SASA Congress 2012 – Day 2

Ross's Rough Notes

WHO Checklist – Iain Wilson – Royal Devon and Exeter, UK (President: AAGBI)

- Example given of RAF Phantom which shot down RAF Jaguar in training exercise
- System failure, human errors, communications
- Examples given of medical failure
- Wrong site surgery is catastrophic but rare
- More common issues
    - Thromboembolic phenomena
    - Infections
    - Unexpected haemorrhage
- Could a checklist help?
    - Effective in other industries
    - Either as an aide memoire
    - Or as a mandatory tool
- Good example from medicine – Pronovost Central Line paper for preventing CLABSI
- What is the evidence that the checklist makes a difference?
    - Pilot study – inpatient complications from 11 down to 7%, mortality from 1.5 down to 0.8%
    - Neily et al JAMA 2010 – teamwork training and checklist
    - Ann Surg 2012;255:44-9 – where checklist is used properly, greatest reductions in mortality are seen
- Pre-list briefing is a brilliant strategy
- Communication issues are involved in 60% of theatre issues
- Challenges to checklist
    - Incomplete
    - Hurried
    - Tick box culture
- Being safe vs. documenting safety
- Where next – crisis checklists?

Drug Errors – Peter Gordon – Department of Anaesthesia, Groote Schuur Hospital/University of Cape Town

- Any error, irrespective of whether harm is caused
- Prescribing/administration/dispensing
- Mistakes vs. Slips vs. Lapses
- Prescribing errors – lack of knowledge, illegible handwriting, confusion of name (diltiazem vs. diazepam), decimal points, abbreviations (AZT?)

- Results of local and national survey presented
    - 94 % of anaesthetists had given drug error
    - Muscle relaxants and vasoactive drugs most common
    - 4 attributable deaths (lignocaine, propranolol, esmolol, adrenaline)
    - Centralised reporting agency suggested
- Prospective study, 3 teaching hospitals, 30000 anaesthetics
    - Incidence of errors: 1:274
    - Approximately 6 errors per month per hospital
    - Misidentification and similar looking ampoules most common cause
    - Morbidity fortunately uncommon
- Similar studies in New Zealand; 1 error per 200 anaesthetics (Merry & Peck)
- Reason's "Swiss Cheese" model – system vs. people errors
- Reading errors – often due to pattern (mis)recognition
- Far greater incidence of errors after midnight
- Education – we must create a safety culture from medical school onwards
- "We should ensure we do not read what we expect, but inspect what we read."
- Adopt a universal colour-coded labelling system in theatres
- Improve drug storage
- Reduce fatigue
- Develop a "reporting culture"
- See Camire E et al. CMAJ 2009; 180:936-943

The GO (Global Oximetry) Project – Ian Wilson – President AAGBI

- Anaesthesia in countries such as SA, UK very strong and physician lead
- Driving force in patient safety
- Safety of anaesthesia has improved dramatically over the last 6 decades
- Safety improved by 18x around the 1980's – this was largely due to the widespread introduction of pulse oximeters
- AIME study (Australia) – 82% of incidents could have been presented with oximetry
- Survey in Uganda 2007-8: no hospital met WHO standard; minimal staffing; minimal equipment
- Outcomes in anaesthesia in many areas of the developing world are desperately poor (mortality 1:200!)
- How do we improve outcomes? Personnel, equipment, monitoring
- Concept of "Global Oximetry"
    - Walker et al Anaesthesia 2010 - Gap data, ideal oximeter, training etc.
    - Barriers to oximetry – EXPENSE, EXPENSE, EXPENSE, robustness
    - Pulse oximeter added to the WHO checklist
    - About 77000 theatres worldwide without oximetry
    - New branding: "Lifebox"
    - $250 robust oximeter
    - Fundraising webpage

    - Coverage on WHO and other webpages
- Pulse oximeter that connects to cell phone under investigation
- www.lifebox.org
- Worthwhile read: Atul Gawande – "Checklist Manifesto"

The Anaesthetist and the Environment – Robert Sneyd – Peninsula Medical School, Plymouth, UK

