Integrated Emergency Health Care
The Copenhagen model

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Capital Region of Denmark
Capital region of Denmark

- Population 1.8 million
- 2,561 km² mixed urban & rural
- Population density 5 x national average
- 29 municipalities
- 40,400 health employees
- 5 university hospitals (at 10 different locations)
- Level-1 Trauma Center
- Budget € 5.3 billion
EMS Organisation 2018

- 5 Health Care Regions responsible for provision of EMS
  - Ambulance services contracted through public EU tender
- 3-tiered “blue-light” system (ground based and rotor-wing):
  - EMT/Paramedic/Emergency Physician
- Regional Emergency Medical Coordination Centre
  - Health-related emergency call-taking (1-1-2)
  - Criteria based blue-light dispatch
- Specific for Copenhagen
  - 24/7 on-site medical direction (Chief Emergency Physician)
  - 24/7 Medical Helpline (1813) and out-of-hours urgent care
10 years ago: setting the national scene

- National Health Care reform: from 14 Counties to 5 Regions
- National Board of Health recommendation: reduce number of ED’s and strengthen prehospital sector
- National Government: reduce number of hospitals and strengthen prehospital sector
- Medical college expertise: Centralisation of complex medical procedures and strengthen prehospital sector
- Once in a lifetime window of opportunity – political support and funding for boosting EMS
Why the need for change?

• Growing and aging population – increased public expectations for better and more accessible care
• Health Care System becoming increasingly complicated
• Increasingly difficult for patients (and physicians) to navigate – overcrowding and long waiting times
• Getting the right patient to the right treatment at the right time - lower redundant expenses
• Inability of Health Care System to manage and prioritize resources in the face of growing costs
• Little transparency – and even less control – with prehospital sector
Emergency Medical Services Copenhagen

Reorganizing EMS in Copenhagen
Capital Region mission: single point of contact for emergency health care

• Regional governmental plan for the Capital Region (2008):
  • Full equity in access to Health Care for all citizens in the region
  • Organizational and physical centralization of emergency care
  • One point of entry – recommendation on integration of GP out-of-hours consultancy with hospital system
  • Full transparency and accountability

• Governmental funding 2013 of Health Care Regions = implementation of changes in Capital Region by Spring 2014
Where are we today?

• More than 85% of citizens with emergent/urgent health care issues are referred via Emergency 112-calls and “1813-Medical Help-line” at the regional Emergency Medical Dispatch Center

• Ambulances, paramedics, physicians, HEMS and NET are dispatched by the Region according to priority algorithm A-B-C-D

• Better quality of care on-scene and during transport to nearest relevant facility based on joint regional guidelines

• Integrated ICT system, clear Regional responsibility and executive power

• All aspects of pre-hospital emergency care organized as integral part of Regional Health Care System – with one point of contact for emergency help
The Emergency System before 2014

- 112: Take care of our self
- 1813: General practitioner (GP)
- The former “Lægevagt”
- Emergency dentist service
- The mental health services admissions
- Sundhedshuset Helsingør
- Frederiksberg Hospital
- Amager Hospital
- Glostrup Hospital
- Bornholms Hospital
- Gentofte Hospital
- Herlev Hospital
- Righospitalet
- Bispebjerg Hospital
- Nordsjællands Hospital
- Hvidovre Hospital

REGION
SPOC - Emergency Health Care since 2014

- 1813
  - Advice and Self care
  - General Practitioners
  - Emergency Dentist Care
  - Home visits
  - 5 ED full capacity
  - 6 ED others
  - Children
  - Adults
  - 8 Mental Care Emergency Departments
  - Hospitalizations

- 112
  - Ambulance
  - MCCU Physician staff
  - Psychiatric Mobil Care Unit
  - Social-Ambulance
  - HEMS

- 112
  - Triage
  - Scheduled
  - Injury
  - Illness
  - Triage
  - Scheduled
  - Injury
  - Illness
Why did it succeed?

