Improving perioperative care: death, disability & digital records
Overview

- Intro & Background
- Perioperative death & disability
  - Size & source
  - Significance
- Digital records
  - Clinical efficacy: AIMS, Beyond the OR & bigger EHR systems
  - Cost effectiveness: AIMS & EHR
- Translational clinical informatics
  - Why, what & how
- Conclusions
Intro & background

- Graduate entry into medical school Queen's University of Belfast
  - Year in EM
  - Anaesthesia training last 7 years.
- Interest
  - HIT / EHR, Deteriorating patients & RRS / MET
  - QI - VIRTUE perioperative fluid management by foundation doctors
  - Organisational learning - black box medicine RCRR
- HIT
  - UK & Ireland - early stage adoption & some high profile failures
  - NIECR major success with access to information across silos
  - COI - currently early POC work on RRS based digital noting tool with SEHSCT
Perioperative D&D......size & source of the problem

- National confidential enquiries in early 80s
  - Deficiencies at extremes of age and in emergency care
- Observational studies 2000 - 2010
- National audits & more extensive epidemiological work last few years
- Under recognised burden......
Fecho et al. perioperative mortality 2008

- Department QI database (04/05). 12,739 Inpatient operations
- 48h & 30d Mortality - 0.57% & 2.1%
- Statistically associated with both early & delayed mortality
  - ASA & Age (Extremes: 0 – 1yr & 64+)
  - Emergency surgery & postoperative ICU admission
- Not statistically associated with either
  - Trauma & invasive monitoring
- Mortality higher at 30days....
  - But Emergencies. OR X8 at 48h v X3 at 30d
- Insufficient detail on adverse events...
One week cross section observational cohort study 4/4/11 - 4/11/11
- 46,539pts, 498 hospitals, 28 European nations
- 4% overall Mortality. Elective 3%, Urgent 5% & Emergency 10%
- Elective perioperative mortality four times greater if unplanned ICU admission post op. 2% v 8%
- Significant regional variation across Europe on adjusted OR
  - Lowest in Finland - 0.44 (0.19 - 1.05)
  - Highest in developing nations 6.92 (2.37 - 20.27)
Figure 2. Planned and unplanned admission to a critical-care unit according to urgency of surgery. Data are n (%) or median (IQR). We collected data describing the first critical care admission for any individual patient.
International 7-day cohort study of elective inpatient surgery in adults (inc. cardiac)

- 41,378 pts; 474 hospitals; 19H (inc UK & USA), 7M, 1L income countries.

Overall morbidity 16.8%;

- 19.8% High income v 11.1% low & middle income.
- Mortality 0.5% v 2.6% after complication (failure to rescue)
- 9.7% planned ICU v 0.9% unplanned ICU
- Mortality 0.2% no post op ICU but 1.9% after complication in this group (9.5 v 2 times)
<table>
<thead>
<tr>
<th></th>
<th>All patients (n = 44,814)</th>
<th>Immediate post op critical care (n = 4360)</th>
<th>No post op critical care (n = 39,935)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>207/44,814 (0.5)</td>
<td>105/4360 (2.4)</td>
<td>99/39,935 (0.2)</td>
</tr>
<tr>
<td>Complication(s)</td>
<td>7508/44,814 (16.8)</td>
<td>2198/4360 (50.4)</td>
<td>5270/39,935 (13.2)</td>
</tr>
<tr>
<td>Death following a complication</td>
<td>207/7508 (2.8)</td>
<td>105/2198 (4.8)</td>
<td>99/5270 (1.9)</td>
</tr>
<tr>
<td>(failure to rescue)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adjusted risk (odds ratio) of complications with 95% confidence intervals and in-hospital mortality in different surgical procedure categories.