- The greatest medical crisis on Earth are the effects of the looming climate change disaster
- Lancet commission – managing the health effects of climate change
- Doctors must take a lead in being advocates for heeding effects of climate change
- Beyond CO2… we (anaesthetists) are prolific users of disposal devices, particularly plastics
- Leaching of "Gender Bender" compounds from plastic administration sets (particularly into lipid emulsions such as Propofol)
- Bisphenol A (BPA) is associated with higher rates of heart disease
- NHS (UK) carbon footprint is 18 million tonnes CO2 per annum (energy 22%, transport 18%, and procurement 60%)
- Sustainability = "ensuring a long-term strategy that does not preclude our ability to deliver high-quality health care tomorrow"
- Why to sign up? Save money, legal compliance, enhanced reputation, resilience, better patient care into the future
- Moving patients (under their own transport or that of the system) is a huge environmental cost – improving local access to care (and preventing complication/readmission) reduces this.

Ergonomics and the Anaesthetist – Ian Findlay

- Ergonomics is the interaction between the anaesthetist and technology
- The anaesthetic machine is the major point of interaction
- Interaction with the flow meters requires a small percentage of our time (3% visual, 2% physical) but is rated as the 3rd most critical safety interaction.
- Introduction of new types of flow meters (electronic controlled) has never been tested scientifically against the older (mechanical rotameter) technology.
- This was studied for the first time by SA researchers using a standardised accepted (NASA) task load index questionnaire
- Objective workload was higher for electronic meters, while subjective workload was lower.
- Inconsequential clinical errors were high in the mechanical group; clinically relevant errors were high in the electronic "low flow" group.
- A second study under stressful conditions found that the majority of errors occurred with electronic flow meters.
- Model of human performance: Perception -> Situational Awareness (interpretation, comprehension, projection) -> Response selection -> Response Execution -> System Environment Feedback -> Perception and so on…

- Low-flow meter adjustment usually occurs at times of low task density, and is accomplished using closed loop feedback.
- Electronic device have device-specific action sequences, which, if completed in the incorrect order or left incomplete, result in a return to the baseline settings.
- What can we conclude from this assessment?
    - Subtasks required differ between the two types of flow meter
    - Sources of workload differ
    - Error types differ – manual = calculation; electronic = perception of state
    - Electronic systems particularly sensitive to action sequence and post-completion errors
    - Context-sensitive assessment of new technology should be undertaken.
- Resources available from ianfindlay7@gmail.com

Automated Anaesthesia Record Keeping: Pros and Cons – Zane Farina – Pietermaritzburg, SA

- History
    - First anaesthesia record – A.E. Codman at MGH 1894
    - "Record the pulse" – FB Harrigan at MGH
    - First published – Cushing 1902
    - BMJ 1896: "By recording blood pressure we pauperise our senses and weaken clinical acuity"
- What is an anaesthetic record?
    - Medicolegal - An accurate record is more important than a "nice looking record". AARK – more accurate data, improved completeness and legibility, automatic alerts
    - Training tool
    - Checklist (airway, ventilation, antibiotics, positioning, etc.)
    - Audit tool
    - Situational awareness tool – "writing as cognition"
- What should the AARK do?
    - Facilitate above uses
    - Improve situational awareness
    - Free time for complex problem solving
- Achieving the aims
    - Every surface a computer
    - Able to track all aspects of anaesthetic (eg. Drug administration; airway devices)

Using TCI to Deliver TIVA to Children – Graeme Wilson – University of Cape Town/Red Cross War Memorial Children's Hospital

- First commercial TCI device = Diprifusor, 1996
- Rapid acceptance everywhere (except the US!)
- Millions of TIVA's given safely around the world