• Political support and funding
• Clearly defined goals and measurable targets
• Full executive power - new organisation
• An innovative and robust ICT-system capable of substantiating the workflow and predicting and validating results
• Several innovative ICT contractors able to integrate solutions - no single vendor is best at all functions
• Hard work (!!!!)
Integrated ICT-system
Computers are incredibly fast, accurate, and stupid; humans are incredibly slow, inaccurate and brilliant; together they are powerful beyond imagination.

Albert Einstein
Incremental ICT-solutions for EMS (1)

2008: Inhousing of non-emergency transport dispatch

Basic ICT-platform (integration server R3I), planning and dispatch of NET (Logis), Optima Predict

2009: Regional Call-center

Voice-logging (Cisco)
New ambulance tender

2011: Inhousing of emergency dispatch

Ambulance dispatch (Logis)
112 triage and decision support for call-takers (Norwegian Index)
Digital secure radio system (SINE) and radio dispatch
Incremental ICT-solutions for EMS (2)

2012: EMS Copenhagen independent regional corp.
   Medical Helpline established (Swedish Nurse Triage Manual)

2014: Single point of contact for emergency care
   Out-of-hours GP consults and home visits
   All emergency referrals to ED (Logis)
   Decision support and electronic patient records (Logis)
   Electronic Pre-hospital Patient Record – joint platform for ambulances, hospitals and Dispatch Center (Judex, CSC)

2016: Full medical control of ambulance services
Advantages with integrated ICT-system (Logis IDS)

- Telephone Triage based on adjustable decision guide protocols (112 / 1813).
- Unique Incident key common for all events.
- Dispatch recommendations based on logistics, urgency and crew qualifications.
- Integrated communication – fast and reliable access to all units
- Integrated with hospital systems
- Referral and ”discharge” notes to ED and GP
Advantages with integrated ICT-system (Logis IDS)

- High utilisation rate (NET 95 %, Ambulances 75 %)
- Automatic control of subvendor contracts (unit hours, skill profile, break & end-of-shift management)
- Automotive dispatching (exception management)
- Easy to evaluate and communicate complex operational issues (play back, logs, maps etc)
- Vast amounts of data – bulk load to BI system daily + live DWH.
- KPI reports to executive level
EMS Copenhagen – a closer look
Main tasks for EMS Copenhagen

• Emergency Medical Command and Control Centre
• Health related emergency calls (1-1-2)
• Medical help line 1813 for health care advice, home visits and referral to ED - 24/7
• Dispatch Centre for prehospital units
  • Ambulances, emergency physician units, HEMS, Babylance
• Interhospital transfers
• Mobile Psychiatric critical care unit
• “Socialance”
• Preparedness planning and coordination for the Capital Region
• Quality improvement, innovation and research.
Activity

- 126,000 Emergency medical calls (1-1-2)
- 945,000 Medical Helpline 1813
- 165,000 Emergency ambulance missions
- 18,000 Mobile Critical Care Unit (Physician-staffed) missions
- 10,000 Interhospital transfers (3000 Physician-escorts)
- 23,000 Scheduled ambulance tasks
- 66,000 Non-emergency transports (NET)
- 1,000 Mobile prehospital psychiatric care unit tasks
- 1,000 Helicopter Emergency Medical Services missions
- 15,000 Home visits (1813-physician)

• Approximately 700 missions per day
1813 Medical Helpline
HAR DU BRUG FOR HJÆLP?

1813
AKUTTELEFONEN

www.1813.dk
The role of the GP ”out-of –hours”

Before 2014

- GP’s private entrepreneurs
- Tasked with out-of-hours medical help
  - Often unavailable during daytime - refer to themselves ”out-of-hours”
- Independant private organization contracted by Region
- Non-transparent quality of care, only number and type of services provided
- Financing of services provided non-transparent
- Data not available/disclosed
- Uncoordinated with hospital system/ED’s
"Out-of –hours” service since 2014

• GP’s invited on-board as part of a regional public joint health care system

• Conflict with GP’s Union
  • Significant loss of income and influence for GP’s
  • Questions about medical quality (GP vs nurses/non-GP’s)
  • Union boycott of physicians seeking employment with Region/1813
  • Approx. 1/3 of physicians at 1813 are GP’s

