Anaesthetic-related shivering

- aetiology
- management
- my study at Box Hill
Incidence

- 60% of patients recovering from GA
- 30-40% of patients recovering from epidural
Effect of shivering

Increases metabolic heat production by up to 100%
  – Exercise can increase it by 500%
  – Increase VO2 not associated with increased myocardial ischaemia

• Increase ICP / IOP
• Wound pain
• Patient satisfaction/comfort
• Does not occur in newborns
Basic physiology of thermoregulation

• Interthreshold range (0.2 degrees C)
• Thermoneutral zone
• Central controller
  – Anterior hypothalamus – warm responses
  – Posterior hypothalamus – cold responses
• Afferent input
  – Skin, hypothalamus, brain, spinal cord, deep structures
    • Each contribute about 20%
    • Aδ/C fibres via spinothalamic tract
Efferent responses

• Have gain (slope of response)
• Sweating
• Behavioural
• Peripheral vasoconstriction / vasodilation
• Shivering
• Non-shivering thermogenesis
Effect of general anaesthesia on thermoregulation

• Behavioural responses not relevant
• Interthreshold range increased from 0.2 to 2-4 degrees
• Gain and maximum intensity of responses reduced
• Typical pattern of fall in core temp
• Propofol, alfentanil and dexmedetomidine/clonidine all produce decrease in threshold for shivering
• Shivering rare during GA
  – Paralysis
  – Shivering threshold is 1 degree less than vasoconstriction threshold; reduced further during GA
  – Gain of shivering response is less during GA
Aetiology of shivering

- Thermoregulatory (most) vs non-thermoregulatory
- Core hypothermia
- Secondary to fever
  - Set point increased; get shivering at higher core temp
  - This can be suppressed by steroids/NSAIDs
- Release of cytokines (secondary to the surgery)
  - ie pyrogenic mediators
- Other non-thermoregulatory shivering
  - Eg. Due to pain
Non-thermoregulatory shivering

- ie. Patients are normothermic
- Has been attributed to
  - Decreased SNS activity
  - Adrenal suppression
  - Anaesthetic drugs
    - Eg isoflurane
      - Patients recovering from iso anaesthesia exhibit a 5-7 Hz EMG pattern that differs from the 4-8 cycle/min waxing and waning pattern in thermoregulatory shivering
      - Also get decrease in shivering threshold and in maximal shivering intensity
      - ie. Likely non-thermoregulatory
  - Loss of descending control
Relationship of pain to post-op shivering

• One study looked at knee surgery

• One group received 20ml intra-articular lignocaine 1.5%, the other group received saline

• Both groups normothermic (FAW) intra-op, post-op

• Pain score in lignocaine group (5mm) less than in placebo group (46mm)

• Shivering occurred in 43% of placebo group and was absent in the lignocaine group
Neuraxial anaesthesia

- Autonomic thermoregulation is impaired
- Core hypothermia
  - Often not “perceived”
  - Still get shivering
- Epidural and spinal anaesthesia decrease shivering threshold (above the level of the block) by 0.6 degrees
- Effect is neuraxial, not due to IV absorption
- Reduction in shivering threshold is proportional to the number of spinal segments blocked
Concept of “apparent” leg temperature

- Typically it is cold signals that dominate thermal input from leg skin at OT temperature
- Regional anaesthesia blocks this
- Brain then interprets decreased cold input as relative leg warming
- This reduces the vasoconstriction and shivering thresholds
Core hypothermia / warm skin

- Occurs frequently during neuraxial anaesthesia
- Thermal perception is largely determined by skin (rather than core) temperature
The effect of warming sentient skin

- Can treat established shivering
- Entire skin surface contributes about 20% to thermoregulatory control
- Only half of the skin surface may be available to warm
Shivering in pregnant women

- May have a different aetiology
- Often occurs in normothermic / vasodilated patients
- May be non-thermoregulatory
- Poorly understood
Drugs described for treatment/prevention of shivering

