Elderly surgical patients: automated computation of healthcare quality indicators by data reuse of EHR

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Introduction
Assessing quality of care

- Quality indicators
  - Structure indicators
    - E.g. expenses, consumption of hydroalcoholic solution
    - Impact on the outcomes?
  - Result indicators
    - E.g. proportion of death in intensive care
    - Difficult to interpret
  - Process indicators:
    - Percentage of adherence to a guideline
    - Widely used in healthcare:
      - Close to patients’ outcome (≠ structure indicators)
      - Not impacted by the initial severity of the patients, easier to interpret (≠ result indicators)
      - Directly enable to identify areas of improvement
Definition of a minimal dataset widely available, enabling to compute process indicators

**Administrative data**
- 88 years old woman

**Diagnoses**
- I10  Arterial hypertension
- Z8671  Personal history of myocardial ischemia
- I620  Non-traumatic subdural hemorrhage

**Medical procedures**
- ABJA002  Drainage of an acute subdural hemorrhage, by craniotomy
- FELF001  Transfusion

**Drugs**
- Acetaminophen
- VKA
- Vitamin K
- Statin
- Red blood cells

**Laboratory results**
- INR
- Hemoglobin

**Free-text reports**
- Discharge letter
- Surgical report
Process indicators: literature review

- Previous work: systematic literature review
  - identified 8,744 papers, kept 126 papers
  - 440 process indicators
  - 22.3% of them could be automatically computed using a minimal dataset as defined before (diag, drugs, procedures, admin. data, lab. results, keyword research, linkage)

- Objective
  - To implement and evaluate 9 process indicators about surgery on elderly

Material and methods
Material

- Inpatient stays
  - 15,000 randomly-selected and de-identified inpatient hospital stays, from a French community hospital (ICD10, CCAM, ATC, local names for laboratory results)

- Process indicators
  - 9 process indicators defined in free-text:
    - Example 1: “If an elderly patient is undergoing surgery, then creatinine clearance should be estimated.”
Implementation of the process indicators

- Direct implementation of each indicator as a PHP function, then conformity rate = mean(X)

- During the implementation: getting a good precision, decreasing the over-alerting by:
  - relaxing the conformity criteria
  - tightening the inclusion criteria

Input = 1 stay

HIS

Inclusion criteria

False → X=NA

Conformity criteria

False → X=0

True → X=1

Return value = X
Evaluation of each process indicator

- Evaluation:
  - Automated computation:
    \[ \text{conformity} = \frac{a+b+c}{a+b+c+d+e+f} = \text{mean}(X) \]
  - Expert review (45 stays/indic):
    \[ \text{precision} = \frac{e}{d+e+f} = \frac{\#(X=0 \cap Y=0)}{\#(X=0)} \]

<table>
<thead>
<tr>
<th></th>
<th>Compliant</th>
<th>Not compliant</th>
<th>Excluded</th>
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<tbody>
<tr>
<td><strong>Compliant</strong></td>
<td>a</td>
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<td><strong>Not compliant</strong></td>
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Results
Indicator #01: creatinine clearance dosage

If an elderly patient is undergoing surgery, then creatinine clearance should be estimated.

- **Inclusion criteria**
  - age≥75 & surgical stay & emergency admission
  - impossible to screen ambulatory laboratory exams in case of pre-planned admission => only emergency admissions are analyzed

- **Conformity criteria**
  - creatinine clearance or creatinine dosage before surgery
  - we assumed some physicians were able to compute the creatinine clearance by hand from the creatinine dosage

- **Results**
  - n=238
  - conformity=86.6% [81.6-90.7]
  - precision=86.7% [59.5-98.3]
Indicator #02: confusion

If an elderly patient is undergoing surgery, and has a new diagnosis of delirium, then an evaluation should be undertaken for: infection, electrolyte abnormalities, hypoxia, uncontrolled pain, urinary retention or fecal impaction, use of sedative-hypnotic drugs.

