Clinical Data Mining

Philips Healthcare, PCMS
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Bern, January 24, 2014

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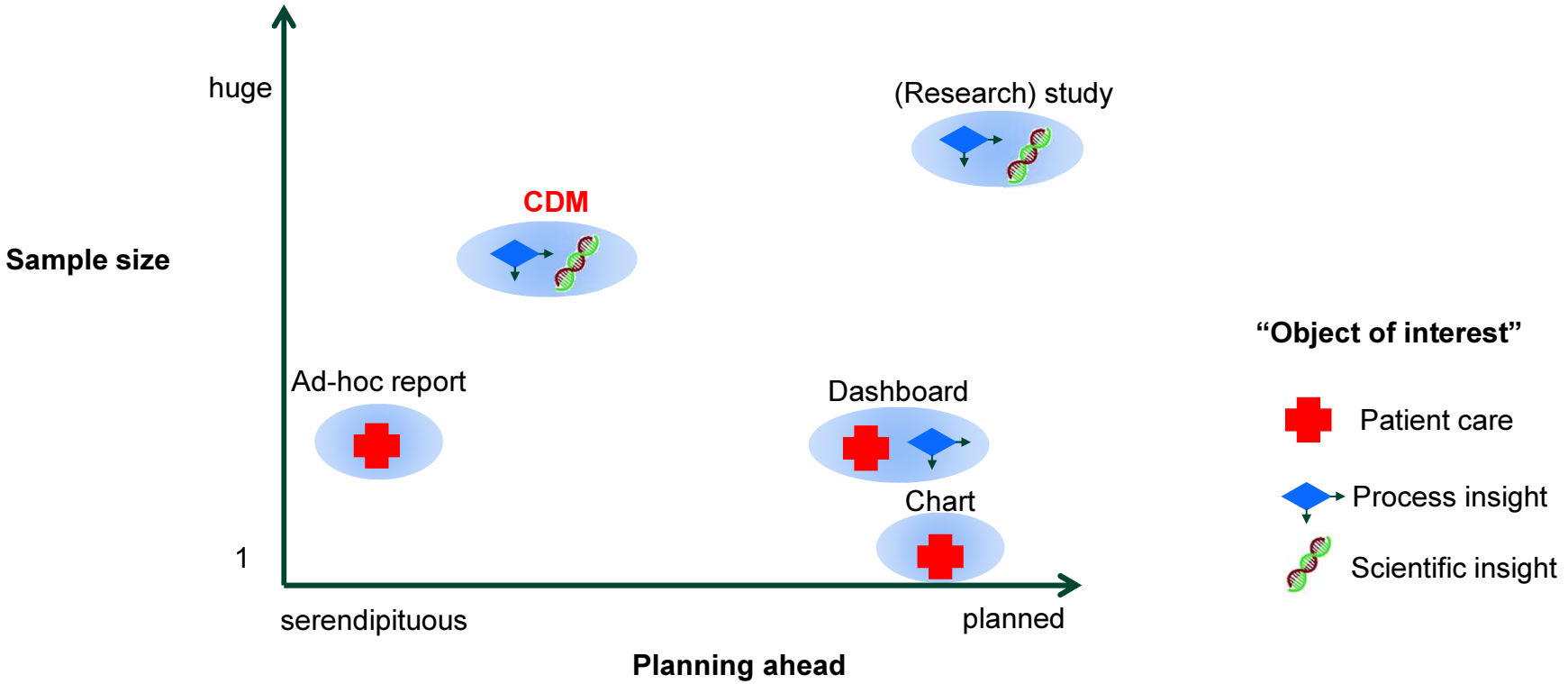
Some basic remarks / preparing the ground

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



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Some laws apply:

1st Law: "If it ain't in, you won't get it out"

2nd Law: "If you don't plan for it, it won't be in."

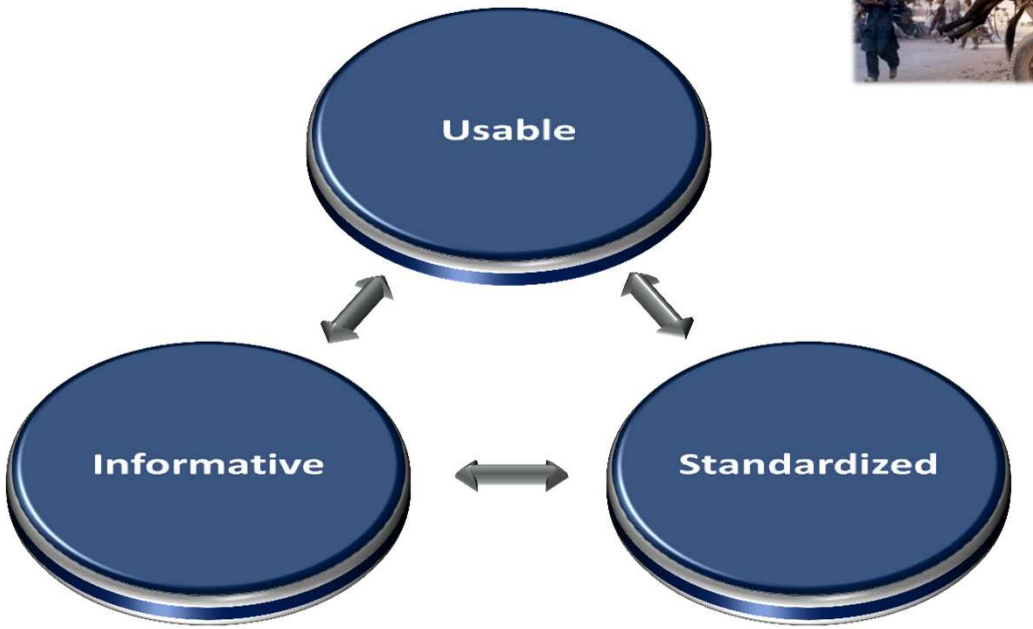
3rd Law: Data will only be valid if the feeding systems are the sole source of truth for patient care

