The transformative Power of digital health in the Emergency Department

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HL7 Foundation:

- HL7 the best and most widely-used eHealth standards since 1986
  - HL7 v2, Clinical Document Architecture, HL7 FHIR
  - 20 National Affiliates in Europe (~38 worldwide)
  - European HL7 foundation established in 2010

- European Funded Research Projects
  - eHGI, Antilope, Semantic Healthnet, Trillium Bridge, Expand, Trillium-II
  - PHC34: ASSESS CT, OpenMedicine, eStandards

- Annual HL7 in Europe Newsletter
  - Website: www.HL7.eu

- eHealth policy & Research
  - eHealth stakeholders group; mHealth Guidelines; ENISA expert group
  - EFMI council (2012-): EFMI Board (2016-)
  - HIMSS Europe

- SDO Joint Initiative Council
Emergency Department: A harsh and complex collaborative decision environment

**Characteristics**
- High decision density
- Decision fatigue
- Throughput pressure
- Wide range of illnesses
- Diagnostic Uncertainty
- Narrow time windows
- Interruptions and distractions
- Shift work/sleep disruption
- Shift changes: cognitive decline 30%

**Diagnostic Error in ED**
- Radiology 5%
- Missed injuries 12%
- Cardiovascular 19%
- Respiratory 30%

*Overall ~16%*

*It’s not about what we know, it’s about how we think!*

Source: Dr. Pat Croskerry, Emergency London; https://www.youtube.com/watch?v=GFE6D54600E
# 10 AI Applications That Could Change Health Care

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>POTENTIAL ANNUAL VALUE BY 2026</th>
<th>KEY DRIVERS FOR ADOPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot-assisted surgery</td>
<td>$40B</td>
<td>Technological advances in robotic solutions for more types of surgery</td>
</tr>
<tr>
<td>Virtual nursing assistants</td>
<td></td>
<td>Increasing pressure caused by medical labor shortage</td>
</tr>
<tr>
<td><a href="https://www.youtube.com/watch?v=08b3pMGGoxU">https://www.youtube.com/watch?v=08b3pMGGoxU</a></td>
<td>20</td>
<td>Easier integration with existing technology infrastructure</td>
</tr>
<tr>
<td>Administrative workflow</td>
<td>18</td>
<td>Need to address increasingly complex service and payment fraud attempts</td>
</tr>
<tr>
<td>Fraud detection</td>
<td>17</td>
<td>Prevalence of medical errors, which leads to tangible penalties</td>
</tr>
<tr>
<td>Dosage error reduction</td>
<td>16</td>
<td>Proliferation of connected machines/devices</td>
</tr>
<tr>
<td>Connected machines</td>
<td>14</td>
<td>Patent cliff; plethora of data; outcomes-driven approach</td>
</tr>
<tr>
<td>Clinical trial participation</td>
<td>13</td>
<td>Interoperability/data architecture to enhance accuracy</td>
</tr>
<tr>
<td>Preliminary diagnosis</td>
<td>5</td>
<td>Storage capacity; greater trust in AI technology</td>
</tr>
<tr>
<td>Automated image diagnosis</td>
<td>3</td>
<td>Increase in breaches; pressure to protect health data</td>
</tr>
<tr>
<td>Cybersecurity</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**SOURCE**: Accenture
ED congestion: a safety risk and a cause of adverse outcomes

- 91% of EDs in USA overcrowded, 40% ambulance diversion daily in 2004
- ED delays increase mortality and hospital length of stay
  - 1997 to 2004 median wait for ED physician from 22’ to 30’, AMI from 8’ to 14’.
- Patients “boarded” in ED experienced longer LOS
  - In 13,460 visits to Canadian hospital (Apr 2006-7) 11.6% of admitted patients with boarding delays >12h had 12.4% higher LOS, 2183 addtl days, +11% costs $2M, BMC Emerg Care 16(2010):1-6
  - In 995,379 ED visits to 187 hospitals. Patients on days with high ED crowding: 5% greater odds inpatient death (95%CI 2% to 8%), 0.8% longer LOS(95% CI 0.5% to 1%), 1% increased admission costs (95% CI 0.7% to 2%), 6200 hospital days (95% CI 2,800 to 8,900), and $17 million (95% CI $11 to $23M) in costs. [Ann Emerg Med 2013;61:605-611]

- Patients leave without receiving the care they need
  - Of patients that left, 46% required medical attention, 29% requiring care in 24 to 48 hours.
  - 11% were hospitalized within one week, while only 9% of those who waited to be seen required hospitalization
Median Wait Time to See an Emergency Department (ED) Physician
1997–2000 and 2003–2004 (United States)

IP LOS, the inpatient length of stay, is the time patients spend in the hospital following ED treatment.