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<table>
<thead>
<tr>
<th>Complications by type &amp; number</th>
<th>N = 44,814</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Mortality for patients who developed complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial surgical site</td>
<td>1320 (2.9)</td>
<td>681/1320 (51.6)</td>
<td>517/1320 (39.2)</td>
<td>122/1320 (9.2)</td>
<td>17/1320 (1.3)</td>
</tr>
<tr>
<td>Deep surgical site</td>
<td>566 (1.3)</td>
<td>120/566 (21.2)</td>
<td>250/566 (44.2)</td>
<td>196/566 (34.6)</td>
<td>28/566 (4.9)</td>
</tr>
<tr>
<td>Body cavity</td>
<td>340 (0.8)</td>
<td>97/340 (28.5)</td>
<td>136/340 (40.0)</td>
<td>107/340 (31.5)</td>
<td>24/340 (7.0)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>708 (1.6)</td>
<td>240/708 (33.9)</td>
<td>325/708 (45.9)</td>
<td>143/708 (20.2)</td>
<td>55/708 (7.8)</td>
</tr>
<tr>
<td>Urinary tract</td>
<td>681 (1.5)</td>
<td>294/681 (43.2)</td>
<td>333/681 (48.9)</td>
<td>54/681 (7.9)</td>
<td>13/681 (1.9)</td>
</tr>
<tr>
<td>Bloodstream</td>
<td>417 (0.9)</td>
<td>140/417 (33.6)</td>
<td>162/417 (38.8)</td>
<td>115/417 (27.6)</td>
<td>48/417 (11.5)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>139 (0.3)</td>
<td>45/139 (32.4)</td>
<td>43/139 (30.9)</td>
<td>51/139 (36.7)</td>
<td>26/139 (18.7)</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>1222 (2.7)</td>
<td>468/1222 (38.3)</td>
<td>568/1222 (46.5)</td>
<td>186/1222 (15.2)</td>
<td>74/1222 (6.1)</td>
</tr>
<tr>
<td>Pulmonary oedema</td>
<td>330 (0.7)</td>
<td>127/330 (38.4)</td>
<td>141/330 (42.8)</td>
<td>62/330 (18.8)</td>
<td>34/330 (10.3)</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>78 (0.2)</td>
<td>17/78 (21.8)</td>
<td>33/78 (42.3)</td>
<td>28/78 (35.9)</td>
<td>5/78 (6.4)</td>
</tr>
<tr>
<td>Stroke</td>
<td>111 (0.2)</td>
<td>31/111 (27.9)</td>
<td>28/111 (25.2)</td>
<td>52/111 (46.9)</td>
<td>18/111 (16.2)</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>153 (0.3)</td>
<td>N/A</td>
<td>N/A</td>
<td>153/153 (100.0)</td>
<td>91/153 (59.5)</td>
</tr>
<tr>
<td>Other complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal bleed</td>
<td>201 (0.4)</td>
<td>95/201 (47.3)</td>
<td>66/201 (32.8)</td>
<td>40/201 (19.9)</td>
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</tr>
<tr>
<td>Acute kidney injury</td>
<td>778 (1.7)</td>
<td>423/778 (54.4)</td>
<td>203/778 (26.1)</td>
<td>152/778 (19.5)</td>
<td>76/778 (9.8)</td>
</tr>
<tr>
<td>Postoperative bleed</td>
<td>1362 (3.0)</td>
<td>N/A</td>
<td>1147/1362 (84.2)</td>
<td>215/1362 (15.8)</td>
<td>55/1362 (4.0)</td>
</tr>
<tr>
<td>ARDS</td>
<td>142 (0.3)</td>
<td>46/142 (32.4)</td>
<td>41/142 (28.9)</td>
<td>55/142 (38.7)</td>
<td>34/142 (23.9)</td>
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<tr>
<td>Anastomotic leak</td>
<td>208 (0.5)</td>
<td>52/208 (25.0)</td>
<td>62/208 (29.8)</td>
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</tr>
<tr>
<td>All others</td>
<td>2934 (6.5)</td>
<td>1342/2925 (45.9)</td>
<td>1200/2925 (41.0)</td>
<td>392/2925 (13.4)</td>
<td>83/2925 (2.8)</td>
</tr>
<tr>
<td>Total infectious complications</td>
<td>4032 (34.5)</td>
<td>1572/4032 (39.0)</td>
<td>1723/4032 (42.7)</td>
<td>737/4032 (18.3)</td>
<td>104/4032 (2.6)</td>
</tr>
<tr>
<td>Total cardiovascular complications</td>
<td>2033 (17.4)</td>
<td>688/2033 (33.8)</td>
<td>813/2033 (40.0)</td>
<td>532/2033 (26.2)</td>
<td>141/2033 (6.9)</td>
</tr>
<tr>
<td>Total other complications</td>
<td>5625 (48.1)</td>
<td>1958/5625 (34.8)</td>
<td>2719/5625 (48.3)</td>
<td>948/5625 (16.9)</td>
<td>158/5625 (2.8)</td>
</tr>
<tr>
<td>Total number of complications</td>
<td>11,690</td>
<td>4218/11,690 (36.1)</td>
<td>5255/11,690 (45.0)</td>
<td>2217/11,690 (19.0)</td>
<td>207/7508 (2.8)</td>
</tr>
</tbody>
</table>
## Complications by type & number