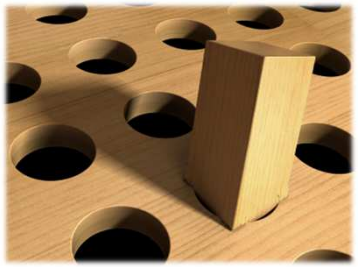
4th Law: Systems will only be used in this fashion if they are not overloaded by "research requests"

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!

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What do our customers do?

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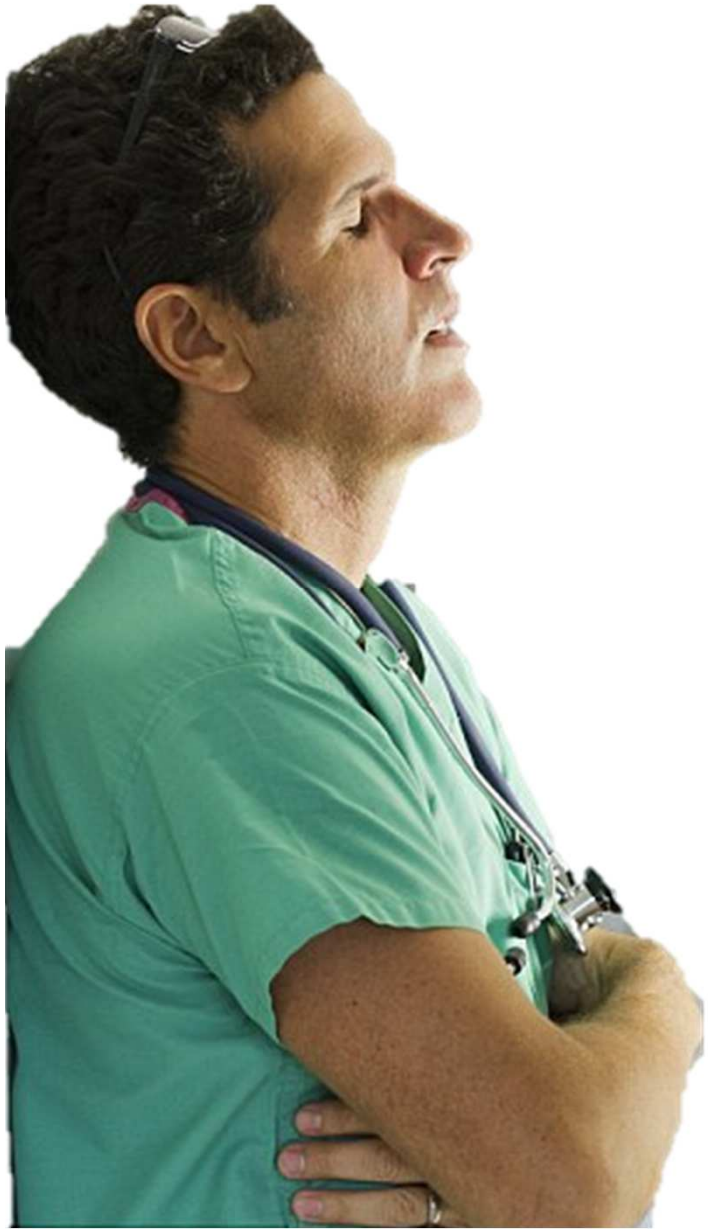

