Practice Changes as Technology Advances
Examples in Trauma and Acute Care Surgery

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Outline

1. What is Trauma and acute care surgery?
2. How Practice changes as technology advances
3. Application of the deep learning in Trauma images
General surgery & Trauma care

- Stomach and intestine
- Liver, pancreas, biliary system
- Breast
- Thyroid
- Trauma & acute abdomen
- Intensive care

Disease course

- Primary Prevention
- Screening
- Early intervention
- Exposure
- Pathologic changes
- Diagnosis
- Treatment
- Stage of Susceptibility
- Stage of Subclinical Disease
- Stage of Clinical Disease
- Stage of Recovery, Disability or Death

What’s your expectation for the doctor’s diagnosis? What’s your expectation for the doctor’s treatment?
Cancer course

Exposure → Pathologic changes → Diagnosis → Treatment

Stage of Susceptibility → Stage of Subclinical Disease → Stage of Clinical Disease → Stage of Recovery, Disability or Death

Several years
5-year survival rate

From diagnosis to treatment: weeks to months

Gastric perforation course

Exposure → Pathologic changes → Diagnosis → Treatment

Stage of Susceptibility → Stage of Subclinical Disease → Stage of Clinical Disease → Stage of Recovery, Disability or Death

Peptic ulcer disease

From diagnosis to treatment: hours to day
Die within days if no treatment
Trauma with spleen injury course

From diagnosis to treatment: **mins to hours**

Die within **hours** if no treatment, estimate blood loss: liters

Total blood volume in adult: 7%, ~5,000ml

How Practice Changes as Technology Advances
How medical practice change?

- Medical inventions
- Preclinical studies
- Clinical trials
- Market release
- Integrate into clinical workflow
- Evaluation (many studies)

**Paradigm shift**

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**Acute appendicitis**

The **lifetime risk** of appendicitis is **8.6% for males** and **6.7% for females**.

**Typical initial symptom:** epigastric pain, shift to right lower quadrant, diffused abdominal pain if perforated

**Treatment:** Appendectomy

Image source: https://www.aboutkidshealth.ca/appendicitis
Acute appendicitis

1848, First abdominal surgery for appendicitis
1894, McBurney incision
1980, Kurt Semm performed the first laparoscopic appendectomy

Image source: https://www.aboutkidshealth.ca/appendicitis

Diagnosis point of view

History taking and physical exam
“15% negative appendectomies”
Alvarado score in 1986, sensitivity: 72%
Computed tomography, sensitivity: 95%, Specificity: 96%

Pros and cons, What is your choice?
What’s people’s selection in 1990?
Appendectomy: Open vs Laparoscopic

Appendectomy: Open vs Laparoscopic
Appendectomy: Single port vs NOTES

Robotic surgery?

- 1.5-2cm (umbilicus)
- No external wound
- transgastric
- transvaginal

Appendectomy: Open vs Laparoscopic

The laparoscopic approach was superior for:
- A lower rate of wound infections (OR 0.3 to 0.52)
- Less pain on postoperative day 1 (↓ 0.7 to 0.8/10-point)
- Shorter duration of hospital stay (↓0.16 to 1.13 days)

The open approach was superior for:
- A lower rate of intra-abdominal abscesses (OR 1.56 to 2.29)
- A shorter operative time (↓ 7.6 to 18.3 minutes)
Spleen injury

**Diagnosis:**
- Deep peritoneal lavage?
- Ultrasound (FAST)
- Computed tomography (speed matters)

**Treatment:**
- Splenectomy
- Observation
- Angiographic embolization
Angiographic embolization


Spleen injury

Image from https://avantehs.com/p/ge-innova-3100-cath-angio-system/13787
Application of the deep learning in Trauma images

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Machine learning

Unsupervised learning

Reinforcement learning

Supervised Learning

Algorithm

Artificial neural network

Deep neural network

Computing power (GPU)

Algorithm (DCNN)
Rapid, Accurate
No miss
Plain Pelvic film (PXR) is the essential of trauma survey

**IMPACT EVALUATION**

10-14% of people with a hip fracture miss-diagnosed

Miss-diagnosed hip fracture **Doubled the risk of dying** before the end of the first postop year

Cobanu et al. MRI and CT of Insufficiency Fractures of the Pelvis and the Proximal Femur. AJR, 2008.
Displaced fracture

Non-displaced fracture

Fracture Site
### CHARACTERISTICS OF THE CASES

<table>
<thead>
<tr>
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<th>With hip fracture</th>
<th>Without fracture</th>
<th>p-value</th>
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<tr>
<td>No.</td>
<td>1975</td>
<td>1630</td>
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<tr>
<td>Age</td>
<td>72.34 (16.73)</td>
<td>44.88 (20.46)</td>
<td>&lt;0.001</td>
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<tr>
<td>Gender</td>
<td>839 (42.0)</td>
<td>1112 (68.2)</td>
<td>&lt;0.001</td>
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<td>ISS</td>
<td>9.96 (4.21)</td>
<td>14.01 (9.29)</td>
<td>&lt;0.001</td>
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<tr>
<td>Fracture type</td>
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<tr>
<td>Femoral neck</td>
<td>931 (47.1%)</td>
<td>NA</td>
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<tr>
<td>Trochanteric</td>
<td>1044 (52.9%)</td>
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![ROC curve diagram](image-url)
Interpretability AI Diagnosis

96%

Clinical workflow

Doctor get a PXR on PACS
Press the button on window
Show PXR with heat map

Accuracy increased
Plain Pelvic film (PXR) is the essential of trauma survey

HIP fracture
Pelvic fracture
Femoral shaft fracture
Hip dislocation
Periprosthetic fracture
Take home message

- Practice changes as technology advances. Slow, but it happens.
- Patient outcome is determinant.
- Try to identify the problem from clinical workflow.
- We can make medicine better!

Questions and Discussion