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<tr>
<th>Complication</th>
<th>N (% of total)</th>
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## Mortality for patients who developed complications

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<thead>
<tr>
<th>Complication</th>
<th>N (%)</th>
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<tr>
<td>Deep surgical site</td>
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Ghaferi. Variation in mortality 2009

  - 84,730 pts general & vascular procedures.
  - Mortality quintiles very low to very high.
  - 3.5% - 4.6% - 4.8% - 5.8% - 6.9%
- All complication & major complication rates flat across quintiles
- But FTR ranges from 12.5% to 21.4%
  - AKI, Haemorrhage, Sepsis (Deep wound & septic shock)
Rates of All Complications, Major Complications, and Death after Major Complications, According to Hospital Quintile of Mortality.
UK Emergency laparotomy network first report 2012
- Mortality in under 50 ~ 10% increasing by ~4% per 10 yrs in age
- 39.1% planned L1 care
- 50% of all were >60 & ASAIII, 22% L1 care post op with 17% mortality...

Scott et al. JAMA surg. 2016 – top 7 operations causing 80% clinical burden of operative emergency general surgery
- Looked at D&D
- Death 22% laparotomy
- Comp. Rate 40 - 45%. Small bowel, colon, PUD procedures
Figure Legend:

Cumulative National Burden of Emergency General Surgery Procedures, by Rank. Each line represents the proportion of cumulative national burden of procedure volume, patient deaths, complications, and costs. The vertical dotted line delineates the top 7 ranked procedures, which accounted for approximately 80% of all cumulative burden. Data were obtained from the National Inpatient Sample for admissions between 2008 and 2011.
Comparison of Mortality and Complication Rates With Procedure Volume

Association between mortality (A) and complication (B) rates and the volume of procedures. Data were obtained from the National Inpatient Sample for admissions between 2008 and 2011. PUD indicates peptic ulcer disease.
Emergency general surgery complications

- Scarborough et al. JAMA surgery 2016
  - 2012 – 2013 ACS NSQIP data base on EGS procedures. 79,183 pts
- Used population attributable fractions to estimate impact of 8 complications
  - Bleeding & pneumonia…….
Cumulative hazard plot for mortality after postoperative morbidity according to FMD.

Significance

- Big problem – high volume
  - 10% High risk
  - Morbidity varies up to around 50% in emergency cases
  - Affects patients long term survival (3yrs after)
- Complications amplify mortality especially if L1 post op
  - Significant postoperative exposure to L1 care in terms of LOS
  - Focus on part of the journey is not enough
Digital records & perioperative outcomes

- Clinical efficacy:
  - AIMS
  - Beyond the OR
  - Bigger EHR systems

- Cost effectiveness: AIMS & EHR
  - Promise & potential
  - Population & provider perspective
Anaesthesia Information Management systems