They complain about

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

but…

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They are happy about…

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

Some examples…

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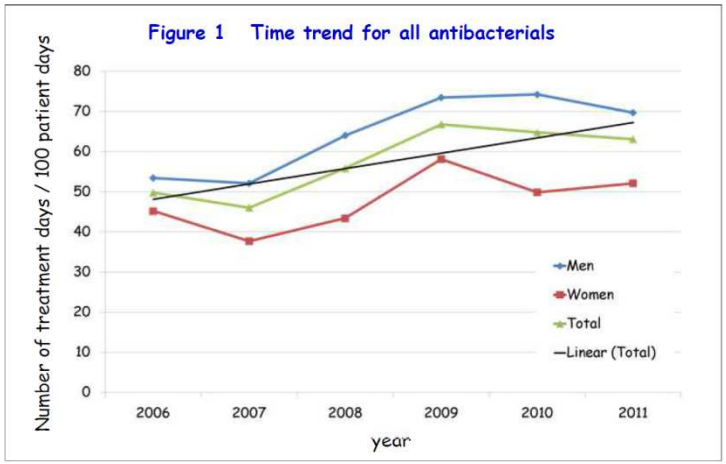
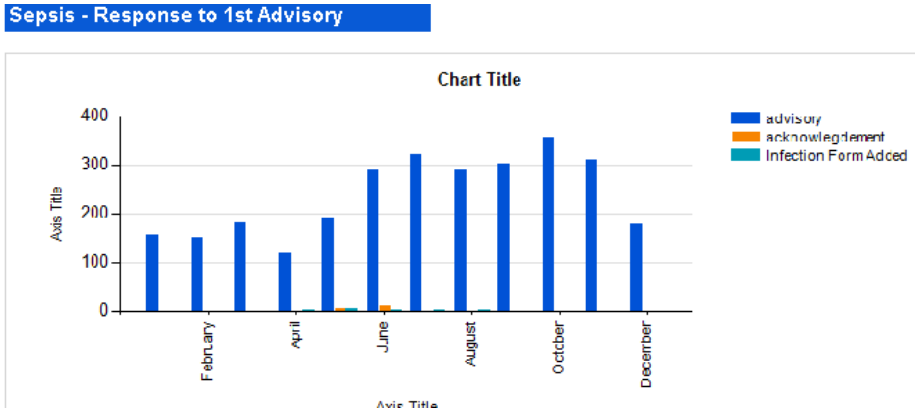
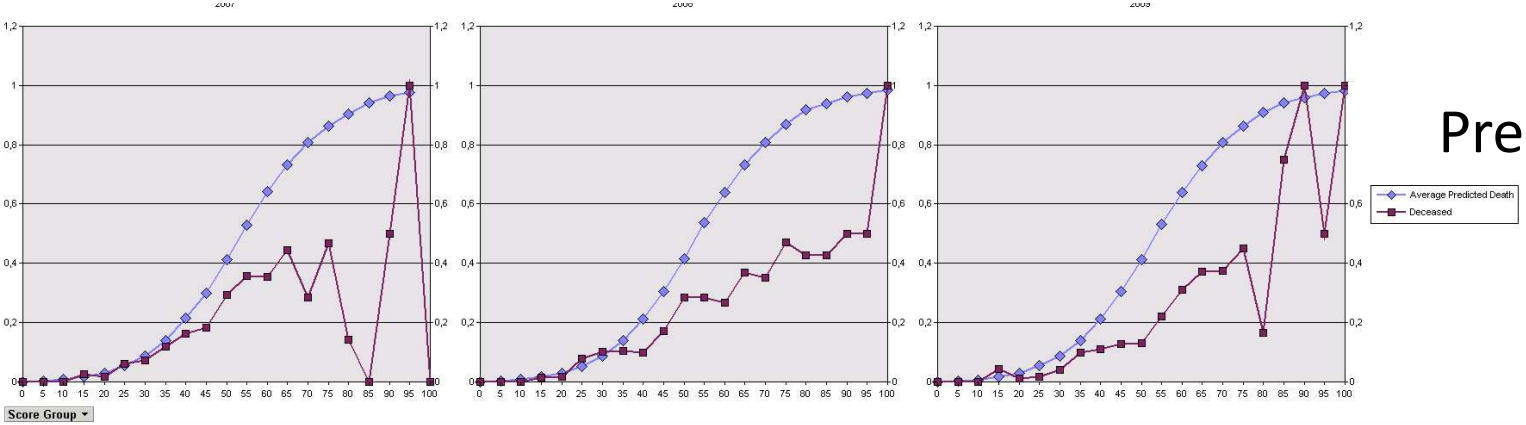
Examples from customers



Usage of antibacterials



Response to CG-advice



Predicted vs. observed mortality

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Examples from customers

Not shown

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

Tidal volumes for patients with severely low PaO2/FiO2

Glucose vs Actrapid Infusion

Date Range

Unit *ICU* *Month* *September 2009*

Low Glucose Charttime	2009-09-10	04:22	59	**Decline per hr**		
Previous Glucose Charttime	2009-09-10	01:29	95	13,14 %		
					Actrapid Charttime	**Dosis**	**Time diff to Glucose**
					2009-09-10 04:00	7	-22
					2009-09-10 04:32	4	10
					2009-09-10 05:00	4	38
Low Glucose Charttime	2009-09-10	05:53	45	**Decline per hr**		
Previous Glucose Charttime	2009-09-10	04:22	59	15,65 %		
					Actrapid Charttime	**Dosis**	**Time diff to Glucose**

Dienstag, 27. Oktober 2009 SEITE 3 VON 5

Continuation of insulin infusion despite normoglycemia

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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[1].

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[2]

Many centers are yet to adopt a restrictive transfusion policy as recommended by many publications and guidelines[3]

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 education and awareness, 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, Phillips) against published AAGBI transfusion guidelines

Transfusion was deemed appropriate if:

- –Recent or ongoing blood loss > 1500mls
- –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

~ £264,000 cost

299 surgical vs 180 medical patient transfusion episodes

There was no significant difference between age, sex, APACHE II, LOS and outcome between the appropriate and inappropriate group.
Significantly more surgical (125/299) than medical (71/180) patients were transfused inappropriately 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.