**ESTIMATES OF THE PROBABILITY OF SPENDING MORE THAN A GIVEN LENGTH OF STAY (LOS) FOR NONDELAYED AND DELAYED PATIENTS**

![Graph showing the probability of spending more than a given length of stay (LOS) for non-delayed and delayed patients.]

LOS >25 days: 9% non delayed, 13% for delayed

### Patient Population Study: Patients Who Leave ED without Being Seen

#### PATIENT CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients Who Left Without Being Seen* (n = 159)</th>
<th>Patients Who Waited Until Seen (n = 211)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>35.0</td>
<td>36.8</td>
</tr>
<tr>
<td>Sex, % male</td>
<td>51.6†</td>
<td>39.3</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% black</td>
<td>25.6</td>
<td>29.9</td>
</tr>
<tr>
<td>White</td>
<td>26.3</td>
<td>24.2</td>
</tr>
<tr>
<td>Latino</td>
<td>41.0</td>
<td>40.8</td>
</tr>
<tr>
<td>Other</td>
<td>7.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Insurance Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Medicare</td>
<td>5.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Medi-Cal</td>
<td>12.5</td>
<td>7.7</td>
</tr>
<tr>
<td>Private insurance</td>
<td>2.0</td>
<td>3.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Uninsured</td>
<td>78.3</td>
<td>85.0</td>
</tr>
</tbody>
</table>

* Only includes patients who arrived at the emergency department between 7 am and 11 pm.
† P = .02. All other comparisons were not significant.
## CHIEF COMPLAINTS

<table>
<thead>
<tr>
<th>Chief Complaint</th>
<th>Patients Who Left Without Being Seen* (n = 150)</th>
<th>Patients Who Waited Until Seen (n = 202)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>4.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>12.0</td>
<td>11.4</td>
</tr>
<tr>
<td>Musculoskeletal pain</td>
<td>18.0</td>
<td>16.8</td>
</tr>
<tr>
<td>Headache</td>
<td>3.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Trauma or injury</td>
<td>4.7</td>
<td>8.9</td>
</tr>
<tr>
<td>Laceration</td>
<td>2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Soft-tissue infection</td>
<td>5.3</td>
<td>6.9</td>
</tr>
<tr>
<td>Cough</td>
<td>3.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Vaginal bleeding</td>
<td>0.0†</td>
<td>7.9</td>
</tr>
<tr>
<td>Other</td>
<td>46.0</td>
<td>36.1</td>
</tr>
</tbody>
</table>

* Only includes patients who arrived at the emergency department between 7 am and 11 pm whose medical records were available.
† The lack of cases of vaginal bleeding in the group that left without being seen may be due partly to incomplete reporting of these cases from the obstetrics and gynecology area.

ACUITY RATINGS, TRIAGE ASSESSMENT, AND HEALTH STATUS SCORES

<table>
<thead>
<tr>
<th></th>
<th>Patients Who Left Without Being Seen* (n = 150)</th>
<th>Patients Who Waited Until Seen (n = 202)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acuity rating, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1, needs immediate evaluation</td>
<td>46.0</td>
<td>40.3</td>
</tr>
<tr>
<td>Level 2, evaluate within 24 to 48 h</td>
<td>26.7</td>
<td>27.9</td>
</tr>
<tr>
<td>Level 3, can wait &gt; 48 h</td>
<td>24.7</td>
<td>28.9</td>
</tr>
<tr>
<td>Level 4, no symptoms</td>
<td>1.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Triage nurse urgency assessment, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergent</td>
<td>2.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Urgent</td>
<td>22.6</td>
<td>29.1</td>
</tr>
<tr>
<td>Nonurgent</td>
<td>75.3</td>
<td>66.8</td>
</tr>
<tr>
<td>Health status scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 107)</td>
<td>(n = 210)</td>
<td></td>
</tr>
<tr>
<td>Usual overall health impairment</td>
<td>23.9 ± .9</td>
<td>23.9 ± .6</td>
</tr>
<tr>
<td>Health impairment on presentation to emergency department</td>
<td>34.9 ± .9</td>
<td>36.5 ± .7</td>
</tr>
<tr>
<td>Usual physical limitations</td>
<td>8.3 ± .3</td>
<td>8.4 ± .2</td>
</tr>
<tr>
<td>Physical limitations on presentation to emergency department</td>
<td>11.3 ± .4</td>
<td>12.3 ± .3</td>
</tr>
<tr>
<td>Usual psychological distress</td>
<td>5.8 ± .3</td>
<td>5.8 ± .2</td>
</tr>
<tr>
<td>Psychological distress on presentation to emergency department</td>
<td>7.9 ± .3</td>
<td>7.9 ± .2</td>
</tr>
</tbody>
</table>