- Technophilic speciality and AIMS from 1980s
  - Improved technology & functional complexity
- Diverse functional characteristics & focus in literature
  - Phase of care, technical aspects & patient safety
- Temporal distinction around alerting
  - Real-time, near real-time or retrospective alerts
- Two systematic, one narrative & a simple review
  - Clinical or administrative processes or tasks
Clinical care

- Antibiotics & beta blockers
- Antiemetics
- Blood pressure
- Glucose management
- Tidal volumes
Administrative, resource or technical functions

- Documentation
- Fresh gas flow
- Education & training
- Integration, data management & analytics
- OR management
EHR beyond the OR

- Surgical ICU & Cardiac surgical care
  - CLABSI – 85% decrease but not for LOS/C.Diff/Readmission
  - POAF – better compliance with process but low uptake
- Perioperative care in general – Systematic review
  - Observational studies
- Methodological limitations with service development interventions
  - Low evidence
  - Highlights implicit value as enabler in QI
- Magical thinking & confounding
To leverage EHR for better outcomes need to appreciate the whole perioperative journey.

- LOS & immediate, intermediate and longer term outcomes determined by many factors.
- Examples of impact in other specialties & organisational levels are important in understanding the "biological" mechanism of EHR impact on care.

- Early studies tended to be single centre evangelist adopters
- Evolving evidence on outcomes at higher levels.
Early health technology assessment highlighted improved process adherence for CDSS

- Specialist home grown systems

Jones et al. National cohort study

- AMI, Heart failure, Pneumonia
- No v basic v advanced EHR
- Quality change 2004 v 2007 adjusted relative to no EHR
- Heart failure only significant increase in quality and only for basic EHR
- Some process indicators more individual performance dependent than others?
EHR – ehealth perspective

- Systematic overview (Black et al 2011) grouped into themes
  - Storing/managing/transmitting data
  - Clinical decision support
  - Facilitating care from a distance
- Diverse body of literature (53 reviews & 55 supplemental reviews)
  - Narrative synthesis – Weak & inconsistent empirical evidence for benefit
- Insight in to
  - EHR dimensions individual v aggregate...
  - eHealth equivalent of Mechanism of action....
EHR & medical care post HITECH

- AMI (Enriquez et al.) & Ischaemic Stroke (Joynt et al.)
  - EHR adoption / capability & Quality of care & outcomes
  - National registries 2007 – 2010
- Stroke
  - No significant improvement after controlling for confounders
  - But less likely to have LOS>4days & increased component care with EHR
- AMI
  - No significant difference in STEMI care
  - But NSTEMI, UFH dosing and risk of major bleeding & mortality lower with full EHR
EHR—more recent evidence

- Medicare beneficiaries (Lammers 2016)
  - HRR measures of physician EHR adoption v ACSC admissions & readmissions (DM, IHD, CHF, COPD/asthma)
  - Physician adoption reduced admissions not readmissions
- Readmissions more difficult to influence with single site EHR
  - Interoperability & health information exchange a big issue around preventing admissions between providers
- Barnett (2016) observational study of EHR adoption / upgrade on mortality
  - No significant increase in mortality
  - But signal of work around
Nguyen (2014) demonstrated multidimensional evaluation framework to assess benefits & issues - highlighting EHR complexity
  - Quality, use & intended use, net benefit & contingent
Adler-Milstein (2016) highlighted temporal trends with EHR adoption and hospital performance
  - EHR adoption over time v process, pt satisfaction & efficiency
Campanella (2015) reported strongest empirical evidence (SR & MA) of EHR on health care quality to date
  - Documentation time, guideline adherence medication error, ADE & mortality
Yanamdala (2016) observational study with conflicting results
  - Mortality, readmission, PSI & LOS in surgical patients. Stratified by No, partial & Full EHR
From: Complications and Failure to Rescue After Inpatient Noncardiac Surgery in the Veterans Affairs Health System

JAMA Surg. 2016;151(12):1157-1165

Figure Legend:

Thirty-Day Outcomes During the Study Period: All 30-day outcomes decreased during the study period (trend test, P < .001 for all).
RAND (2005) estimated saving of $81 billion annually
- Based on ten year adoption & Non-health industry estimates
- Children's medical center – EHR increased OR revenue by 53%
  - Ambulatory v Inpatient case load changes in main OR
- Rate of growth in health spending short of 1.5% productivity improvement
  - But is heading away from national spending prediction
  - Focus on interoperability, adoption & utility
Cost effectiveness / ROI........

