UAVs in medicine – value equation and pilot project

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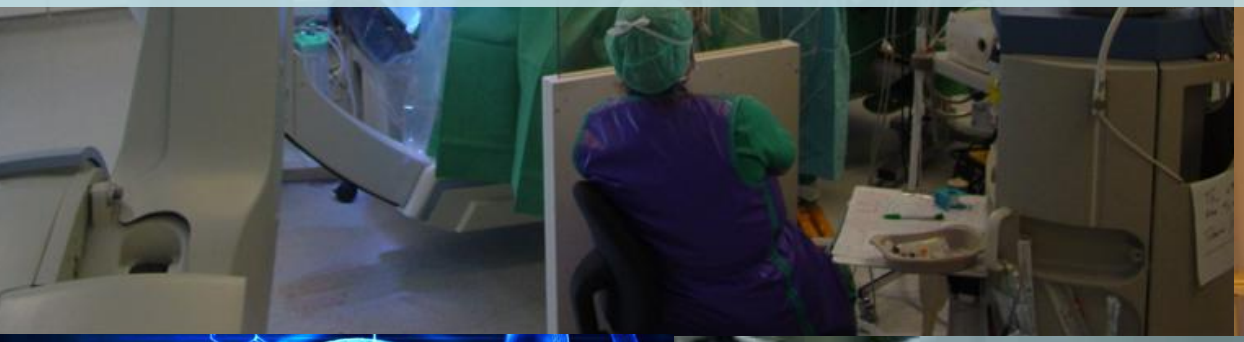
The Intervention Centre

Oslo University Hospital



Technology transforms medicine

Imaging

- Fluoroscopic guidance
- Ultrasound
- Videoscopic surgery

Computerisation

- Automated procedures
- Robots

Communication

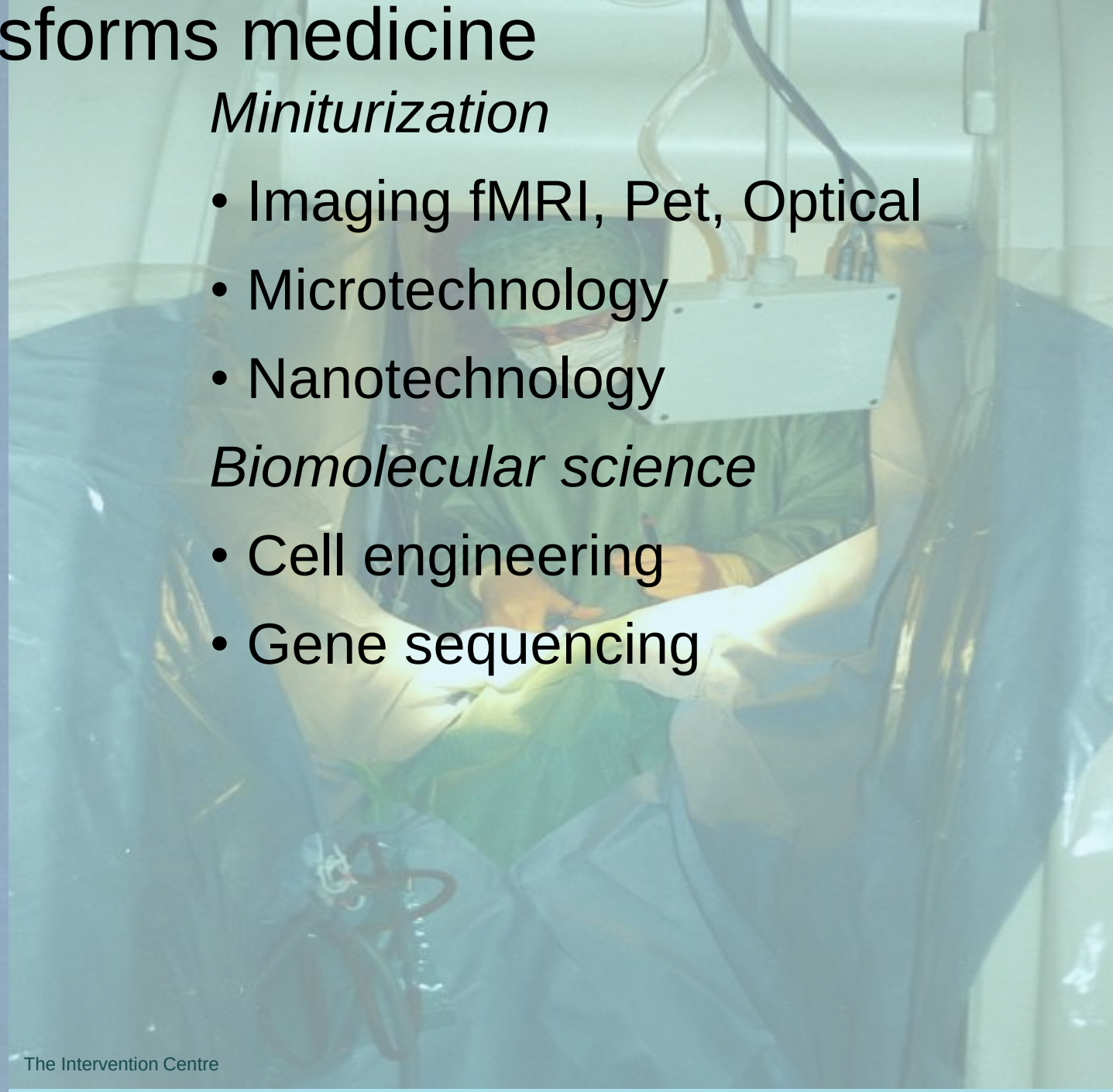
- Digital information
- Telemedicine
- Patient information