Is it appropriate?

	Transfusion episodes	Pre-transfusion Hb (g/dL)	Units of blood (n)
Appropriate	351 (65%)	7.4 (7.0-7.8)	928
Inappropriate	200 (35%)	8.5 (8.2-8.8)	391

Conclusions

~34% of blood transfusions were deemed inappropriate when compared to the AAGBI guidelines.
Surgical patients seem to receive blood at significantly higher pre-transfusion Hb levels without any signs of bleeding. This highlights an educational and interface issue on our unit.
Based on our results, even the most conservative estimate shows that 13% of the blood transfused on our unit is inappropriate and wastage of precious resources.
Further education is warranted for the critical care and surgical residents about appropriate blood transfusion.
Our plan is to introduce a decision support tool for transfusion using our electronic CIS to raise awareness and reduce inappropriate use of red blood cells

References

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

2.) Blood Transfusion and the anaesthetist: Red Cell transfusion 2 AAGBI, 2008

3.) Corwin HL, Gettinger A, Pearl RG, et al.: The CRIT Study; Crit Care Med 2004, 32:39–52.

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Audit of Ventilation Practices (Spain)

Not satisfied (yet)?

Royal Glamorgan Hospital

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

Szakmany T, Pain T, Beckett F, Jerrett H, Hermon A

CHALLENGE

Ventilator associated Pneumonia (VAP) is a common problem on UK ICUs: 4.9 – 49.5/1000 ventilator days.

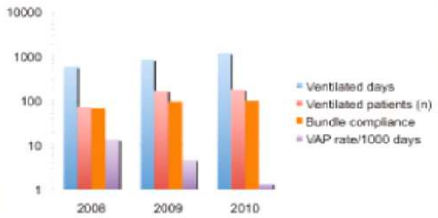
- *Usually multiresistant organisms with high mortality and morbidity if appears.*
- *Prior to initiating the bundle the VAP rate was 21/1000 ventilator days.*
- *MRSA, Acinetobacter and multiresistant pseudomonas key contributors.*
- *Mortality >40%*
- *VAP occurred ~8 days of ventilation.*

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 had a daily sedation break if FIO<0.5, head elevated >30, peptic ulcer prophylaxis and DVT prophylaxis.
- Used ICIP clinical information system (CIS) to provide 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 ICIP database every month.



RESULTS

VAP Rate

2008 - 5 VAP in 6 months

3 Pseudomonas, 1 Acinetobacter, 2 E. Coli, 2 MRSA

Mortality 3/5

2009 - 4 VAP in 12 months

2 Pseudomonas, 1 E. Coli, 1 MSSA

Mortality 1/4

2010 – 2 VAP in 12 months

1 Pseudomonas, 1 MSSA

Mortality 0/2

***Time to VAP:* 8±3 days to 16±3 days**

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 to 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

Royal Glamorgan Hospital, Ynysmaerdy, Llantrisant, Wales, UK

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Audit of Ventilation Practices (Spain)

Not satisfied (yet)?

St. Joseph's Healthcare Hamilton

Leading and Transforming Care using Technology through Implementation of Clinical Advisories in the Intellivue Clinical Information Portfolio

Marg Maclennan RN (ICIP Systems Administrator, Clinical Informatics), Lily Waugh (Nurse Manager ICU/CCRT), Mark Soth, MD (Medical Director ICU), Joanne Takaoka RN, Julie Garnham -Takaoka RN, Angela Greiter RN, Shawn Quait RN, May Griffiths-Turner (ICP), Elaine Wilson (Application Analyst), Jacqueline Lata (Nurse Manager Clinical Informatics), Jackie Barrett (Director of Clinical Programs), Deborah Cook MD, Dan Perri MD
St. Joseph's Healthcare Hamilton, Ontario CANADA

Philips EPIS Users Group Meeting
November 17 - 19, 2010

BACKGROUND:

St. Joseph's Healthcare Hamilton (SJHH) is a regional, tertiary referral and premier academic research health science centre. SJHH is member of the St. Joseph's Health System, one of the largest corporations in Canada devoted to healthcare. The SJHH site has over 650 beds, staff of 4000+, 12 Medical Stepdown beds, 6 Surgical Stepdown beds, and 15 ICU beds (15 ICIP beds). Patient safety is an identified priority at SJHH. As a leader in research, and patient safety and best practice implementation, the ICU has implemented safety bundles which are aligned with the SJHH organization and *Safer Healthcare Now!* Canada patient safety initiatives.