- More recent observational study on Medicare expenditure & EHR adoption (Lammers 2016) at hospital referral region level
  - $3.8 Billion decrease in FFS
  - $1.6 Billion decrease in acute care
  - Increase in lab $0.55 per beneficiary

- A study of five ambulatory offices with 28 providers did show significant logistical savings
  - Initial costs recaptured in 16 months (18 – 36 range cited)
  - Annual estimated savings $9,983 per provider
Cost effectiveness / ROI summary

- Lies, dam lies, statistics, health economics
  - Who pays v who profits disconnect
  - Productivity & efficiency v revenue generation
- Difficult analysis & gets harder for bigger implementations
  - More and more assumptions with greater influence of hidden costs and exposure to value of money over time
- What will it cost for next generation technology & is that affordable
- Incentive & responsibility to demand more from vendors…….
Translational clinical informatics

Why
- EHR technology needs to advance
- Adoption of EHR is high

What & how
- Two big challenges -
  - Design / develop better solutions
  - Demonstrate - Usability & utility
AIMS/EHR - Why TCI?

- Perioperative outcomes & whole patient journey
  - Some examples of EHR / AIM use to drive QI
- Sociotechnical insight v magic thinking
  - Primary & secondary use of clinical information
  - Processing clinical information v information for clinical processes
- Usability and interoperability highlighted as critical
- Anaesthetists (perioperative physicians) are well placed to guide development of digital records
How – Design (Basic Science)

- Problems: Understand antecedents to adverse clinical outcomes in perioperative care
  - "Weak Spots"
  - Retrospective case record review
- Performance: Human factors and ergonomics
  - HIT safety framework
- Processes: Quality improvement science – Demming
  - Rapid response system perspective
Failure to rescue in perioperative care

- Chain of prevention in rapid response systems
  - Smith 2010
  - Sorensen 2015
- How could technology improve
  - Automation?
  - Alerting?
  - Authoring?
Performance of rapid response systems of care in a district general hospital: results of an immediate care audit project

A. Dawy, N. Brain, J. Smith and I. Skipsey

Cumbernauld Hospital, Inverclyde, Scotland

jwilson@cas.ac.uk

Abstract

The purpose of this study was to evaluate the performance of rapid response systems of care (RRS) in a district general hospital in Scotland. The study was carried out as part of an immediate care audit project. The audit was conducted over a period of 12 months, and included the review of all patients who received a rapid response. The audit focused on the identification of any areas where the RRS could be improved, and the development of strategies to address these areas.

Introduction

Rapid response systems of care (RRS) are an important component of the delivery of high-quality care in hospitals. RRS are designed to identify and respond to patients who are at risk of developing acute deterioration, and to provide timely intervention to prevent further deterioration or adverse outcomes.

Methods

The audit was conducted using a retrospective review of patient records. All patients who received a rapid response were included in the audit. The audit focused on the following areas:

- Patient demographics
- Indication for rapid response
- Time to response
- Outcome of rapid response
- Strategies for improvement

Results

The audit found that the majority of patients who received a rapid response were elderly and had multiple comorbidities. The most common indications for rapid response were respiratory failure, cardiovascular failure, and neurological impairment. The average time to response was 30 minutes, and the majority of patients received adequate intervention to prevent further deterioration.

Discussion

The results of this audit suggest that the RRS is effective in identifying and responding to patients at risk of acute deterioration. However, there is room for improvement in terms of the timely delivery of intervention. Strategies for improvement include improving communication among healthcare professionals, and developing protocols for the timely delivery of intervention.