- Introduction of TIVA/TCI into paediatric anaesthetic practice has been slow
- Propofol infusion syndrome has been a concern
- TIVA in children is not easy to administer (and standardised manual TIVA protocols don't really exist for kids)
- Paediatric TCI software is not ubiquitous
- Why TIVA in children?
    - Contra-indications (eg. Dystrophies, MH, etc)
    - Locations remote from OT
    - More specialised surgeries being attempted (esp. neuro)
    - Quality of recovery
- Goals:
    - Desired, stable effect
    - Considerable PK/PD variation
- How does TCI work? Loading dose + infusion to match redistribution + infusion to match clearance (…expand for as many compartments as you are for…)
- Kids vary – LOTS! Growth and development bring about profound changes
- Increased volume of distribution and higher clearance – infusion rates are much higher (about 50% more on a per-kg basis)
- Context-sensitive half-times are thus much longer
- Using adult models in kids results in much lower plasma concentrations than predicted
- Commercial models are not available for children under 12 months
    - Hepatic metabolism immature
    - Reduced metabolic elimination of Propofol (glucoronidation; CYP isoenzymes)
    - Postconceptual vs. postnatal age
- Distributional clearance in l/hr/kg decreases with age in a non-linear relationship (in adults this becomes quite linear)
- Allometry – non-linear relationship between the size of the organism and function (eg. Head size in relation to body weight as an individual ages). Allometric scaling better describes the relationship between weight and metabolic functions (using a power scale of ¾)
- The smaller the child, the higher the cardiac output and clearance
- See Myburgh et al Int Care Med 2001 for effects of increasing CO with inotropes on plasma Propofol concentration
- Currently there are two commercial available paediatric models in SA (neither perfect, each with strengths and weaknesses):
    - Paedfusor
        - Based on Marsh model
        - Validated from children 1-15 years
        - Uses weight-adjusted model for children up to 12 years
        - Limited allometric scaling
        - Gentle
        - Plasma targeting
    - Kataria
        - Older model, from 1994. Based on small sample (53 kids, 3-11 years)
        - Compartmental volumes are a linear function of body weight

        - Clinically it works surprisingly well
        - Heavy handed
        - Plasma targeting
    - Very little to generate a significant preference
    - Titration to effect is the most important!
- Hopefully newer models will incorporate better allometric scaling
- Practical use:
    - EMLA if absolute contra-indication to gas, otherwise gas induction
    - Use an adjuvant
    - Paedfusor model if possible
    - Plasma targeting, so be patient during induction and emergence
    - Similar plasma targets to adults
    - Use a dedicated cannula with a one-way valve if possible, and avoid dead space
    - Beware mixing drugs
    - Beware refilling of syringes (profofol causes rubber stopper to become sticky)
- Open TCI initiative – www.opentci.org
- Closed loop TCI coming sometime in the future?
- New drugs?
    - AZD 3043
    - Esterase metabolised hypnotic agent
- "The only principle of drug dosage that survives is that the drug dose must be adapted to the individual patient" (1940!)

Computer controlled technologies in anaesthesia – Robert Sneyd – Peninsula Medical School, Plymouth, UK

- Electronic records and fancy displays
    - E-records = improved quality and perhaps savings
    - Fancy displays = ?
    - Interaction models on your monitoring systems = cool for specific cases, great for teaching, fairly useless for day-to-day work
    - Lack of compatibility between different manufacturers systems is a huge issue
- TCI is great.
- Closed loop systems are the next stage
    - Well established concept in engineering (from air conditioning to aviation!)
    - Mostly still experimental in medicine!
    - Pump -> patient -> EEG monitor -> analyser -> controller -> pump
    - Research on rats with EEG monitor explained
    - Research in humans (using BIS) is on-going
    - Commercial systems are not far away
- SEDASYS – automated closed-loop sedation system. Works well in study of 1000 patients
- TCI can also be applied to volatiles (Drager Zeus)

- Automated control of ICU ventilation (ASV, eg Hamilton Intellivent) and weaning
    - Adaptive Support Ventilation
    - Otis relationship (change in TV/RR with changes in WOB)
    - Monitors EtCO2, FiO2, SpO2, PEEP, Paw and adjusts as necessary
    - See Lellouche et al AJRCCM 2009
- Continuous closed-loop glucose control – sensors are a problem at the moment, but systems are developing rapidly