• GP’s role in daytime unchanged

• NEW ROLE (1813): coordinated referral to ED’s 24/7
Out-of –hours GP service before 2014
Out-of–hours service since 2014
Fully integrated with 112 and hospital system
Gatekeeper vs Quarterback
Home visits/consultations via dispatch
Emergency Health Care system components

- **112** Emergency telephone 112
- **1813** Medical Helpline 1813
- **?** Emergency Medical Dispatch Centre
- **+** Emergency departments
- General practitioner (GP)
- Mental health services admissions
- Emergency dentist service
- Poison Control Hotline
- Etc…
Emergency Medical Services Copenhagen

Call per month 2014-2017

[Bar chart showing the number of calls per month from January 2014 to December 2017, with data for each year from 2014 to 2017 displayed in different colors for each month.]
Call distribution 1813 (time of day)
Response following calls to 1813
Emergency Department referrals

- 500,000 referrals reduced by 10%
- 85% referred by Medical Helpline 1813
- Over-crowding significantly reduced
ED waiting time before SPOC-EMS

- Average waiting time from arrival to start treatment (University Hospitals) 60-80 minutes.
- Rush hour waiting time often 4-8 (even up to 12) hours for busy University Hospitals
- Lower waiting hours for local hospitals
- Choice of hospital is patients preference (hearsay, prejudice)
ED waiting time after SPOC-EMS

Urgent
Nurse Triage on Arrival

• Time from arrival to start of treatment: 9-11 min.
• Total time from calling us to start of treatment, including telephone call time, transport and waiting time at the emergency department: 60 min.

Non-urgent
No Triage on arrival

• Time from arrival to start of treatment (triaged): 27 min.
• Total time from calling us to start of treatment, including telephone call time, transport and waiting time at the emergency department: 93 min.

More even distribution between University and Local Hospitals according to patient needs

In spite of a 40 % increase in number of patients (formerly handled in GP out-of-office clinics)
Emergency admissions 2012-2015

2012/3013

Total

All

Children
Patient satisfaction
Patient satisfaction
Sharing data for optimising care, planning and prevention

• Electronic pre-hospital charts
• Data from 112 and 1813 calls
• Referrals and “discharge” notes
• Data-driven management at all levels
• Research
Data summary

1. 920,000 calls per year for population of 1.8 mil
2. Time to call answered: 3-4 minutes (median)
3. Shortest waiting time in Emergency departments ever
4. ED visits reduced by 10%
5. Fewer home visits by physicians
6. Emergency hospital admission rates unchanged
7. Increase in ambulance mission (national)
8. Patient satisfaction high
9. Few complaints (15-20 per months for 80,000 calls)
10. Few patient safety issues
11. Not more expensive than before SPOC-EMS
Advantages of our Integrated Solution

• Easy and equitable access to emergency care 24/7 for any perceived urgent medical issue or question
• Shortest waiting times ever in emergency departments
• Reduction in ED visits by 10%
• Best use of health care system capacity and resources 24/7
• Millions of data provides a wealth of opportunities for research, planning and development
Challenges – it was not easy!

- Short implementation from political decision to launch
- Traditional thinking in hospital structure, facilities & logistics
- Physicians vs nurses, GP’s vs other physicians
- General Practitioners Private Union
- Battle for power and money
- Hard work – every day, every hour
1-1-2 Emergency
Emergency Medical Coordination Center
Call taking, prioritize, decision advise

Technical dispatching

Non-emergency health care advices and referral

- Ambulance with EMT
- Ambulance with PM
- Mobile CCU
- HEMS
- Patient Transfers
- Psychiatric Mobile CCU
- Social-ambulance
- Advise and self care
- GP
- ED referral
- Hospital admission
- Psychiatric referral
- Emergency Dental Care
- Others .....
Medical emergency dispatching

Distribution of the 1-1-2 calls and the following response type:

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Category A</td>
<td>40%</td>
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<tr>
<td>Category B</td>
<td>39%</td>
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<tr>
<td>Category C + D</td>
<td>1%</td>
</tr>
<tr>
<td>Category F (advice)</td>
<td>20%</td>
</tr>
</tbody>
</table>

Ambulance response 6.30 (blue light, category A)
(90% < 13 minutter)
Mobile Critical Care Unit

- Staffed with consultant critical care physician, specially trained for prehospital environment. Paramedic as doctor’s assistant

- Meet with ambulance on scene ("Rendez-vous" system)

- Dispatched for potential life threatening emergencies, advanced medical interventions and interhospital transfers

- Chief Emergency Physician (Major Incident Medical Officer)

- 6 units in Region
Prehospital Emergency Physicians

”Bringing the Emergency Department to the patient”

- Better diagnostics, service and quality for the public
- Reduced mortality and morbidity – better survival
- Better triage & referral: reduced need for secondary transfers
Inhospital – Consultant in Anaesthesiology & Intensive Care Medicine
Paramedics in role as physicians assistant

- Experienced paramedic and critical care physician form unique partnership
- Dynamic well rehearsed team
- Ongoing scenario/simulation training
- Respectful and trusting teamwork environment
Neonatal Transport
Neonatal Transport

- Manned by duty Paramedic 24/7
- Inter-regional retrieval service
- Approx 400 transports annually
- Staffed by Neonatal team from University Hospital Copenhagen
- Rooms parents in separate compartment
- Video feed above child
Major incidents
3 week joint incident command training with Police and Fire Brigade Commanders
Mobile Casualty Clearing Station
Mobile Casualty Clearing Station
Mobile Casualty Clearing Station
Mobile Casualty Clearing Station
Tactical Emergency Medical Service TEMS
Major Incident Command & Control Center

- 24/7/365 on-site Chief Emergency Physician
- Medical lead of coordination of emergency care between hospitals
- One point of entry for contact to hospitals in case of emergencies
- Information, alerting and activating hospitals in case of major incidents and emergencies
- Point of contact for other authorities (Police, Fire and Rescue services)
- Media cooperation and coordination
Mental Health Emergencies
Mobile Psychiatric Critical Care Unit

- Experienced psychiatrists from Regional Mental Health Services
  - Attached to Emergency Medical Services on consultant basis
  - On-call "out-of-hours" (GP’s responsible during office hours)
  - Access to relevant electronic patient records
  - In-depth knowledge of regional and community mental health services
  - Blue light response option (paramedic as assistant)
  - Special vehicle with room for patient and police escort
Mobile Psychiatric Critical care Unit

- Approx. 1000 tasks/year
  - 70% managed by phone
  - 30% face to face on scene

- Dispatched via Emergency Medical Coordination Centre
  - 1-1-2 national emergency number
  - 1813 Medical Helpline
  - Police
  - Social Welfare Services
  - Ambulances and somatic Mobile Critical Care Units
Emergency psychiatry in the prehospital setting

- Prehospital psychiatric missions via 1-1-2/1813:
  - 50% managed by ambulances
  - 40% managed by psychiatric Mobile Critical Care Unit
  - 10% managed by somatic Mobile Critical Care Unit

- Very limited capability for emergency response from Mental Health Services or GP’s.
- Emergency Psychiatric Physicians integrated part of EMS-toolbox
The "Sociolance"
A regional-municipal collaboration

- Extremely popular with clients
- Social healthcare worker and a paramedic
- Bridge-building between Social & Mental Services
Cardiac Arrest

as a key performance indicator of the Emergency Medical System
Association of National Initiatives to Improve Cardiac Arrest Management With Rates of Bystander Intervention and Patient Survival After Out-of-Hospital Cardiac Arrest

Wissenberg et al

The danish case: tripling survival after OHCA

Reference: GRA Paper
Follow-up study: Do Cardiac arrest survivors get back to work or not? Circulation 2015

Return to Work in Out-of-Hospital Cardiac Arrest Survivors
A Nationwide Register-Based Follow-Up Study

