Clinical Data Mining

Philips Healthcare, PCMS
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Some basic remarks / preparing the ground

“Clinical Data Mining (CDM) is the retrospective analysis of mass patient data in order to produce new insights”
Some laws apply:

1\textsuperscript{st} Law: “If it ain’t in, you won’t get it out”

2\textsuperscript{nd} Law: “If you don’t plan for it, it won’t be in.”

3\textsuperscript{rd} Law: Data will only be valid if the feeding systems are the sole source of truth for patient care

4\textsuperscript{th} Law: Systems will only be used in this fashion if they are not overloaded by “research requests”

Corollary: CDM is ...
...in a Trilemma

Make sure the documentation closely matches the needs of clinical staff!

Make sure the documentation unambiguously and comprehensively identifies potentially interesting phenomena!

Make sure to keep the documentation close to the factory settings of the provider!
What do our customers do?
They complain about

- Site-specific configuration
- Configuration changes
- Technical & clinical competencies necessary
- Missing change history
- Shallow learning curve, complexity (no. of tables, table size)

but...
They are happy about...

• Flexibility
• Time stamping
• Richness of clinical content
• Possibility to feed back results into clinical routine

Some examples...
Examples from customers

Usage of antibacterials

Response to CG-advice

Predicted vs. observed mortality
Examples from customers

Tidal volumes for patients with severely low PaO2/FiO2

Figure shows there is room for improvement:
aim to increase TV, expectation to lower mortality of ARDS patients

Glucose vs Actrapid Infusion

<table>
<thead>
<tr>
<th>Unit</th>
<th>ICU</th>
<th>Date Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>September 2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Glucose Charttime</td>
<td>2009-09-10 04:22</td>
<td>59</td>
</tr>
<tr>
<td>Previous Glucose Charttime</td>
<td>2009-09-10 01:29</td>
<td>95</td>
</tr>
<tr>
<td>Decline per hr</td>
<td>13.14 %</td>
<td></td>
</tr>
</tbody>
</table>

Continuation of insulin infusion despite normoglycemia
Audit of Ventilation Practices (Spain)

Not satisfied (yet)?

**Introduction**

Liberal blood transfusion strategy has been attributed to worse outcome and increased cost on the intensive care unit. Potential risks of transfusion include ABO incompatibility, transfusion reactions, transfusion transmitted infections, transfusion associated circulatory overload, transfusion related acute lung injury, transfusion associated immunomodulation and an increased incidence of hospital acquired infections. A UK National guideline advocates tolerating low haemoglobin (Hb) levels in ICU patients. Many centers are yet to adopt a restrictive transfusion policy as recommended by many publications and guidelines.

**When is blood transfusion appropriate?**

(AAGBI, 2008)

A strong indication for transfusion is a haemoglobin concentration <7 g/dL. Transfusion will become essential when the haemoglobin concentration decreases to 5 g/dL. A haemoglobin concentration of 8-10 g/dL is a safe level even for those patients with significant cardiorespiratory disease

**Background of audit**

The Royal Glamorgan Hospital is a busy District General Hospital with large numbers of major vascular and general surgical patients. These patients often pass through the ICU/HDU during their stay, and a considerable number receive blood transfusions. It has been recently noticed that a seemingly significant number of patients are receiving blood transfusions above the threshold stated in the AAGBI guidelines, without evidence of significant bleeding.

An audit of transfusion practice was therefore proposed to evaluate our use of blood transfusions, improve staff awareness and understanding, and reduce potential harm to patients by over-transfusion.

**Appropriate blood transfusion on the ICU: An audit of current practice in a District General Hospital**

A P Hadfield, J Naughton, T Szakmany

Anaesthetics, Critical Care and Theatres, Royal Glamorgan Hospital, Llantrisant, UK

**Methods**

Retrospective analysis of all patient data stored between January and December 2010 in our Clinical Information System (Carevue, Philips) against published AAGBI transfusion guidelines

Transfusion was deemed appropriate if:

- Recent or ongoing blood loss > 1500mL
- Hb < 8g/dL

Patients age, sex, APACHE II score, length of stay (LOS), surgical status, ICU and hospital outcome were recorded.

Pre-transfusion Hb level and number of units of blood was recorded for every transfusion episode

Statistical analysis performed with Chi-squared and Mann-Whitney U test. Data presented as median and inter-quartile range.

**Results**

323 patients were transfused in 580 transfusion episodes

1319 units of blood

- £204,000 cost

299 surgical vs 180 medical patient transfusion episodes

There was no significant difference between age, sex, APACHE II, LOS and outcomes between the appropriate and inappropriate group. Significantly more surgical (125/299) than medical (71/180) patients were transfused appropriately during the observed transfusion episodes (p=0.031).

Surgical patients had significantly lower APACHE II scores and significantly higher pre-transfusion Hb levels. When analyzed the single transfusion episodes (when blood transfusion was given only once during the ICU stay) we found that in 75 episodes using 156 units of blood the transfusion was inappropriate.

**References**

1.) Hebert PC et al. NEJM 1999;340:409-417.

2.) Blood Transfusion and the Anaesthetist: Red Cell transference 2 AAGBI, 2008

Audit of Ventilation Practices (Spain)

Not satisfied (yet)?