## Patients’ Reasons for Leaving ED without Having Been Seen

<table>
<thead>
<tr>
<th>Questions</th>
<th>Patients Who Answered Yes, %* (n = 140)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Did you leave because you felt too sick to sit in the waiting room any longer?</td>
<td>53</td>
</tr>
<tr>
<td>2. Did you have to go home to take care of small children or someone else in your family?</td>
<td>21</td>
</tr>
<tr>
<td>3. Did you leave because you would have had problems getting transportation home if you had waited longer?</td>
<td>32</td>
</tr>
<tr>
<td>4. Did you leave because waiting longer would have been a problem with your work schedule?</td>
<td>28</td>
</tr>
<tr>
<td>5. Did you leave because you thought that you could go somewhere else where the wait would be shorter?</td>
<td>39</td>
</tr>
<tr>
<td>6. Did you change your mind and think that you didn't need to see a doctor?</td>
<td>12</td>
</tr>
<tr>
<td>7. Did you leave because you were angry that you had to wait so long?</td>
<td>57</td>
</tr>
</tbody>
</table>

*The sum of all percentages is greater than 100 since patients could respond yes to more than one question.

Case of Univ of Colorado Medical Center ED

- Patients leave the ED without being treated.
  - Competing hospitals get these patients. Are they better?
  - Ambulance diversion >8 of every 24 hours
  - Patient- and staff-satisfaction scores close to zero.

- Broken Relationships with referring physicians, EMS.
- Near-weekly Dept of Public Health visits for patient complaints and code violations.
Case of Univ of Colorado Medical Center ED
Transforming the image of the Emergency department

From the overcrowded front door for
- medical emergencies, accidents and trauma
- safety-net for people that lack access to care

to a Diagnostic center
- the critical intersection of inpatient and outpatient services

HOW?

highly integrated leadership team to set up new standards for emergency care driven by patient needs!

How We Transformed Emergency Care at Our Hospital by Richard Zane, MD, HBR Dec 17, 2015

The transformative power of digital health in the emergency department

Glasgow, Scotland, 9.9.2018
Case of Univ of Colorado Medical Center ED
Transforming the image of the ED (con’t)

Double space plans – fewer treatment areas or

Build leadership team with three core functions:
  - quality, operations, and process improvement (PI): 8-10 people committees

PI committee plan to follow a series of patients
  - document their movements
  - prepare a detailed task analysis of staff members
  - compare performed tasks with each provider’s scope of work.

Doctors and nurses often spend time on low skill level tasks.

Operations committee developed, tested, implemented solution
  - Teaming up nursing and health professionals.
Six Guiding Principles

- **Put patients at the center – drop focus on triage**
  - Senior physician starts the care process without delay

- **Use data and information relentlessly**
  - **Accountability** to measure anything that affects patients.
  - **Electronic medical record**, stopwatches and direct observation.
  - **Dashboards** that included department- and provider-specific measures of process, resource utilization, and quality
  - **Indicators** compared with department goals & national standards and providers who don’t measure up follow remediation plan

- **Speak with one voice**
  - Debate and discuss but once a decision is made, it is implemented and publicly owned, while missteps and failures ack’d & fixed.
Six Guiding Principles (con’t)

- Value everyone’s perspective
  - Value opinion of people at the front line of patient care — who practice medicine, run ventilators, stock equipment, transport patients, deliver food, change linens
  - Make them feel invested in the department’s core mission.

- Deliver high-quality care universally
  - Identify high-risk conditions (heart attack, stroke, major trauma, sepsis) or conditions associated with practice variability (chest, abdominal, back pain)
  - Care pathways to guide care and use of resources, prompt interventions, inform decisions

- Set the standards
  - Dedicated not only to patient care but also to innovation and education
  - 40 academic medical centers worldwide spent time with us to learn our processes, our leaders speakers on 30 occasions, model for orgs as ACEP, Press Ganey, UHSC.

