarthroplasty for hip fracture.

In the trust there have been cases of BCIS which have resulted in cardiovascular collapse requiring resuscitation.

2. Scope of this document

This policy will initially cover all cemented hemiarthroplasty's performed in the trauma theatres at Worcestershire Acute Hospitals NHS Trust.

3. Bone cement Implantation syndrome

Bone cement Implantation syndrome (BCIS) is characterized by hypoxia, hypotension or both and/or unexpected loss of consciousness if patient is awake. This can occur around the time of cementation, prosthesis insertion, reduction of the joint or, occasionally, limb tourniquet deflation in a patient undergoing cemented bone surgery. Features of BCIS (most commonly Grade 1) have been reported in approximately 20% of operations using a cemented prosthesis.[1]

Incidence of adverse effects during arthroplasty using cemented prosthesis[2]

- Grade 1: SpO_2 < 94% or > 20% fall in systolic blood pressure from baseline (≈20%)
- Grade 2: SpO_2 < 88% or > 40% fall in systolic blood pressure from baseline, or loss of consciousness (≈3%)
- Grade 3: Cardiovascular collapse requiring CPR (≈1%)

4. Perioperative Practice

Surgeons and anaesthetists can modify their perioperative practice to reduce the risk of cardiovascular events and to improve the outcome following an event.

Preoperative Management

Identify patients at increased risk of severe cardiovascular events during cemented hemiarthroplasty.

Patient Factors

- Increasing age
- Male sex
- Significant cardiopulmonary disease
- Pre-existing pulmonary hypertension
- Use of diuretic medication

Surgical Factors:

- Pathological Fracture
- Intertrochanteric Fracture
- Long-Stem Arthroplasty

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Clear DNACPR discussion with patient and/or family should be documented. Anaesthetists and surgeons need to ensure the balance of risks and benefits of surgery, anaesthesia and treatments including intensive care have been explained fully and understood by the patient.

It is often appropriate to suspend a DNACPR recommendation during the peri-operative period, but this should be discussed with patient and or family by the anaesthetist, and this documented on anaesthetic chart and highlighted during the team brief. The pre-operative understanding of the patient's priorities and goals of care should influence clinical decision-making by the anaesthetist and surgical team (See Appendix).

The potential for adverse events should be identified for each patient as part of the pre-list briefing before starting the theatre list and the World Health Organization (WHO) safe surgery checklist 'time –out'.[3]

Intraoperative Preventive Measures[3]

1. **Surgical Techniques:**
    - Use retrograde cement insertion and avoid excessive pressurization, especial ly in elderly or frail patients.
    - Employ intramedullary plugs/cement restrictors and thorough pulse lavage to clean and dry the femoral canal.
    - Insert prosthesis carefully, minimizing mechanical stress and embolic load.
2. **Anaesthetic Considerations:**
    - Maintain systolic blood pressure within 20% of pre-induction values.
    - Prepare vasopressors for immediate use in case of hypotension or cardiovasc ular collapse.
    - Continuous monitoring of oxygen saturation, blood pressure, and ECG is ess ential during cementation and prosthesis insertion.

All members of the theatre team should be aware of the problems with femoral instrumentation and cemented prosthesis and follow the **Cement Curfew** protocol (below).

5. The Cement Curfew

A novel 'Cement Curfew' protocol has been developed and implemented[4], which involves all members of the operating theatre team assuming specific roles and focus around the time of prosthesis insertion.

Pre-operative Planning:

1. Identifying cases on the trauma list requiring Cement Curfew i.e. cemented hips.
2. Discuss cementing technique i.e. is cementing appropriate?
3. Does the ananesthetist need invasive monitoring? Cardiac output/"A" line/CVP line.
4. At the end of time out, assign roles to theatre team members.
5. Mark name against roles on cement curfew sheet/laminated card/white board/ name badges.

Prior to Cementing:

6. All members of the theatre team with assigned roles should be available in theatre.
7. Distractions-e.g. - like music to be minimised at the time of the cement curfew.