Miniturization

- Imaging fMRI, Pet, Optical
- Microtechnology
- Nanotechnology

Biomolecular science

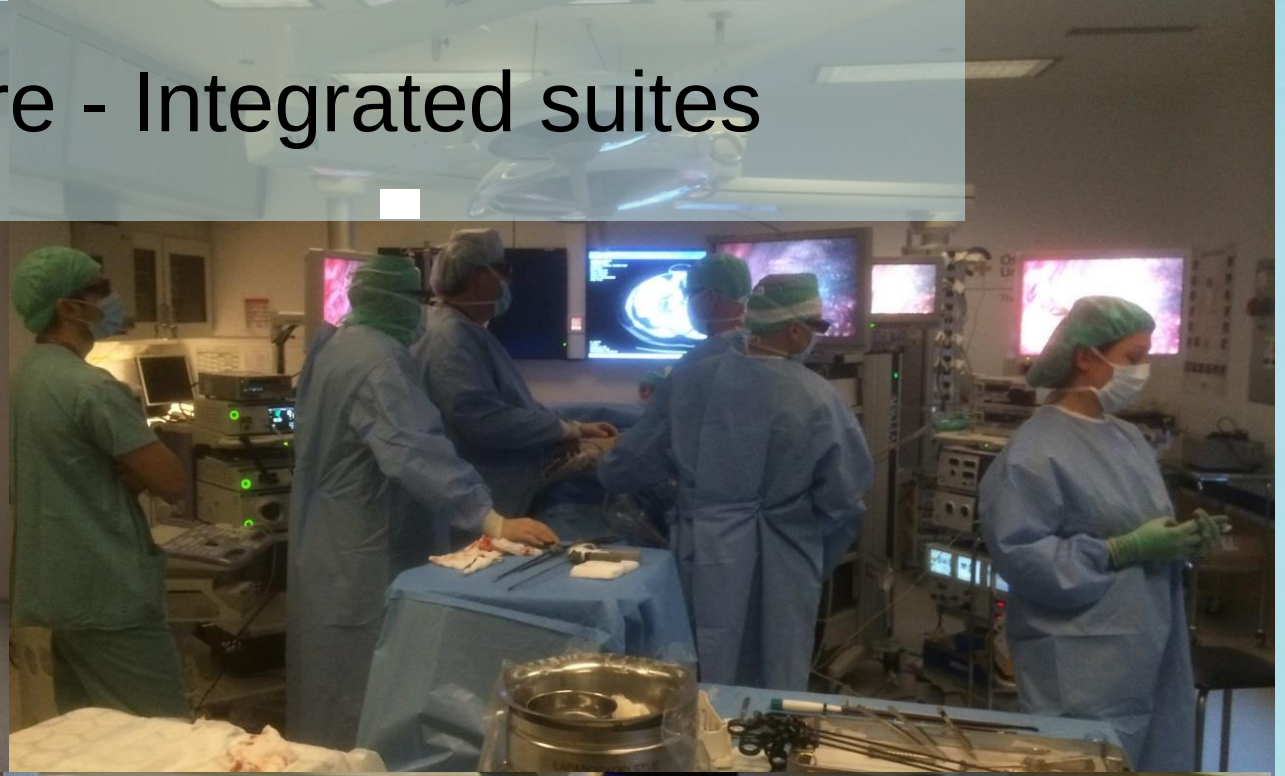
- Cell engineering
- Gene sequencing



The Intervention Centre
Established 1996

- **DEVELOP NEW PROCEDURES AND METHODS**
- **DEVELOP NEW TREATMENT STRATEGIES**
- **COMPARE NEW AND ESTABLISHED TREATMENT STRATEGIES**
- **STUDY SOCIAL, ECONOMIC AND ORGANIZATIONAL CONSEQUENCES OF NEW METHODS**