CHALLENGE:

Several strategies have been shown to decrease central line associated blood stream infection (CLA-BSI) and ventilator associated pneumonia (VAP) rates. However, compliance can be challenging. According to the evidence, reliable and timely care for high-risk and critically ill clients can be achieved

GOALS:

- To determine if a real time standardized approach to nurse acknowledgement of Intellivue Clinical Information Portfolio (ICIP) advisories are associated with compliance
- To determine if implementation and compliance to safety advisory alerts in ICIP can impact patient safety outcomes and decrease CLA-BSI and VAP rates
- To determine if a standardized approach to education can positively impact patient safety and best practice outcomes

METHODS:

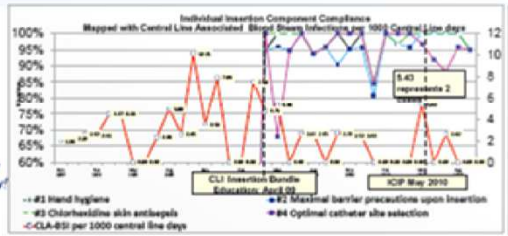
Within 15 minutes of a central venous line insertion, and through direct assistance and observation, a 4 component paper based checklist was completed by the bedside nurses (April 2009)

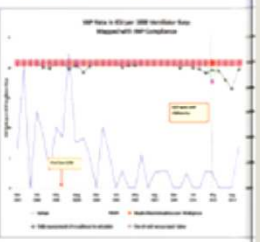
1. hand hygiene
2. maximal barrier precautions
3. chlorhexidine skin antisepsis
4. subclavian site selection unless contraindicated

Compliance for each of these components was reviewed by nursing informatics on a paper case report form initially with transition to the electronic medical record and ICIP reporting after the first year (ICIP Activation May 5,2010)

Central venous line insertion, maintenance and VAP prevention compliance cues were built into ICIP along with clinical advisories

A standardized approach to education of safety bundles and checklist completion with 1:1 RN led education and Physician led medical learner simulator training (SIM)





The CLA-BSI rate was tracked by the hospital infection control practitioner for 17-months pre-intervention (before) and for 18 months after the intervention started (post). (November 2007-September 2010)

ICIP reporting was used to determine compliance after May 2010

Online audits with direct staff feedback using Sharepoint

Infection Rates and process improvements were tracked monthly with mandatory reporting to the Ontario Ministry of Health

Post implementation survey completed by staff

RESULTS:

The CLA -BSI and VAP patient safety bundles built into ICIP are aligned with *Safer Healthcare Now! Canada*

ICIP has been live in ICU since May 2010

Customized electronic charting rows and clinical advisories cue nursing staff to complete compliance checklists that are associated with moderate compliance and a moderate decrease in CLA-BSI

Staff feedback includes appreciation of the quarterly graphic reports displaying the decrease in CLA-BSI and VAP rates

Nurses are empowered to speak up and halt the procedure whenever a breach in bundle protocol is observed

Use of an online chart audit form and website allows for standardized chart review and direct staff feedback

Evaluation and follow up results will be available following further analysis

OBSERVATIONS:

Nurse led best practice initiatives empower nurses to advocate on behalf of patient safety

A standardized approach in the electronic documentation system with ICIP advisories cue and remind nurses to document the care they have provided, and can provide real time improvement in patient safety bundle compliance

Implementation and compliance of patient safety ICIP advisory alerts, monitoring compliance and process feedback can positively impact CLA-BSI and VAP outcomes

A standardized approach to nurse and physician led education can improve timely care for high-risk and critically ill clients in ICU. It is recognized that SIM education assisted in bundle compliance

CONCLUSIONS:

A 5 month post implementation survey was completed November 2010
Early results indicate: staff find the clinical advisories beneficial, they have readily adapted to ICIP, and they find ICIP a pleasure to use

LESSONS LEARNED:

Several factors contributed to successful ICIP implementation including:

1. Visionary leadership – established steering group and team meetings
2. Senior Executive team support
3. RN Clinical Informatics leadership with an interprofessional team approach to configuration and team education – RN, RT, MD, IT, IPAC, Dietitian, Pharmacist
4. ICU team leadership
5. Dedicated ICU resources
6. Physician collaboration and engagement throughout the process
7. Process for ongoing support, feedback, and communication

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Audit of Ventilation Practices (Spain)

Not satisfied (yet)?

Use of a Custom Advisory To Improve Regulatory Compliance on Methicillin Resistance Staph Aureus Surveillance Testing

Alcina Fonseca, Manager IMC/CSICU, Maryann Fischer, Manager ICU, Laurie Nagle, Manager CCU,
Katherine Peck, System Administrator

The Valley Hospital, Ridgewood, New Jersey

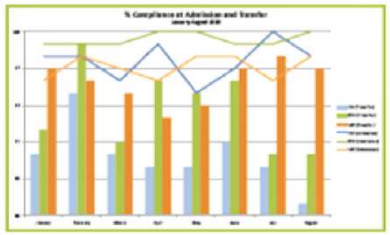
Philips EPIS Users Group Meeting • November 17 - 19, 2010

CHALLENGE

In 2007, the New Jersey Department of Health and Senior Services (NJSA 26: 2H-1)mandated surveillance testing for Methicillin Resistant Staph Aurea (MRSA). Critical care units were required to obtain a nasal swab within the first 24 hours of admission and at transfer. Obtaining the swab sample on admission was often problematic due to the criticality of the patient's condition and required frequent reminders from others to ensure that the specimens were sent.