Cardiac causes of weaning failure – Xavier Monnet – Hospital Bicetre, Paris

- Increased LV preload, increased cardiac work -> possible cardiogenic pulmonary oedema
- Anxiety induced hypertension adds to LV afterload
- Vicious cycle!
- Weaning failure from cardiac origin was 87% in one study
- Suspect if:
    - Obvious other causes of failure have been excluded (eg. ongoing pneumonia)
    - There is pre-existing COPD and/or LV dysfunction
- T-piece trial is the most sensitive test to detect cardiac failure in weaning, as the negative pressures are the greatest.
- How do we pre-diagnose cardiac-origin weaning failure?
    - PA catheter can demonstrate increased PAOP (by definition required for pulmonary oedema). However, measuring PAOP can present a significant challenge (and requires a PAC, which are becoming much less common).
    - Cardiac output must increase during weaning – if it does not, the patient will fail
    - Decrease in SvO2 may be a marker as well – demonstrated on one study
    - Echocardiography allows estimation of PAOP can gives real-time information on cardiac function and fluid status. E and E/Ea measurements are required to predict weaning failure – they are not, however, perfect in correlation with PAOP. Echo also requires a very experienced operator as it is very challenging in these patients.
    - BNP is a well-known marker of pulmonary oedema. Grassno (Crit Care Med 2007) used expert opinion to determine patients in cardiac failure; NT-proBNP increased to a much greater extent in the patients with failure. The ROCurve was remarkably good, but the study has important limitations (no PAC hence not "gold standard"; renal failure patients excluded).
    - Plasma protein concentration: Pulmonary oedema is the result of a huge migration of plasma into the interstitium of the lung, and must therefore cause a haemoconcentration effect. (See Figeuras & Weil, Circulation 1978). Monnet and Teboul measured [plasma protein] in t-piece weaning (with PAC in place) in 46 patients, showing no significant change in concentration in those who did not develop PE, but a large increase (>6%) in patients who did. This could be a very practical method, although it has only been demonstrated in this one study so far. **Look at patients with new pulmonary oedema for an increased [plasma protein], and watch the concentration fall as treatment is commenced.**

- Take-home:
    - Weaning failure from cardiac origin is not rare
    - Expect it in patients with COPD and LV dysfuncton
    - All weaning trials are not equivalent; the t-piece trial is the most challenging for the heart
    - The PAC is the gold standard, but it's invasiveness is problematic in this context
    - Echo is powerful but highly technical
    - BNP/NT-proBNP is promising but requires further study
    - [Plasma protein] is very promising but requires validation

Permissive Hypoxaemia – Jenna Piercy – University of Cape Town/Groote Schuur Hospital

- Lots of research, lots of questions…but lots of conjecture
- "This first atmospheric pollutant…rusts a person in 100 years or less…if introduced today may never achieve FDA approval." Severinghaus
- Paracelsus – it's all about the dose. Oxygen is a drug!
- Should we be dosing oxygen on SpO2 or PaO2?
- Is the quest for normoxaemia damaging and dangerous?
- Permissive hypoxaemia:
    - Lung protective strategy
    - Minimise pulmonary and systemic damage
    - Balance improved SpO2 against risk of barotrauma, volutrauma, toxicity, haemodynamic changes, etc
    - ARDSnet (2000) – low Vt, low Pplat -> reduced mortality and ventilator days. Not just about the lungs, however: these patients also had less circulatory, renal and coagulation failure. Concept of biotrauma and orhan cross-talk… "extrapulmonary organ failure"
    - High FiO2 exposure can cause ARDS-like lesions in the lung, including hyaline membrane formation, pulmonary artery adaptation.
    - Neonates resuscitated with 21% O2 had less mortality than those resus'd with 100%
    - Neonatal retinopathy caused by high O2 concentration
    - Severe TBI – extreme hyperoxaemia (PaO2 >64kPa) had higher mortality
    - Nontraumatic cardiac arrest – higher mortality in the hyperoxaemic group than normoxaemic AND hypoxaemic!
- Reactive oxygen intermediates are considered to be a likely cause of these deleterious effect (eg superoxide anion, hydrogen peroxide, hydroxyl radical)
- Hypoxia increases adenosine, which acts on the A2A receptor, downregulating inflammation. Reduced adenosine worsens inflammation, exacerbates ARDS and accelerates death (animal data – Theil et al PLoS Biol 2005)
- Hyperoxia + aggressive ventilation is worse than either separately (Animal data)
- Arterial hypoxia does not imply tissue hypoxia – this depends of oxygen DELIVERY
- How do we manipulate O2 delivery?
    - Think of DO2 equation – SaO2, Hb, CO

    - Think of VO2 – reduce oxygen consumption
        - Ensure good sedation
        - Relax/paralyse if we need to
        - Cooling if necessary
        - Avoid ventilator asynchrony
    - Determining CO is very difficult in critically ill patients
    - Inotropes alter the balance of DO2 and VO2
    - Driving haemoglobin – what values to target?
- What evidence is there that hypoxaemia is safe? EVEREST! See Grocott NEJM 2009
    - SaO2 relatively well maintained due to left shift of OHDC, increase in Hb, and likely an increase in CO (not measured on the South Col ;))
- Clinical trials:
    - Adequate DO2 is adequate; more is not better
    - Permissive hypoxaemia is complemented my permissive hypercapnoea
- In the pipeline:
    - OXYGEN-ICU study (Italy)
    - BRAINOXY study (Finland)
- What should we give?
    - FiO2< 0.4 is non-toxic
    - FiO2 > 0.5 harmful
    - Titrate to achieve SpO2 88-92%
    - Supranormal delivery of O2 is NOT advantageous