Effect of bundle compliance on reducing ventilator associated pneumonia in a mixed medical-surgical ICU

CHALLENGE

Ventricular associated Pneumonia (VAP) is a common problem on UK ICUs: 4.9 - 48.5/1000 ventilator days.
- Usually multiresistant organisms with high mortality and morbidity if appears.
- Prior to initiating the bundle the VAP rate was 21/1000 ventilator days.
- MRSA, Acinetobacter and multiresistant pseudomonas key contributors.
- Mortality >40%
- VAP occurred >8 days of ventilation.

SOLUTION

Objectives: (1) To implement, monitor and evaluate the effect of the VAP Bundle to reduce the incidence of VAP and improve patient outcomes. (2) To identify gaps in process compliance.
Method: A robust education program was rolled out targeting nurses, Senior medical staff and rotating junior medical staff.
- Every ventilation patient has a daily sedation review if FIO2>0.5, head elevated >30, peg gastrointestinal prophylaxis and IVT prophylaxis.
- Used ICP-clinical information system (CIS) to generate an easy, reliable, robust, and accessible method for monitoring VAP bundle compliance.
- Nurses documented on the flowchart every shift using simple drop down menus and compliance reports were compiled from the CIS database every month.

RESULTS

<table>
<thead>
<tr>
<th>Year</th>
<th>VAP Rate</th>
<th>Bundle-compliance</th>
<th>VAP rate/1000 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>5 VAP in 8 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>3 Pneumonias, 1 Acinetobacter, 2 E. Coli, 2 MRSA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>4 VAP in 12 months</td>
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CONCLUSION

- Our data shows that implementation of care bundles can significantly and sustainable reduce VAP on the ICU without extra expenditure.
- Our CIS helped us to monitor compliance and reinforce the message with high medical staff turnover.

LESSONS LEARNED

- Focus on process measures rather than outcomes
- Multiple practices rather than single intervention
- Before-after design
  - Hawthorn Effect
  - Ceiling effect on already embedded practices
- Incorporate new evidence to change practice
Audit of Ventilation Practices (Spain)

Not satisfied (yet)?
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Not satisfied (yet)?

MECHANICAL VENTILATION IN PATIENTS WITH Acute Lung Injury (ALI)/Acute Respiratory Distress Syndrome (ARDS): CLINICAL AUDIT.

Molina R, Arnal D, García del Valle S.

**CHALLENGE**

- ALI/ARDS and its treatment is one of the most common challenges in critical patients in an ICU.
- Incidence of ARDS varies between 1.6-7.5% of 100,000 persons.
- 25-40% of those cases are fatal.
- Use of low Tidal Volumes (TV) is the only measure of mechanical ventilation that has shown to improve survival.
- Unnecessary hyperventilation is a common condition when dealing with ARDS.

**OBJECTIVES**

- Determine the patterns of Mechanical Ventilation used in our unit in critical patients.
- Compare them to the standard patterns considered as optimal and acceptable ventilation.

**METHODS**

- Six months retrospective audit of records on patients with mechanical ventilation for more than 24 hours using ICU/PHILIPS.
- Evaluate those records with TV/TV breaths of 1001/70 and/or patients with cardiogenic respiratory insufficiency.
- Build a database with 2 daily records (7AM/7PM) for each patient.
- Basic statistical analysis of the data obtained.

**RESULTS**

- 28 patients
- Mean stay in ICU: 14.8 days.
- Mean time on Mechanical Ventilation: 11.9 days.
- 83.2% of the records received Adequate Ventilation.
- 14.6% of the records received Unnecessary Hyperventilation (8 patients)
- 2.1% of the records received Optimal Ventilation.

**CONCLUSIONS**

- The majority of our patients (83.2%) received Adequate Ventilation.
- We discovered that more than one third of our patients were exposed to Unnecessary Hyperventilation at some point of their admittance in our unit.
- Clinical portfolios (such as ICIP) serve as a valuable tool to perform clinical audits, make decisions according to clinical standards and guidelines based on the data displayed, and elaborate simple alerts to avoid unwanted clinical outcomes (such as Unnecessary Hyperventilation).
- Data obtained commits us to re-audit our ventilation patterns and determine if following a protocol increases the records of Optimal and Adequate Ventilation, and/or affects the prognosis of our patients.
- After our experience we plan to use ICIP to establish an alert system to avoid unwanted results in our patients.
What do we do?
The objective of this Bioengineering Research Partnership is to focus the resources of a powerful interdisciplinary team from academia (MIT), industry (Philips Medical Systems) and clinical medicine (Beth Israel Deaconess Medical Center) to develop and evaluate advanced ICU patient monitoring systems that will substantially improve the efficiency, accuracy and timeliness of clinical decision making in intensive care.

The database can be found on PhysioNet. It is created by obtaining data from the hospital’s ICU information systems, hospital archives and other external data sources.

Link
Process model for Clinical Data Mining

How to find a needle in a haystack?

Visibility of needles in haystacks may range from...

well below $0.1 \text{ VR}_{nh}$...

... to almost $1 \text{ VR}_{nh}$. 
Process model for Clinical Data Mining

Literature suggests...

Knowledge Discovery in Databases\(^1\)

1. Business understanding
2. Data set selection
3. Data cleaning and processing
4. Data reduction and projection
5. Matching objective into mining method
   (classification, clustering, regression)
6. Choice of algorithm
7. **Pattern extraction (= “Data Mining”)**
8. Data interpretation
9. Documentation and use of discovered knowledge

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Process model for Clinical Data Mining

Experience suggests: It’s a bit more messy.
Remember:

Data mining is not “science without rigor”.

It is about discovering things that matter to you and your patients.

Somethings you didn’t even expect these things to exist.

Thank You!