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8. When cement is prepared for mixing, the scrub nurse informs the team that the cement curfew is about to start.
9. Lead surgeon informs the team when the cement is about to be inserted.
10. Lead anaesthetist ensures that the patient has a good cardiac output and increases the frequency of blood pressure measurement to stat/every 2.5 minutes in case of non-invasive method and confirms that the patient is ready for the cement insertion.

During Cementing:
11. Cement is inserted with a third generation technique usually without excessive pressurization.
12. Lead surgeon informs team when the prosthesis is being inserted.
13. Lead surgeon informs the team when the hip is relocated.
14. Anaesthetist declares the end of the cement curfew.

If evidence of BCIS:

- The lead anaesthetist ensures that the team is aware
- The lead anaesthetist decides if there is cardiovascular collapse requiring CPR and informs the team
- Team members perform their roles and patient placed supine if required
- Once the critical event is over the patient is returned to the lateral position if at all possible and the hip is closed quickly, but formally.

Postoperative Considerations

- Monitoring: Continue close observation in the post-anesthesia care unit (PACU) or ICU for delayed cardiovascular or respiratory events.
- Documentation: Record the occurrence, severity, and interventions for BCIS to inform future procedures and risk stratification.

TREATMENT OF BCIS

Under general anaesthesia, a significant drop in systolic pressure may herald cardiovascular collapse, whilst a sudden drop in end-tidal pCO2 may indicate acute reduction in pulmonary blood flow and right ventricular failure, resulting in reduced cardiac output.

In an awake patient under a regional anaesthetic, early signs of BCIS may include dyspnoea and/or an altered sensorium.

There is an absence of clinical trials comparing different management approaches to BCIS, so current recommendations are empiric and guided by case reports as well as basic physiological principles. Cardiovascular collapse, in the context of BCIS, should be viewed and treated as right ventricular (RV) failure. In general, early and aggressive resuscitation is the cornerstone of treating BCIS[5].

- Administration of 100% inspired oxygen is a first-line therapy, with airway control dictated by clinical necessity.
- Invasive haemodynamic monitoring (if not already in place), should be established.
- In cases of severe BCIS (when patient has arrested, or peri-arrest), standard advanced cardiopulmonary life support (ACLS) algorithms and procedures should be followed.
- Judicious fluid resuscitation to optimise right ventricular preload (avoiding over-distension), combined with inotropic support where indicated.

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- Vasopressors (such as phenylephrine and noradrenaline) primarily cause peripheral vasoconstriction, increase aortic blood pressure, which in turn supports coronary artery blood flow, and thus improve myocardial perfusion and contractility.
- Use of vasopressors and inotropes should be continued into the postoperative period as necessary, under the management of the intensive care unit (ICU).

BCIS is a time-limited phenomenon; with human and animal studies strongly suggesting that pulmonary artery pressure normalises within 24 hours[6]. Even with large embolic loads, healthy hearts may recover in seconds to minutes. The underlying mechanism – acute pulmonary hypertension and secondary right ventricular failure – should be considered reversible. Aggressive stabilisation and supportive therapy are the cornerstones in managing BCIS.

For patients who have not met the criteria for severe BCIS but who have a suspicious clinical picture, they should be monitored closely for at least the first 24 hours after the operation

6. Implementation

6.1 Plan for implementation

[A brief description of the plan for dissemination]
Communication via theatre band 7-8 to disseminate information to theatre staff
Case presented at anaesthetic directorate QIM meeting

6.2 Dissemination

Communicated to T and O directorate clinical director. Also to provide simulation training for T and O directorate.

6.3 Training and awareness

Training on bone cement implanatation syndrome will be provided via simulation training on audit days by Dr L Leong/ Dr A Raakkumar

[This section should refer to training as identified in the Trusts Training Needs Analysis Appendix A of the Trusts Mandatory Training Policy.]

7. Monitoring and compliance

[This section should identify how the Trusts plan to monitor compliance with and the effectiveness of this Policy. It should include auditable standards and/or key performance indicators (KPIs) and details on the methods for monitoring compliance]

The NHSLA requirements are –

Organisations should measure, monitor and evaluate compliance with the minimum requirements within the NHSLA Risk Management Standards. This should include the use of audits and data related to the minimum requirements. The organisation should define the frequency and detail of the measurement, monitoring and evaluation processes.