Conclusion

The RRS is an important component of the delivery of high-quality care in hospitals. The results of this audit suggest that the RRS is effective in identifying and responding to patients at risk of acute deterioration. However, there is room for improvement in terms of the timely delivery of intervention. Further research is needed to determine the most effective strategies for improving the performance of the RRS.

References


Figure 1

Figure 2

System and care quality
Neurological
Circulation
Specialty and care quality
Satisfactory
Unsatisfactory

Number of patients
5
0
2
1
3
4
Automation & alerting......

- Electronic observations
- Machine learning
- Acute kidney injury alerts
Authoring (Clinical noting)

- Structured noting solutions established on paper
- Digital noting could support better processing of clinical information
- Minimise cognitive error & support efficiency
  - RESET Shock project
- Change to clinical processes / practice
How to save lives in emergency laparotomy

Emergency Laparotomy Collaborative

Screen patient
NEWS/SIRS/arterial lactate

Is the patient septic?
Antibiotics within one hour

Theatre
within 6 hours of decision to operate

ICU
for all patients

Cardiac output monitored
goal-directed fluid therapy

Consultant surgeon
and anaesthetist
in theatre

www.emergencylaparotomy.org.uk
@emergencylaparotomynhtu.net
#emlpacollaborative
Demonstrate – Usability testing

- Clinical decision support is advanced EHR function
  - Relies on user interaction in heterogeneous clinical settings and scenarios
- Workflow process v processing of clinical information
- Use of simulation allows developers to optimise the later
- Usability testing of Well's clinical prediction rule 62% adoption cf 10 – 20%
- Improvements limited by rigidity of live EHR
Utility – Simulation, Step wedge trials & statistical process control

- Assessment process by juniors evaluated in high fidelity simulation of medium acuity deteriorating patients
- Traversing the concept– clinical practice gap is difficult with service delivery solutions / interventions.
  - Randomisation not logistically or ethically possible.
- Recent reports on stepped wedge trial methodology for electronic observations solution highlights potential
- Methods of measuring & charting process, outcome & balance need further development
Conclusion

- Burden of perioperative D&D is a public health crisis
  - Hot spots & weak spots are being identified and digital records have implicit value in delivering better care
- Evidence of consistent clinical benefits & cost effectiveness emerging & is probably improving with time
- Significant room for improvement in digital patient record technology
- Need to think outside traditional silos - with both clinical & procurement processes
- Translational clinical informatics offers an approach for development and demonstration of better digital records with clinicians in the driving seat
BJA/RCoA International Collaborative Grant 2017

The British Journal of Anaesthesia is delighted to give advance notice of a new International Collaborative grant to be awarded in Spring 2017.

Aim
The grants are intended to support internationally collaborative research projects in Anaesthesia, Critical Care or Pain Management and may be for salaries or for the purchase of items of equipment. We will not consider specific PhD studentships in this grants category - please see here for information on our non-clinical PhD studentship currently available through NIAA Grants 2016 R2.

Eligibility
Applicants should be from outside of Great Britain & Ireland. The proposal must involve real, credible, collaboration with an individual / institution based in Great Britain & Ireland. Pilot / feasibility studies are welcome.

The Research Project
Preference will be given to projects that involve the application of basic science to Anaesthesia, Critical Care or Pain Management but clinical research projects will also be considered. The work may be done in a university department or in an academic clinical department, but preference will be given to projects involving co-operative research between a basic science department and a clinical department.

The Support
£100,000 per grant is available. This support is for salaries (including Superannuation and National Insurance (or equivalent) contributions) the BJA and RCoA will contribute to any other indirect costs, equipment (including VAT) and running costs. Applicants will need to provide full justification of all costs applied for. Applications requesting less than the stated amounts are welcome. The BJA/RCoA will wish to share any intellectual property rights and income arising from this work with the host institution. There will be funding available to make at least one award.

More Information
Potential applicants are welcome to contact the BJA Grants Officer Dr lain Mappett with any questions about the award. A draft version of the application form is available below for information.

The formal application process for this award will open early next year, as part of NIAA Grants 2017 R1.