- Pethidine – 25mg IV or epidurally
- Tramadol – eg 0.5mg/kg IV
- Clonidine – 75mcg IV
- Ketanserin – 10mg IV
- Magnesium sulfate – 30mg/kg IV
- Physostigmine .04mg/kg IV
- Nefopam
- Dexamethasone
Pethidine

- Better than alfentanil and other opiates
  - Remifentanil does not reduce effect of post-op shivering
- Shivering threshold reduced twice as much as the vasoconstriction threshold
  - Not the case for other opiates
- No decrease in gain or maximum response of the shivering
- Efficacy preserved during low dose naloxone (0.5mcg/kg/min) but obliterated during larger doses (> 5mcg/kg/min)
- Probably non-mu receptor
  - Also acts at kappa receptors and as an anticholinergic
  - Thought to be mediated via kappa receptors in the past; moving away from that theory now
  - Alpha-adrenoreceptors thought to be more likely sight
Effect of tramadol in post-spinal shivering in caesarean section

- Took patients with established post-spinal shivering
- Randomised to tramadol 0.5mg/kg IV or pethidine 0.5mg/kg IV
- Duration of shivering less in tramadol group (p = .001)
  - ? How much less
- But tramadol group had increased
  - Nausea
  - Vomiting
  - Somnolence
Tramadol continued

- At a concentration of 200ng/ml it reduces sweating, vasoconstriction and shivering thresholds
- At dose of 3mg/kg given at time of wound closure it eliminates shivering
  - No difference in pain scores b/w group in this study
Clonidine

- Partial alpha-2 agonist
- NNT to prevent shivering is 3.7 (dose 75mcg)
- No advantage increasing dose to > 150mcg
- Effective dose to treat established shivering is less
Ketanserin

- 5HT2 receptor antagonist
  - Also alpha1/H1/D1 receptor effects
- Used to treat carcinoid
- No good studies
- Dose range 5-30mg slow IV
- Ondansetron also studied
Nefopam

- Doses used are 0.1 – 0.15mg/kg
- Meta-analysis says NNT is 1.7 (ie. The most efficacious)
- Studies all flawed
  - Eg. V high incidence of shivering in control group (up to 90%)
Physostigmine

• Anticholinergic
• One study showed that it prevented post-anaesthetic shivering as much as pethidine and clonidine

• Theory is that cholinergic stimulation of HPA axis causes increased release of ADH/adrenaline/NA
  – Hypothalamus has key role in thermoregulation
• Problems – haemodynamic effects, GI toxicity
Dexamethasone and prevention of post-op shivering

- Dexamethasone 0.6mg/kg prior to induction for cardiac surgery
- Reduced incidence of shivering by 33% – This was independent of core temperature
- Researchers concluded that shivering after CPB is due to release of inflammatory mediators / cytokines
Also studied

- Dolasetron
- Midazolam
- Flumazenil
- Methylphenidate (CNS stimulant)
- Urapadil
The effect of intrathecal pethidine on shivering in women undergoing emergency caesarean section: a prospective randomised double-blinded study

• Hypothesis

• Importance
  – 40% of these women experience shivering
  – Main factor is patient comfort
  – Other considerations
    • Interruption of monitoring
    • Increase VO2, CO2 production etc
Prior studies

- **Intrathecal pethidine decreases shivering during caesarean delivery under spinal anaesthesia (Roy et al, Anaesthesia and Analgesia 2004;98:230-4)**
  - 40 patients (non-emergent LUSCS)
  - compares intrathecal bupivacaine 10.5mg, morphine 150mcg and pethidine 0.2mg/kg with intrathecal bupivacaine 10.5mg, morphine 150mcg and saline
  - incidence of shivering was less in the pethidine group (9/20 vs 17/20; p<.02)
  - maximum intensity of shivering was less in the pethidine group (p <.003)
  - no difference with regards to:
    - Duration of surgery
    - Apgar scores
    - Level and time to onset of block
    - Duration of block
    - Blood pressure
    - Patient temperature
  - statistically significant reduction in shivering shown with 40 patients in the trial
  - no direct comparison between Bupivacaine with fentanyl 10mcg and Bupivacaine with pethidine 10mg, which may be more relevant in Australia
Prior studies