SOLUTION

With the implementation of the Intellivue Clinical Information Portfolio at The Valley Hospital in November 2009, a custom advisory was created. This advisory would automatically alert the RN if the MRSA swab was not sent to the laboratory. If the swab was not sent after 12 hours in the unit, the advisory would be displayed on the chalkboard and in the message bar areas of the flowsheet. This message would continue to re-appear every 4 hours until the sample was sent.



RESULTS

The graph shown above demonstrates that there are bettter outcomes with the custom advisory in place as compared with no advisory at the time of transfer. The line graph reflects the admission results and the bar graph displays the results at the time of transfer. Data is collected and compiled by the Infection Control Department using admission information from the hospital information system and microbiology results. Percent compliance is measured by the total number of patients with correctly processed samples (numerator) compared to the total number of admissions or transfers (denominator). Overall, during the eight months studied each unit demonstrated improvement during the admission process:

ICU 7.7%

CCU 5.8%

IMC 1.2%

CONCLUSION

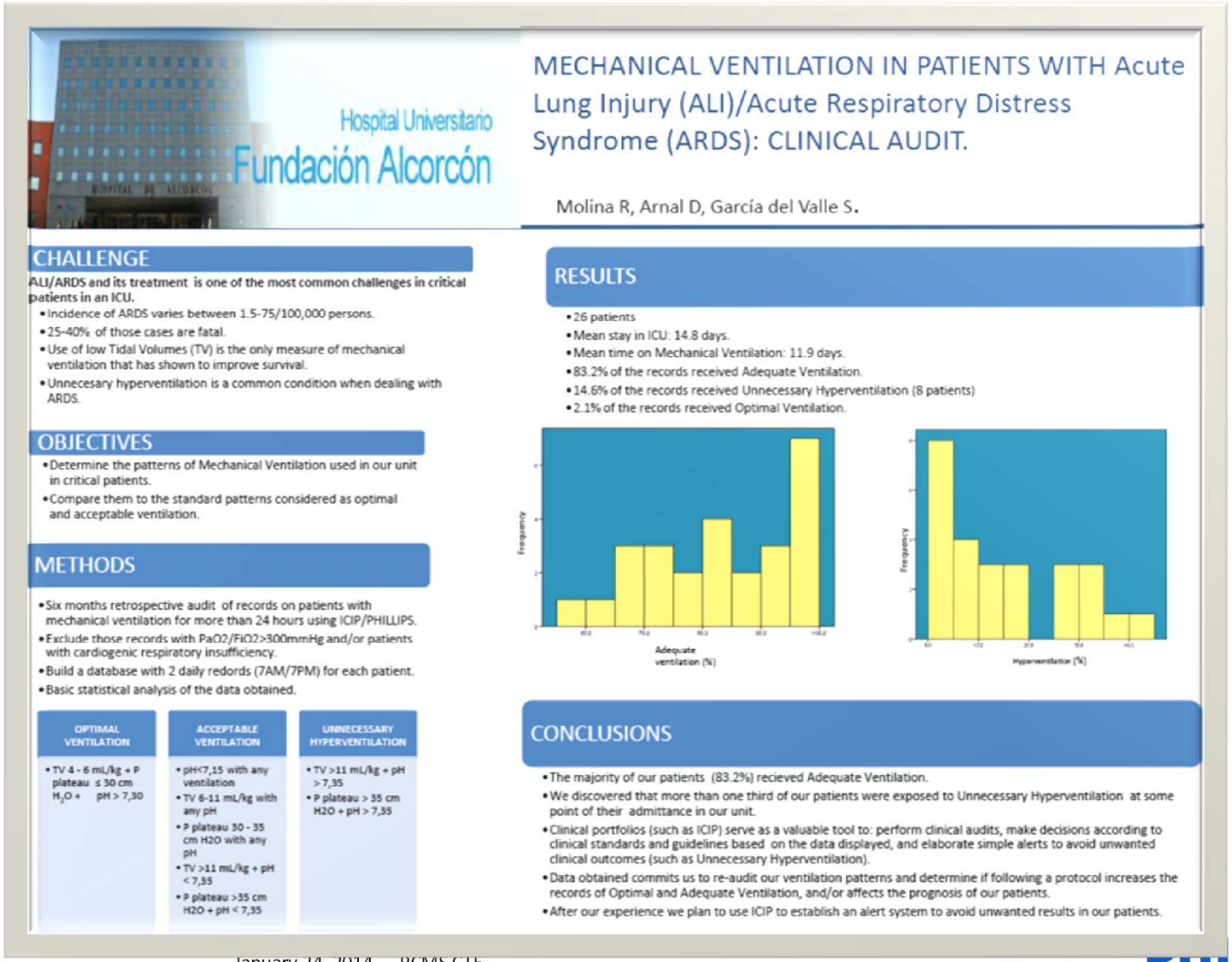
Although simple in concept, the implementation of this custom advisory has been successful in achieving better compliance with the New Jersey Department of Health regulation. The advisory eliminates the need for additional staff interventions and the "nag factor" to make sure the samples are sent. This allows for additional time to be spent with patients and families. At the present time we are discussing the feasibility of an advisory at the time of transfer.

