Expanding the role of smartphones in the operating theatre.

Andy Pybus,
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Conflict of Interest:

Director of MSE (Australia) PL
Smartphones in the operating theatre:

A benefit or a distraction?
Smartphones in the operating theatre:

Smartphones are a distraction.

Smartphones in the operating theatre:

“Create ‘no-smartphone zones’ in sensitive areas like intensive care units, operation theatres, and critical care units.”

Smartphones in the operating theatre:

“There is no evidence to support blanket prohibition on the use of smartphones and laptops in the operating theatre.”

Laptops and smartphones in the operating theatre - how does our knowledge of vigilance, multi-tasking and anaesthetist performance help us in our approach to this new distraction?
Smartphones in the operating theatre:

“Smartphones make smarter doctors.”

Smartphones make smarter surgeons.
Smartphones in the operating theatre:

“There is an inevitability about the widespread adoption of smartphone technology ... it is only imagination and battery life that currently limit their possibilities within clinical use.”

Smartphones make smarter surgeons.
Roles for smartphones:

In addition to their existing role, we can expand their usage in the areas of:

- Monitoring.
- Data management.
- Education.
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Samsung Galaxy S4

8 Core CPU.
64 GB solid-state hard disk.
1920 * 1080 display.
Multi-modal connectivity.
How can we effect wireless connectivity?

All patient monitors make their complete data streams available as ‘Serial’ data.
Wireless serial transmitter.

- Low cost (< $100).
- Widely available.
- Simple to program.
- Bluetooth / WiFi connectivity.
- Attached to monitor data port.

Air Console
Direct Data Transmission:

- Wireless transmitter encodes monitor data.
- Complete dataset streamed to the smartphone using either BT or WiFi.
- Smartphone reconstructs a monitor display in real-time.

Latency (<1.5 sec.).
The smartphone as a monitor.

- Second monitor.
- Supervision of a junior colleague.
- Smartglasses.
- Smartwatch.
- Distant monitoring.
- Novel applications.
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Connecting to the mobile phone network
Should we put every monitor in Australia on the Mobile Phone Network?
The smartphone as a monitor.

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• Novel applications.
Novel monitoring applications

• Cerebral Function Monitoring
• High-speed monitoring
Novel monitoring applications

- Cerebral Function Monitoring
- High-speed monitoring
Cerebral Function Monitoring during anaesthesia

Don’t we do this already???
I’m proposing to monitor the anaesthetist...
Australian workers are starting to have their brains monitored in the workplace

Data from caps worn by workers is used to alert them when they are likely to fall asleep.
Novel monitoring applications

- Cerebral Function Monitoring
- High-speed monitoring
The world’s fastest monitoring system?
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• **Data management.**

• Education.
The smartphone as a data manager.

- Data acquisition.
- Data distribution.
- Data recording.
- Data analysis.
- Data presentation.
The smartphone as a data manager.

- Data acquisition.
- Data distribution.
- Data recording.
- Data analysis.
- Data presentation.
The smartphone as a data integrator.
The smartphone as a data manager.

• Data acquisition.
• **Data distribution.**
• Data recording.
• Data analysis.
• Data presentation.
The smartphone as a data distributor.
The smartphone as a data manager.

• Data acquisition.
• Data distribution.
• **Data recording.**
• Data analysis.
• Data visualisation.
= ~ 10,000 hours of complete anaesthetic data.
The smartphone as a data manager.

• Data acquisition.
• Data distribution.
• Data recording.
• **Data analysis.**
• Data visualisation.
The smartphone as a data analyser.

Complete data sets allow us to perform:

• Expert system analysis (‘Smart Alarms’).
• Calculation of derived variables.
• Real-Time modelling.
• Retrospective review.
The smartphone as a data analyser.

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Why do we need 'Smart' alarms?

Our world is complicated!!
Why do we need 'Smart' alarms?

• “The human brain can only assimilate, integrate and act on a certain amount of information at one time.”

• “Information overload of the anesthesiologist ... may threaten the safety of patients under anesthesia in the operating room.”

What makes an alarm ‘Smart’?

An alarm which can:

• Integrate data from multiple sources.
• Recognise past trends.
• Predict future trends (Model).
• Recognise patterns.
• Interpret rules in the ‘Context’ of the patient.
• Present the alarm state effectively.
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The smartphone as a data integrator.
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Ansermino JM, et al.
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Effect of a transient reduction in FiO\textsubscript{2} on PaO\textsubscript{2} during stable CPB. - Terumo ‘Capiox’ 2.5 m\textsuperscript{2} Lung.
Effect of a transient reduction in FiO₂ on PaO₂ during stable CPB. - Terumo ‘Capiox’ 2.5 m² Lung.
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Context Sensitivity.