- Addition of meperidine to bupivacaine for spinal anaesthesia for caesarean section (Yu et al, British Journal of Anaesthesia 2002;88:379-383))
  - 40 patients (elective LUSCS)
  - compares intrathecal bupivacaine with either saline 0.2ml or pethidine 10mg
  - major finding was that addition of pethidine 10mg to intrathecal bupivacaine for elective LUSCS is associated with prolonged post-operative analgesia
  - post-operative analgesia was prolonged in the pethidine group compared with the saline group
  - did show non-statistically significant decrease in shivering in the pethidine group
    - incidence 40% in saline group, 15% in pethidine group (p = 0.16)
    - methodology for assessing shivering not described
My study

• Will compare intrathecal bupivacaine plus fentanyl 10mcg with intrathecal bupivacaine plus pethidine 10mg

• Randomised, double-blinded
Sample population

- **Inclusion criteria**
  - Patients having emergency LUSCS who do not have an epidural catheter in situ (E1, E2 and E3 patients)
  - ASA I or II patients (ie no significant systemic disease)
  - singleton pregnancies of > 36 weeks gestation
  - spinal anaesthetic the most appropriate anaesthetic
  - able to give informed consent

- **Exclusion criteria**
  - ASA > 2
  - Code greens (therefore requiring general anaesthetic)
Recruitment/randomization process

• All obstetric patients will be informed of study on admission to labour ward
• Anaesthetist responsible for the case will try and recruit patient
• Call me if in hours
• Average 8-10 emergency caesareans that are spinal anaesthetics each month
• Informed consent process/documentation and patient information sheet
Randomization process / blinding

- Dose of local anaesthetic to be used will be chosen by the anaesthetist responsible
  - Heavy bupivacaine 0.5%
- Added opiate will be from pre-prepared, coded syringes
  - 0.2ml of opiate (ie. Pethidine 10mg or fentanyl 10mcg)
  - Pharmacy
  - Allows blinding / randomization
Other protocol

- warmed IV fluids
  - patients preloaded with 15ml/kg of Hartmann’s at time of spinal injection
- standard monitoring
  - NIBP, ECG, pulse-oximetry
- no Bair hugger
- normal draping
- syntocinon 10 units slow IV injection immediately after delivery, and then commencement of an infusion of Syntocinon 40 units over 4 hours
- standardized provision of post-operative analgesia – paracetamol 1g pr, voltaren 1g pr and oxycontin 20mg orally in recovery
Recording of shivering

- T=0 defined as time of spinal injection
- Shivering to be scored according to scale below each 20 minutes
  - 0 – no shivering
  - 1 – piloerection or peripheral vasoconstriction but no shivering
  - 2 – muscular activity in only 1 muscle group
  - 3 – muscular activity in more than 1 muscle group, but not generalised shivering
  - 4 – shivering involving the whole body

- “whole body”
Other data to record

- whether the patient is in active labour or not, and the duration of labour
- whether the patient has received any intramuscular pethidine (dose and timing) prior to the spinal anaesthetic
- dose/volume of local anaesthetic injected
- level of injection
- spinal needle used
- level of block at 5 and 10 minutes
- requirement for any supplemental intra-operative analgesia
- tympanic temperature measured at T=0 and then each 20 minutes, and then once in recovery
- temperature of operating room (thermistor)
- whether the patient felt they shivered
Presence of the following

- Itch
- Nausea
- Vomiting
  - graded 0-2 where
    - 0 = absent
    - 1 = present and not requiring treatment
    - 2 = present and requiring treatment
Finally

– VAS (visual analogue scale) pain score at 4 hours, and time to the patient first requiring oral/parenteral analgesia
  • Recorded by midwives on separate form
Hopefully

• Can recruit 40 patients by Feb 2006
• ? May need to include elective caesareans