LESSONS LEARNED

Prior to implementation as staff were being trained, more emphasis should have been placed on the entire advisory process. Priority was placed on staff competency with the flowsheet, forms and daily documentation requirements. Some additional retraining was required to reinforce the importance and processing of all the advisories (custom and clinical).

Audit of Ventilation Practices (Spain)

Not satisfied (yet)?



Hospital Universitario Fundación Alcorcón

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 1.5-75/100,000 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.
- Unnecesary 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 ICIP/PHILLIPS.
- Exclude those records with PaO2/FiO2>300mmHg and/or patients with cardiogenic respiratory insufficiency.
- Build a database with 2 daily redords (7AM/7PM) for each patient.
- Basic statistical analysis of the data obtained.

OPTIMAL VENTILATION	ACCEPTABLE VENTILATION	UNNECESSARY HYPERVENTILATION
• TV 4 - 6 mL/kg + P plateau ≤ 30 cm H_2O + pH > 7,30	• pH<7,15 with any ventilation • TV 6-11 mL/kg with any pH • P plateau 30 - 35 cm H2O with any pH • TV >11 mL/kg + pH < 7,35 • P plateau >35 cm H2O + pH < 7,35	• TV >11 mL/kg + pH > 7,35 • P plateau > 35 cm H2O + pH > 7,35

RESULTS

- 26 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%) recieved 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?

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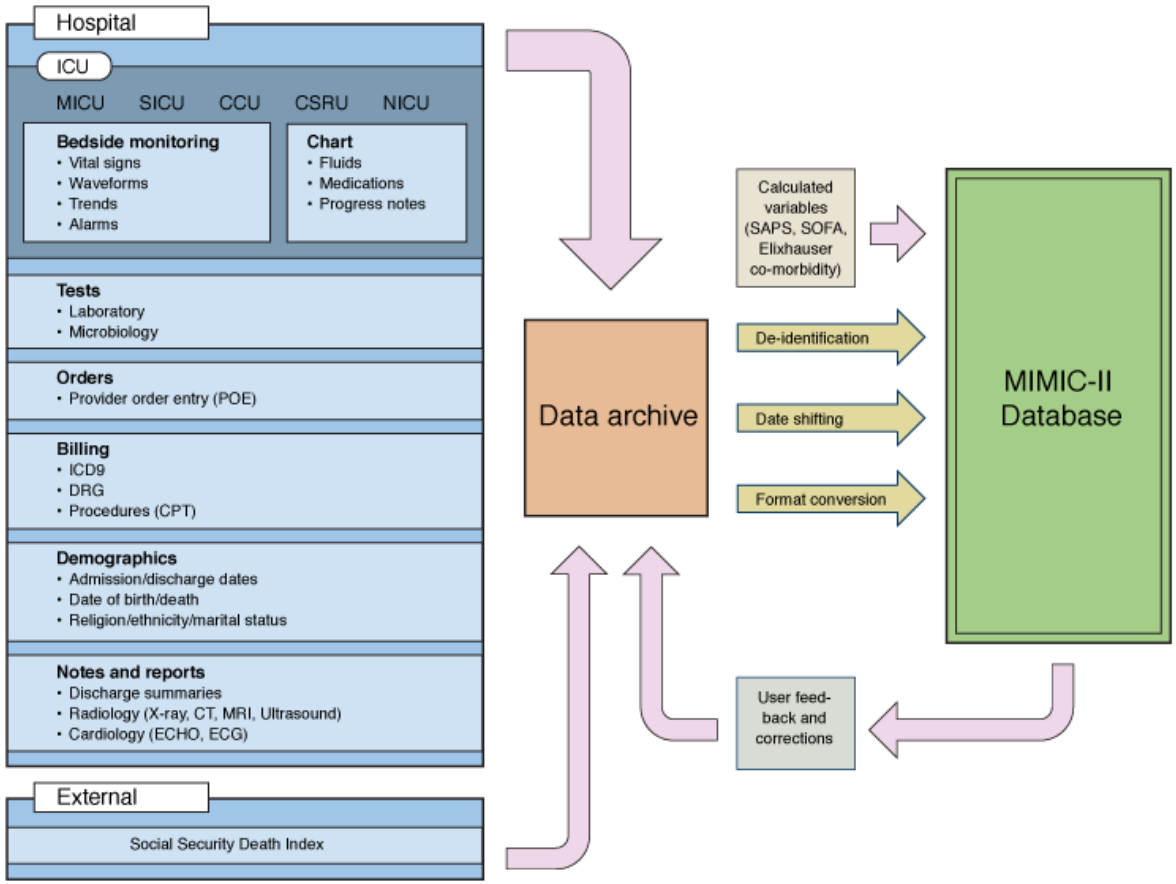
MIMIC II



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 VR_{nh}…

… to almost 1 VR_{nh}.