- **Inclusion criteria**
  - age≥75 & surgical stay & ICD code (F05* | R410*)
  - impossible to analyze the date of the diagnoses

- **Conformity criteria**
  - postoperative dosage of Na+ & K+ & Creat. & Uremia & Glycemia
  - impossible to automatically detect whether the physicians had searched for other clinical factors or drugs administrations.

- **Results**
  - n=8
  - conformity=75 % [34.9-96.8]
  - precision=0%

Capillary blood glucose had been measured from patient bedside but not traced in the databases. In 2 cases there was a post-operative confusion, without ICD10 code.
Indicator #04: intravenous antibiotic prophylaxis (onset)

If an elderly patient is undergoing surgery, then intravenous antibiotic prophylaxis should be started within 1h of skin incision.

- Inclusion criteria
  - age≥75 & surgical stay & no ICD code of (bacterial infection, unprecise infection, or open fracture)
  - We excluded cases were an oral antibiotic treatment was already indicated

- Conformity criteria
  - intravenous administration of antibiotic the day of surgery

- Results
  - n=607
  - conformity=2.4% [1.5-4.2]
  - precision=93.3% [68.1-99.8]

All false positives: absence of ICD10 codes despite an active infection, for which the oral antibiotic treatment was appropriate.
## Healthcare quality indicators by data reuse of EHR

<table>
<thead>
<tr>
<th>#</th>
<th>Topic</th>
<th>n</th>
<th>Conformity</th>
<th>Confidence</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>creatinine clearance dosage</td>
<td>238</td>
<td>86.6%</td>
<td>86.7%</td>
</tr>
<tr>
<td>2</td>
<td>confusion</td>
<td>8</td>
<td>75.0%</td>
<td>0.0%</td>
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<tr>
<td>3</td>
<td>Beta-blockers</td>
<td>18</td>
<td>27.8%</td>
<td>46.2%</td>
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<tr>
<td>4</td>
<td>intravenous antibiotic prophylaxis (onset)</td>
<td>607</td>
<td>2.4%</td>
<td>93.3%</td>
</tr>
<tr>
<td>5</td>
<td>oral antibiotic prophylaxis (continuation)</td>
<td>607</td>
<td>2.3%</td>
<td>93.3%</td>
</tr>
<tr>
<td>6</td>
<td>deep venous thrombosis prevention</td>
<td>314</td>
<td>70.0%</td>
<td>53.3%</td>
</tr>
<tr>
<td>7</td>
<td>anemia treatment</td>
<td>217</td>
<td>60.4%</td>
<td>86.7%</td>
</tr>
<tr>
<td>8</td>
<td>anemia transfusion</td>
<td>19</td>
<td>73.7%</td>
<td>60.0%</td>
</tr>
<tr>
<td>9</td>
<td>postoperative fever</td>
<td>4</td>
<td>75.0%</td>
<td>0.0%</td>
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Discussion

Automated computation of process quality indicators:
- Often feasible (22.3% of indicators in the review)
- Quickly identify threatening situations

Main problems:
- Properly handled *a priori*:
  - Need for medical interpretation, requiring special skills in medicine, medical information sciences, and algorithmics
  - Avoiding over-alerting (algorithmic interpretation)
- Not handled:
  - Data quality: missing codes => solution = free-text analysis
- No problems:
  - Absence of rule management system
  - Absence of ontology

Evaluation of the precision
- Mandatory to make this approach acceptable by physicians
- To be performed in each setting: quality failures are probably hospital-dependent
Tank you for your attention!

emmanuel@chazard.org
Indicator #03: beta blockers

**Inclusion criteria**

- age ≥ 75 & surgical stay & ATC code C07* at d0 or d1 & no death
- Unavailable outpatient treatment. Contraindications could not be traced using ICD10 codes. Dead patients were excluded.