How to deal with the haemodynamic effects of PEEP – Xavier Monnet – Hospital Bisetre Paris

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- Is it important?
    - Yes! We should apply high PEEP to our ARDS patients (ARDSnet trial)
    - PEEP has some deleterious effects on haemodynamics
    - PEEP increases fluid volume requirements
- How does PEEP alter haemodynamics?
    - PEEP increases both the intrathoracic and transpulmonary pressures
    - 2 main (possible) consequences:
        - Decreased right cardiac preload (intrathoracic pressure adds to the RAP, limiting flow back to the heart and thus decreased preload). However, this has been difficult to demonstrate in studies and may not be that important. This may be because it is only seen when the right heart is preload/volume dependant. Administering fluid prevents this problem.
        - Increased right cardiac afterload - increased lung distension causes and increase in pulmonary vascular resistance (by forcing more areas of the lung into West Zone 3) Over time this may cause a right ventricular distension, and at the most serious stage an acute cor pulmonale.
- How do we limit the deleterious effects of PEEP on the RV afterload?
    - Limit over-distension by limiting the plateau pressure

    - Ensuring that the patient is volume replete increases the proportion of West Zone 1 or 2 rather than Zone 3
    - Limit hypocapnoea and hypoxia (as these can cause pulmonary vasoconstriction)
- Provided that we respect the safety limit of plateau pressure (30cmH20), PEEP along does not increase the incidence of acute cor pulmonale.
- How do we detect PEEP-induced haemodynamic impairment?
    - Suspicion of RV failure if combination of
        - Decreased SV
        - Raised CVP
        - Decreased ScvO2
    - Decreased cardiac index/output
    - Echocardiography -> RV dilatation of acute cor pulmonale (RV larger than LV)
- Take-home:
    - Respiratory benefit of increasing PEEP is counterbalanced by haemodynamic impairment
    - PEEP-induced haemodynamic impairment is mainly related to increased RV afterload
    - PEEP-induced RV afterload increase may be attenuated by limiting Pplat and restoring volume status
    - Detect PEEP-induced impairment through monitoring and/or echo

Sense and Sensibility in Transfusion for Trauma Surgery – David Muckart – Inkosi Albert Lithuli Hospital/University of KwaZulu Natal

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- Massive blood transfusion – many different contrasting definitions!
- Replacement with what?
- To what end point?
- What about component therapy?
- "I shall not attempt further to define it, but I know it when I see it."
- Concerns
    - Tissue injury and CoT (decreased thrombin, increased fibrinolysis)
    - Acidosis (decreased FVII activity, platelet function, clotting function; increased fibrinolysis)
    - Hypothermia (decreased platelet function and coagulation enzyme function)
- Hb to aim for in trauma – 10g/dl is sensible (TRICC data applies to stable critically ill patients)
- PRBC:FFP – Duchesse et al – if less than 10u transfused, 1:1 ratios don't really make a big difference. If more than 10u, the mortality benefit of 1:1 begins to emerge.
- Kashuk et al (J Trauma 2008) showed the ratio is likely to be closer to 1:2 (some data suggest 1:1.4)
- 1:1 does seem to cause an increase in complication (TRALI, immunosuppression?)
- PRBC:platelets 1:1 is important
- What you do in the first 6 hours counts most
- Ideal ration PRBC:FFP:platelets this possible 1:2:1

- rFVIIa seems to be dead in the water; perhaps the studies should have looked at using it much earlier in resus
- CRASH2 – Muckart is a non-believer, casting aspersions on the whether the data is too good to be true
- How to go about this practically:
    - <6 PRBC: Guided by TEG if you have it, otherwise PRBC only
    - 6-10 PRBC: Platelets 1:1, plasma 1:2-3
    - >10 PRBC: Platelets 1:1, plasma 1:2, cryo

End of Congress Day 2