Modulation of the alarm trigger state of one variable according to the value of other measured variables.
Apnoea Alarm.

Elapsed Time Modulation.

\[ \Delta T \]
Apnoea Alarm.

ΔT

Elapsed Time + ET CO₂ Modulation.

ET CO₂ High

ET CO₂ Low
Apnoea Alarm.

Elapsed Time + ET CO₂ Modulation.

Δ T

Alarm Set

Alarm Fires

ET CO₂ High

ET CO₂ Low
What makes an alarm ‘Smart’?

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Expert Alarm.

- Circulation.
- Oxygenation.
- Ventilation.
- Anaesthesia.
Depth of anaesthesia?
BIS Index: 85%
ET Sevo: 0.3%
HR: 120
BP: 160/90
The smartphone as a data analyser.

Complete data sets allow us to perform:

• Expert system analysis (‘Smart Alarms’).
• Calculation of derived variables.
• Real-Time modelling.
• Retrospective review.
Calculating Derived Variables.

Artificial Lung:
- Membrane Resistance.
- $\dot{V}O_2$.
- Heat Transfer.

Early indicators of important oxygenator failure modes.
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Morbidity review:

- **Hand-written Record:**
  - 50 – 100 values per hour.

- **Anaesthetic Record Keeper:**
  - 500 – 1000 values per hour.

- **Complete Record Storage:**
  - ~ 250,000 values per hour.
  - Anaesthetic record ‘Playback’.
Cloud Repositories.

• Mobile devices are optimised for ‘Cloud’ interactions.

• Several groups have identified the need for centralised repositories of complete anaesthetic data sets $^{1,2,3}$.

• Repositories can be used for:
  – Pharmacodynamic model validation.
  – Simulation creation or validation.
  – Development of diagnostic or predictive algorithms.” $^{3}$

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The smartphone as a data manager.

- Data acquisition.
- Data distribution.
- Data recording.
- Data analysis.
- Data visualisation.
Data visualisation – protocol delivery

GA Caesar Checklist:
- Simple database app
- Phone delivery
- Watch delivery
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The smartphone as an educational tool.

• Database applications.
  – Echocardiography.
  – FANZCA SAQ / MCQ.
  – Protocols / Checklists

• Simulation

• Internet technologies.
  – Traditional
  – Social media (Collaborative education)
  – Virtual Private Networks
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In this short axis view of the left main coronary artery, ostial stenosis associated with post-stenotic dilatation is demonstrated. The stenotic segment measured 2 mm, the aneurysmal segment 7.7 mm. Peak diastolic velocity in the left anterior descending artery was reduced at 30 cm/sec.

The coronary angiogram of the same patient is shown at the bottom right of the image.

The use of echocardiography for the assessment of the proximal coronary arterial tree is sometimes important in patients who are undergoing aortic root surgery.
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Tablets as simulators:

- Computations easily performed by tablets
- Cheap
- Excellent data recorders
- Excellent video recorders
- Excellent communication between devices
- Device output easily streamed to HDTV
- Multiple devices can be used by simulation system
  - Patient Monitor
  - Heart:Lung machine
  - Ventilator
  - Defibrillator

The smart phone is smarter than you think!
Sterile Cockpit rules:

• No flight crew member may perform any duties during a critical phase of flight not required for the safe operation of the aircraft.

• No flight crew member may engage in any activity during a critical phase of flight which could distract any flight crew member from the performance of his/her duties.

• Critical phases of flight includes all ground operations involving taxi, take-off and landing, and all other flight operations conducted below 10,000 feet, except cruise flight.

US Federal Aviation Authority. Rule 121.542/135.100
Quiet Theatre rules:

• No team member may perform any duties during a critical phase of anaesthesia or surgery which is not required for the safe conduct of the operation.

• No team member may perform any duties during a critical phase of anaesthesia or surgery which could distract another team member from the performance of his/her duties.

• Critical phases of anaesthesia or surgery include: the transfer of patients to or from the operating table; the performance of the “Time Out” check; the induction or emergence from anaesthesia; the initiation or weaning from cardiopulmonary bypass and any other occasion when the surgeon or anaesthetist declares that a critical phase of the procedure is being undertaken.
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"The best way to predict the future is to invent it."

Alan Kay (1971)
Don't worry, Sir, it's only a nuclear reactor: Boy of 13's record-breaking experiment in school science lab

- Jamie Edwards' reactor was able to smash two hydrogen atoms together
- This made him youngest person to create helium through nuclear fusion
- Fusion took place in a controlled environment at his school in Lancashire
- Head teacher Jim Hourigan said: ‘I was a little nervous when Jamie suggested this but he reassured me he wouldn’t blow the school up’

By JAMES TOZER FOR THE DAILY MAIL and FIONA MACRAE FOR THE DAILY MAIL

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