**Conformity criteria**

- ATC code C07* administered from d2 to day prior discharge

**Results**

- n = 18
- conformity = 27.8% [9.7-53.5]
- precision = 46.2% [19.2-74.9]
Indicator #05: intravenous antibiotic prophylaxis (continuation)

If an elderly patient is undergoing surgery, intravenous antibiotic prophylaxis should be discontinued within 24h after surgery (48h for cardiac surgery).

- Inclusion criteria
  - age≥75 & surgical stay & no ICD code of (bacterial infection, unprecise infection, or open fracture)
  - *We excluded cases were an oral antibiotic treatment was already indicated*

- Conformity criteria
  - no ATC code J01* at d3 of surgery
  - *The type of surgery was not taken into account, and a permissive delay was used.*

- Results
  - n=607
  - conformity=2.3% [1.3-3.9]
  - precision=93.3% [68.1-99.8]

All false positives: absence of ICD10 codes despite an active infection, for which the oral antibiotic treatment was appropriate.
Indicator #06: deep venous thrombosis prevention

If an elderly patient is undergoing surgery, then deep venous thrombosis prophylaxis should be provided (unfractionated or low molecular weight heparin) or document why not appropriate. For cancer or previous thromboembolism, mechanical prophylaxis should be added.

- Inclusion criteria
  - age≥75 & surgical stay & CCAM code of (major surgery of lower limbs | major digestive surgery) & no ICD10 code of heparin contra-indication
  - It was not possible to trace mechanical prophylaxis. Therefore we traced heparin administration, only for high risk surgeries. We searched for contra-indication.

- Conformity criteria
  - ATC code B01AB*
  - The type of surgery was not taken into account, and a permissive delay was used.

- Results
  - n=314
  - conformity=70.0% [65.6-76.0]
  - precision=53.3% [26.6-78.7]

False positives mainly due to the inclusion of non-surgical inpatient stays
Indicator #07: anemia treatment

If an elderly patient is undergoing surgery, and has anemia, then the following should be set up prior to surgery: iron, vitamin C, erythropoietin, blood transfusion if hemoglobin < 7 g/dl.

- Inclusion criteria
  - age ≥ 75 & surgical stay & hemoglobin value < 10
  - The threshold was not specified. The severity of anemia is handled in indicator #08.

- Conformity criteria
  - ATC code B03A*/B05AX01 | ICD10 code Z5130 | transfusion

- Results
  - n = 217
  - conformity = 60.4% [53.5-66.9]
  - precision = 86.7% [59.5-98.3]

False positives due to the absence of administered drugs from the databases.
Indicator #08: anemia transfusion

If an elderly patient is undergoing surgery, unless otherwise contraindicated or refused by the patient, then he/she should receive blood transfusion at the following hemoglobin/hematocrit threshold: 8/24 (man), 7/21 (woman).

- **Inclusion criteria**
  - age$\geq$75 & surgical stay & ((man & (hemoglobin<8 | hematocrit<24)) | (woman & (hemoglobin<7 | hematocrit<21)))

- **Conformity criteria**
  - ATC code B05AX01 | ICD10 code Z5130 | CCAM transfusion

- **Results**
  - n=19
  - conformity=73.7% [48.8-90.9]
  - precision=60.0% [14.7-94.7]

False positives due to the absence of transfusion encoding
Indicator #09: postoperative fever

If an elderly patient is undergoing surgery and has a new fever, the following should be performed: urinalysis and urine culture, wound examination, blood cultures of central venous line or catheter, chest radiograph, blood culture.

- **Inclusion criteria**
  - age $\geq$ 75 & surgical stay & ICD10 code (R50* | R65*)
  - Note that if the etiology of a fever is found, then it is encoded and the fever is not encoded.

- **Conformity criteria**
  - CCAM code of chest radiograph
  - Clinical exams and some laboratory exams were not available

- **Results**
  - n = 4
  - conformity = 75% [19.4-99.4]
  - precision = 0.0%

The inflammatory syndrome was most often present before the surgery (no precise date).