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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

1 Fayyad UM, Piatetsky-Shapiro GM, Smyth P, Uthurusamy R; 1996: Advances in knowledge discovery and data mining, AAAI, Menlo Park, CA, 1996

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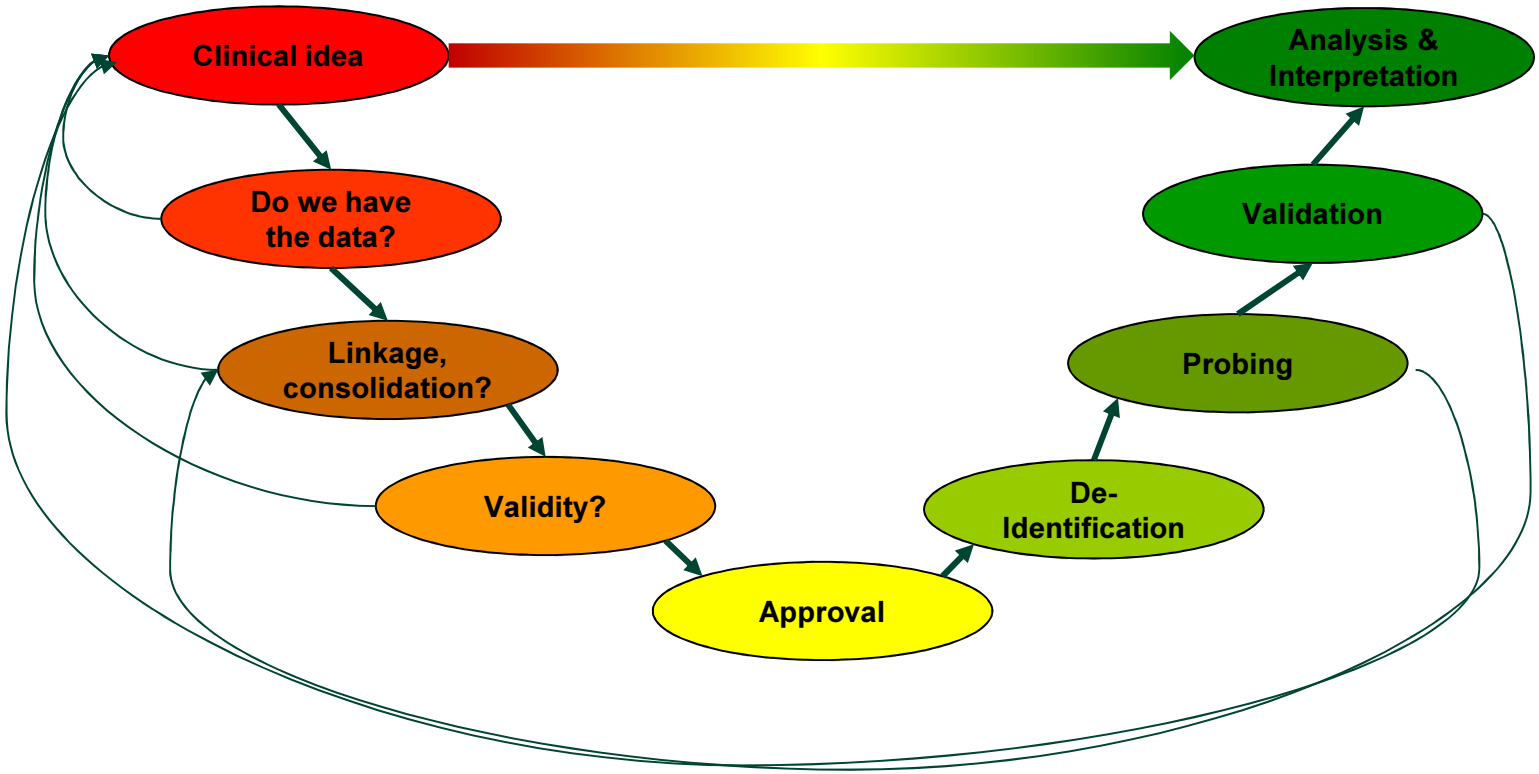
Process model for Clinical Data Mining

Experience suggests: It's a bit more messy.



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Remember:

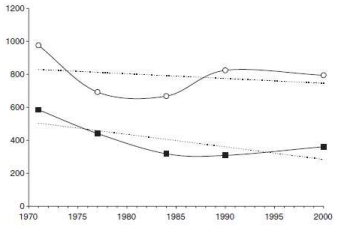
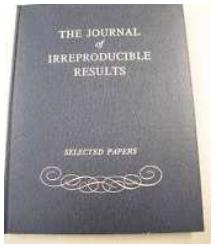


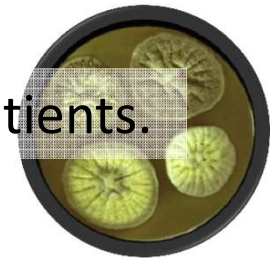
Figure 1. Storks and the birth rate in Lower Saxony, Germany (1971–2000). Open circles show yearly birthrates in hundreds in Lower Saxony. Full squares show numbers pairs of storks in Lower Saxony. Dotted lines represent linear regression trend ($y = mx + b$).

Höfer T, Przyrembel H, Verleger S: New evidence for the Theory of the Stork, *Paediatric and Perinatal Epidemiology 2004,* **18,** 88–92

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.

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Thank You!