The transformative power of digital health in the emergency department
Results

- total treatment time down by more than 40%;
- use of high-cost imaging (CT scan and MRI) has dropped by 15%,
- avoidable hospital admissions have decreased by 20%,
- patients with major heart attack get to cath lab in <90’, 100% of the time.
- total cost of care per patient is down 18%.
- volume has increased by 53%, on track to be the highest-volume ED in Colorado.
- patient-satisfaction scores are in the top box 77% of the time (plan to go to 90%).
  - patients now wait avg 8’ to see an attending physician.
- Virtually no patients leaft ED unseen, never, again ambulance diversion.
- Round 2 of a top-to-bottom process evaluation — CARE 2.0 (Compassionate care, Access, Reliability, and Efficiency) — as we stick to our guiding principles in setting a new standard for emergency care.
Case of Kaiser Permanente: Create a no-wait experience for patients

- Apply lean method to reduce waste and simplify processes

-Sacramento: 122000 patients, 49 Beds, L2 Trauma center, 39% outside KP, Medicaid mostly

-Baseline Departmental Metrics
  - Patients that left without being seen (LWBS): 1% (7-12%)
  - Average time door to doctor (55 min) but can go up to 12 to 14 h
  - Length of Stay (LOS) 4.5 hours for discharged, 8 h for admitted
  - Physicians 12 h shifts, 8 patients/30 left unseen, order tests
  - Ambulance diversions: EMTALA at least stabilize patients with emergency condition
  - 20 questions triage taking 7-8 minutes to complete
  - Could serve only <20 arrivals per hour..

-Creating a culture of innovation and continuous flow
  - Value stream maps: now and future view
  - Long term goal: 12 patients per bed daily

- Glasgow, Scotland, 9.9.2018
  - The transformative power of digital health in the emergency department
Case of Kaiser Permanente: Create a no-wait experience for patients (con’t)

Established observation unit in the process flow to treat patients aggressively and discharge within 24h:
- 8 rooms, 24/7
- Staffed and managed by nurses, patients seen by doctor every 4h
- e.g. GI Bleed, colonoscopy, transfusion

Organize ED in three areas:
- Low acuity area, LOS <60 min
- Medium acuity area for young people (frontline) – vertical, LOS <120 min
- High acuity area

Team assignment system:
- One physician, 2 nurses ownership of patients
- Brief triage and color coding – accountability

Open data philosophy:
- Time, patient satisfaction, quality

Visual workplace principles and mistake-proofing tools:
- Transparent, supportive, self directing
Case of Kaiser Permanente: Create a no-wait experience for patients (con’t)


<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>2007</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median LOS: Low Acuity (hours)—ESI Level 4 or 5</td>
<td>N/A</td>
<td>1.08</td>
<td>0.68</td>
</tr>
<tr>
<td>Average LOS: Low Acuity (hours)—ESI Level 4 or 5</td>
<td>2.50</td>
<td>1.67</td>
<td>0.82</td>
</tr>
<tr>
<td>Average LOS: Treat and Release (hours)</td>
<td>4.50</td>
<td>2.83</td>
<td>2.22</td>
</tr>
<tr>
<td>Average LOS: Treat and Admit (hours)</td>
<td>8.0</td>
<td>5.0</td>
<td>N/A</td>
</tr>
<tr>
<td>Average Door-to-Doctor Time (minutes)</td>
<td>55</td>
<td>23–24</td>
<td>19</td>
</tr>
<tr>
<td>Left without Being Seen (LWBS)</td>
<td>6.6% (as high as 12% some months)</td>
<td>0.9%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Ambulance Diversion Hours</td>
<td>450</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Case of Univ Hospital of Geneva: Improving patient & family ED experience

78%

Figure 1 Eight dimensions of Picker's Patient centred Care

Connecting Parents to a Pediatric Emergency Department: Designing a Mobile App Based on Patient Centred Care Principles F EHRLER, J N. SIEBERT, J ROCHAT, F SCHNEIDER, A GALETTO, A GERVAIX and C LOVIS, The Practice of Patient Centered Care: Empowering and Engaging Patients in the Digital Era R. Engelbrecht et al. (Eds.) © 2017
Case of Univ Hospital of Geneva: Improving patient & family ED experience (con’t)

"Something wasn’t right. I was suddenly very disoriented, dizzy, and couldn’t say what I wanted to. I needed help."

Sandra, ER Patient

**PRE-HOSPITAL**

- **TRIGGER**: Sandra has a terrible headache, feels dizzy, and disoriented.

- **THINKING**: "I feel sick and dizzy."