The Intervention Centre - Integrated suites



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Collaboration with Siemens - Building tomorrows treatment suites

IT-development in health

Digitalization → **Communication** →

Automatization

Electronic patient record

PACS

Laboratory data

Surveillance data

One national

patient record

Secure national health net

Artificial intelligence:

Any device that perceives its environment and takes actions that maximize its chance of success at some goal

- Robots
- Image interpretation
- Text analysis
- Unmanned procedures

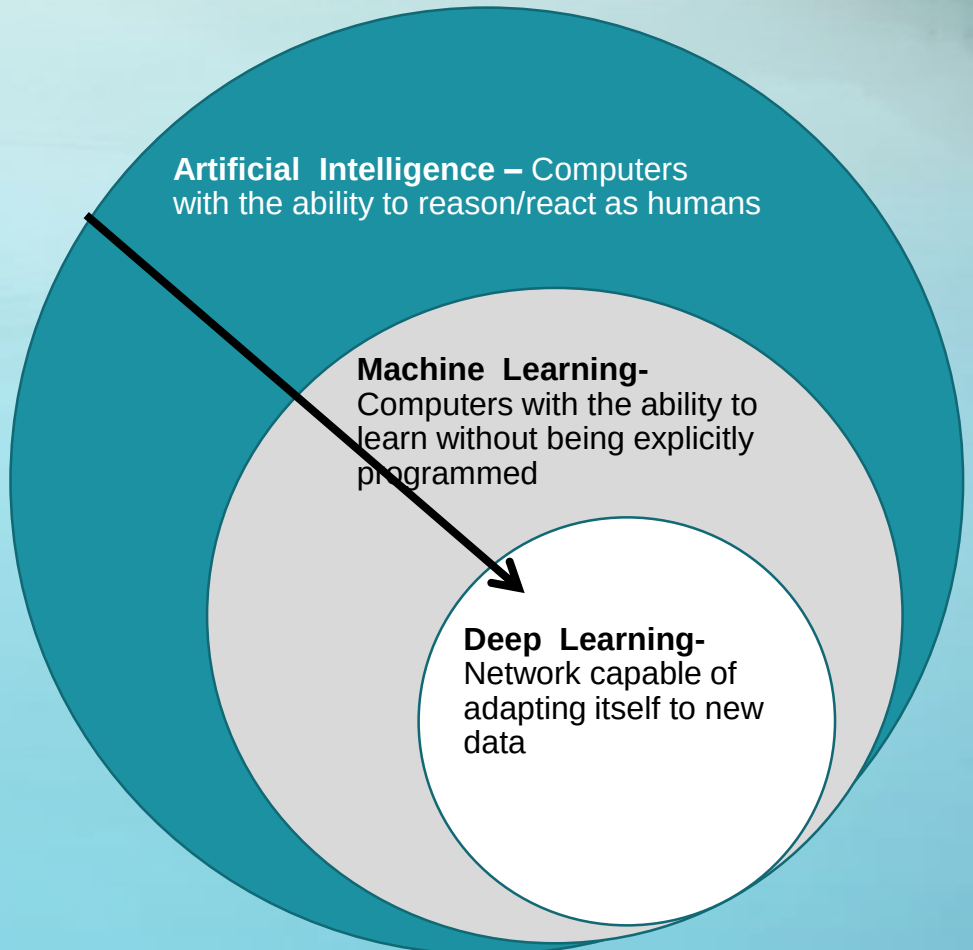


Fig.:

Surgical robots

Current surgical robots are not very intelligent

Microrobots in the future?