Monitoring demonstrates whether or not the process for managing risk, as described in the approved documentation, is working across the entire organisation. Where failings have been identified, action plans must have been drawn up and changes made to reduce the risks. Monitoring is normally proactive - designed to highlight issues before an incident occurs - and should consider both positive and negative aspects of a process.

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APPENDIX: Implementing advance care plans in the peri-operative period, including plans for cardiopulmonary resuscitation: Association of Anaesthetists clinical practice guideline AABGI Feb 2022.

A key principle is an early discussion with the patient preoperatively to ensure a shared understanding about which peri-operative treatments – including chest compressions and/or defibrillation – would be appropriate and desired. Central to this is understanding and documenting the patient's values, preferences, wishes and ideas about their care, including any fears the patient might have. Anaesthetists and surgeons need to work together to ensure the balance of risks and benefits of surgery, anaesthesia and treatments including intensive care have been explained fully and understood by the patient.

Some patients will have pre-existing DNACPR forms or other documents recommending that CPR is not attempted. Intra-operative cardiac arrest is generally rare and when it does occur, survival rates are generally high. This can be attributed to two things. First, common causes of perioperative arrest (cardiovascular response to the induction of anaesthesia; vagal response to interventions; hypoxia; hypovolaemia; haemorrhage) are treatable and potentially reversible. Second, the continuous monitoring of anaesthetised patients and presence of an anaesthetist allow immediate detection and treatment. It is, therefore, usually appropriate to suspend a DNACPR recommendation during the peri-operative period. Since DNACPR recommendations are not legally binding but are a recommendation of what the clinician should do in an emergency, they do not require explicit cancellation. However, the anaesthetist should ensure any temporary suspension of the recommendation has been discussed and agreed with the patient, and explained to the healthcare team. The Working Party does not consider that giving chest compressions to expedite circulation of a drug in the face of low cardiac output (as distinct from cardiac arrest) is qualitatively the same as CPR. Therefore, it does not consider that an advance decision to refuse CPR would normally cover such a situation. Similarly, the Working Party does not consider that such an advance decision normally excludes the use of drugs that are part of the cardiac arrest algorithm where they are used to treat – for example – bradycardia, hypotension or cardiac arrhythmia, during the course of anaesthesia. Finally, the Working Party does not consider that such an advance decision would prevent the use of defibrillation (or synchronised direct current cardioversion) for suddenly occurring arrhythmia.

Where a patient has made an advance decision to refuse CPR, the position set out above should be explained to the patient. All discussions and decisions should be clearly documented, dated and signed by the healthcare professional in the patient's health record and shared at the team brief.

The pre-operative understanding of the patient's priorities and goals of care should influence clinical decision-making by the anaesthetist and surgical team.

At the end of a surgery in an unconscious patient, it is not uncommon to find that the prognosis has changed and is now agreed to be poor. Information that has been gathered using the processes above will be invaluable in guiding decision-making thereafter and should be shared with the ICU team and postoperative team

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References

1. Griffiths R, Parker M. Bone cement implantation syndrome and proximal femoral fracture. Br J Anaesth. 2015;114:6-7

2. Donaldson AJ, Thomson HE, Harper NJ et al. Bone cement implantation syndrome. Br J Anaesth. 2009;102:12-22

3. Association of Anaesthetists of Great Britain and Ireland, Membership of the Working Party, Griffiths R, White S, Moppett M et al. Safety guideline: reducing the risk from cemented hemiarthroplasty for hip fracture 2015. Anaesthesia. 2015;70:623-626

4. Scrase A, Horwood G, Sandys S. Coventry "Cement Curfew": team training for crisis. anaesthesia News 2014;327:8- 9

5. Association of Anaesthetists of Great Britain and Ireland, Membership of the Working Party, Griffiths R, Alper J, Beckingsale A et al. Management of proximal femoral fractures 2011. Anaesthesia. 2012;67:85-98

6. Byrick, R.J. Cement implantation syndrome: a time limited embolic phenomenon. Can J Anaesth (1997) 44: 107.

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