- **PAIN POINTS**: Sandra does not have any family nearby to provide transportation when she is too ill to drive.

**EMERGENCY ROOM**

- **DRIVE**: Sandra cannot drive, so she calls a cab to take her to the ER.

- **ACTIVE**: "I am scared. How will I get to the ER?"

- **PAIN POINTS**: Transportation support through the hospital or an external partner may reduce a patient’s anxiety as they decide whether or not to go to the ER.

**EXAM ROOM**

- **ARRIVE**: Sandra arrives at the ER. She checks-in and her vitals are taken. She is told to wait until she is called.

- **WAIT**: "I have been waiting here a while. When will they call me? I don’t know what is happening!"

- **PAIN POINTS**: Having Sandra review and edit her past information may minimize the length and burden of the check-in process.

**POST-HOSPITAL**

- **EXAM**: A doctor examines Sandra and tells her he is going to order some tests.

- **THINKING**: "Why do I have to wait again? No one is helping me, I just keep waiting and I feel worse."

- **PAIN POINTS**: Offering Sandra take-home instructions and a resource for help will reduce her post-visit stress.

**RESULTS**

- **PRE**: The doctor returns and tells Sandra the results of her tests. She has a serious condition.

- **POST**: A fellow physician in the ED describes her medical condition to Sandra. She is told what needs to be done.

- **THINKING**: "This is too much information to understand."

- **PAIN POINTS**: Sandra leaves with unanswered questions. It is hard for her to remember everything the doctor and nurses said and doesn’t know where to reach out for answers and more information.
Case of Univ Hospital of Geneva: Improving patient & family ED experience (con’t)

A mobile app to guide the patients

A support tool for the caregivers

An administartive app supporting the processes

An information screen to improve the wait

Connecting Parents to a Pediatric Emergency Department: Designing a Mobile App Based on Patient Centred Care Principles Frederic EHRLER, Johan N. SIEBERT, Jessica ROCHAT, Franck SCHNEIDER, Annick GALETTO, Alain GERVAIX and Christian LOVIS, The Practice of Patient Centered Care: Empowering and Engaging Patients in the Digital Era R. Engelbrecht et al. (Eds.) © 2017
Emergency data sets

http://aktin.art-decor.org

AKTIN - Datasets

Some Emergency Care Endeavors

- Emergency Care Treatment Registry AKTIN
- Emergency Data on Health Card
- Acute Care Reports between Ambulances, 911ers, Emergency Services
- Emergency Discharge Report
- Rescue Report
- Trauma Registry Data Submission for National Trauma Data Bank (NTDB)

source: Kai Heitmann

https://tinyurl.com/y7assld4
Patient summary as Health data navigator

Think of the Patient summary as a window to a person’s health or dashboard to support the stakeholders in the ED:

- Medications, allergies, vaccinations, problems and procedures,
- labs, diagnostic imaging, recent or planned encounters, implantable devices
- advance directives

“Bring the Power of Platforms to Health Care” using data to drive:

- administrative automation, networked knowledge, and resource orchestration [Bush & Fox, HBR November 2016]

eStandards need to

- help build trust
- unlock the power of health data
- facilitate decision support
- navigate the health system

Glasgow, Scotland, 9.9.2018

The transformative power of digital health in the emergency department
International Patient summary (IPS) standards

Think Patient summary as

- Active window to a person's health data across locations and jurisdictions
- Dashboard with key information on current situation & to navigate in detailed data to support decision making in the ED

We need to:

- Resources to accelerate implementation and sharing of experience
- Situations for the productive use of patient summaries
- Examine provenance, granularity, and decision power
The IPS Sections

- Medication Summary
- Immunizations
- Past history of illnesses
- Allergies and Intolerances
- History of Procedures
- Pregnancy (status and history summary)
- Problem List
- Medical Devices
- Social History
- Diagnostic Results
- Functional Status (Autonomy / Invalidity)
- Plan of care
- Advance Directives
- Vital Signs
What information goes to the child’s patient summary?

Conclusions

Digital health through data and information can transform the Emergency Department (ED):

- assess and refines ED processes for better hospital and health system investments
- improve decision making of Health professionals by sharing data and information
- change the ED experience of Patients & families acting as navigator

Don’t be shy!

- Measure and share indicators.
Global Community for the practice of Digital Health Innovation

Let’s join forces to make digital health happen in the Emergency Room using data and information productively starting with patient summaries!

Please Contact us:

mhm@medcom.dk
euoffice@HL7.org

www.trilliumbridge.eu
@trillium_II