Kristian Kragholm, MD; Mads Wissenberg, MD; Rikke Normark Mortensen, MSc; Kirsten Fonager, MD, PhD; Svend Eggert Jensen, MD, PhD; Shahzleen Rajan, MD; Freddy Knudsen Lippert, MD; Erika Frischknecht Christensen, MD; Poul Anders Hansen, MD; Torsten Lang-Jensen, MD; Ole Mazur Hendriksen, MD; Lars Kober, MD, DSc; Gunnar Gislason, MD, PhD; Christian Torp-Pedersen, MD, DSc; Bodil Steen Rasmussen, MD, PhD
Follow-up study: Yes

• 75% of those at work before sudden cardiac arrest returned to work

• The absolute number of survivors has increased

AND

• The percentage and absolute numbers of those returning to work have increased even more since the study
Everyone can save a life
"Heart runner" project
A I – “machine learning” in Cardiac Arrest
Problem is still the same - we do not always understand what callers are telling us

Can machine Learning provide tools to reduce uncertainty?
Can a machine learning model be taught to recognise OHCA?

- Yes - pilot study based on 424 calls proved that machine learning algorithm can be taught to recognise OHCA, and convincingly distinct between OHCA and non-OHCA

<table>
<thead>
<tr>
<th>Outcome (n=424)</th>
<th>Condition positive</th>
<th>Condition negative</th>
<th>Predictive value</th>
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</thead>
<tbody>
<tr>
<td>Dispatchers recognition</td>
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<tr>
<td>positive</td>
<td>156</td>
<td>N/A</td>
<td>Positive predictive value N/A</td>
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<tr>
<td>negative</td>
<td>58</td>
<td>210</td>
<td>Negative predictive value 78.4%</td>
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<tr>
<td>Dispatchers recognition</td>
<td></td>
<td></td>
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<tr>
<td>Sensitivity &amp; Specificity</td>
<td>Sensitivity</td>
<td>Specificity</td>
<td></td>
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<tr>
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<td>72.9%</td>
<td>100.0%</td>
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<tr>
<td>Model recognition</td>
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<tr>
<td>positive</td>
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<td>Positive predictive value 99%</td>
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<tr>
<td>negative</td>
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<td>Negative predictive value 95.4%</td>
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<td>Model recognition</td>
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<td>Sensitivity &amp; Specificity</td>
<td>Sensitivity</td>
<td>Specificity</td>
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<tr>
<td></td>
<td>95.3%</td>
<td>99.0%</td>
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Emergency Medical Services, University of Copenhagen
Status – January 2018, Time-to-recognition was significantly shorter for the ML-model

- ML mean time-to-recognition
  - 00:48 mm:ss, 95% CI: 00:46-00:50

- compared to dispatchers mean time-to-recognition
  - 01:19 mm:ss, 95% CI: 01:13-01:25 (p<0.0001).
Conclusion & perspective

• Machine Learning is highly sensitive in recognising OHCA

• Machine Learning is better at recognising cardiac arrest during emergency calls than our medical dispatchers

• Machine Learning is significantly faster in recognising OHCA.

• Perspective: combination of machine learning and automatic dispatch protocol may improve survival after OHCA even further

• Big data for small diseases of high consequence
International collaboration

• EMS Leadership Network
• European EMS Congresses (EMS2016, EMS2017, EMS2018)
• Global Resuscitation Alliance
• Research collaboration
THE FUTURE
Overall strategic efforts over the next 2 years

• To be the best workplace in the Capital Region

• To optimise emergency care pathways (functioning as a role model for the Capital Region, Denmark and the international EMS World)

• Increased use of data and research to document and continuously develop our EMS solution.

• More active engagement with our citizens through media, social media and increased citizen involvement
Looking further ahead

- International research collaboration in Machine Learning
  - Big data for small/rare diseases with high consequence
- Regionally owned ambulance service
- Paramedic registration
- Breaking down barriers between pre-hospital and ED’s
  - Paramedics employed by region
  - ED’s managed and co-staffed by EMS
Blue lights
Thank you for your attention!

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