Automatic image analysis in radiology and pathology

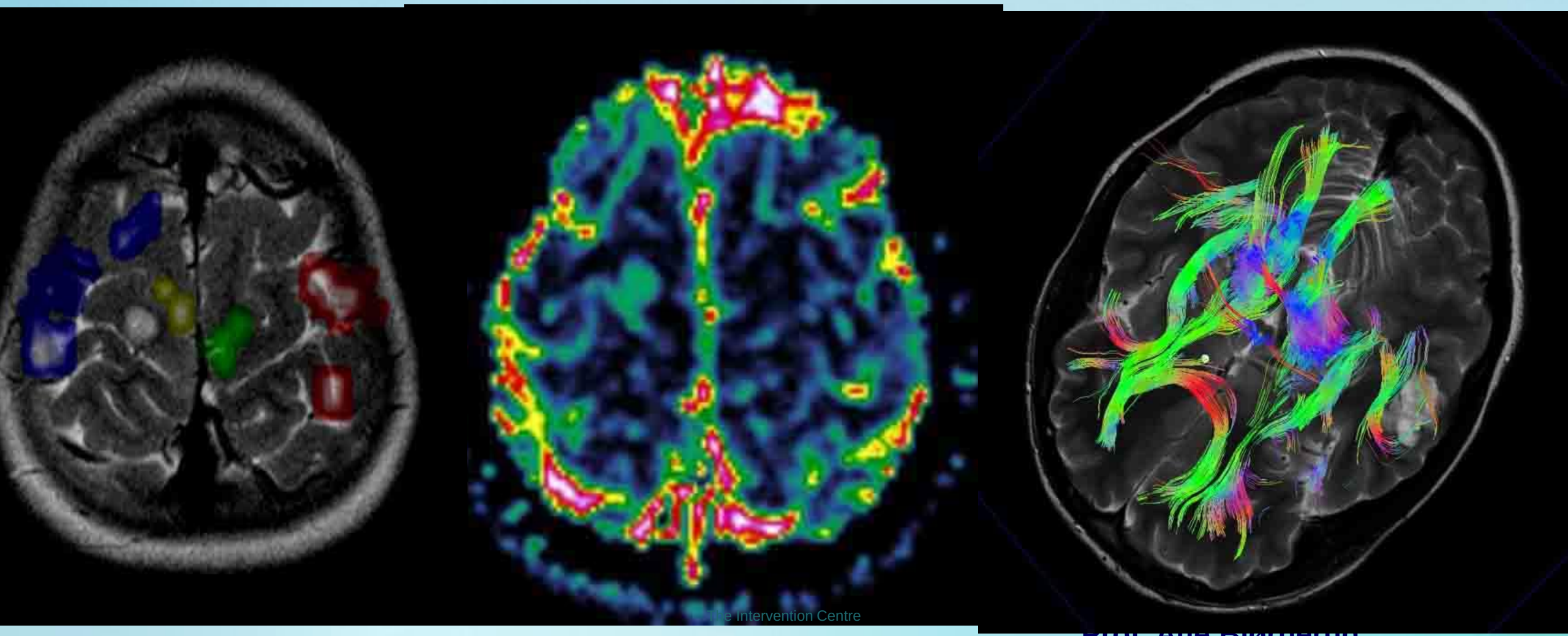
- Computer assisted diagnostics - the machine analyzes the image or the data behind the image
- Digital pathology - the microscope attached to a digital camera, the computer analyses each slice and the whole biopsy with advanced pattern recognition. The tool improves the more analyses it makes

Examination methods in MR

fMRI: Detecting activity causing oxygen consumption

PWI: Detecting small vessels indicating tumour activity

DTI: Mapping nerve trajecories



Machine learning and big data management transform health care

- Patient communication and monitoring
- Primary care/hospital care
- Hospital organization
  - Radiologic departments/surgical suites
  - Laboratories
  - Automated decision making
  - Transportation and logistics

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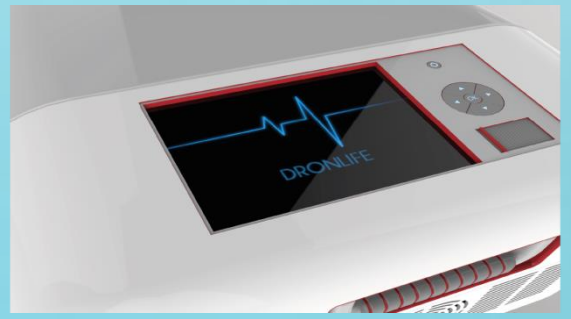
Transport of biologic material between hospitals by UAVs

Avoid duplication of laboratory services
Predictable transportation time
Results within one hour
Bloodbank
Biobank

Control Centre can convert from autopilot to manual flight

Thermostat controlled cargo container



Division of laboratory medicine

- Department of Pharmacology
  - Blood samples
- Department of Immunology and transfusion medicine
  - Blood banking
  - Blood samples
- Department of Medical biochemistry
  - Blood samples
- Department of Medical Genetics
  - Blood samples
- Department of Microbiology
  - Blood and tissue for microbiological studies
- Department of Pathology
  - Biopsies
  - Tissue samples
- Department of forensic medicine
  - Biopsies
  - Tissue samples
  - Blood samples

Department for medical biochemistry- OUH

Rikshospitalet:

Sections:
- General RH (103 employees)
- Section for hemostasis and thrombosis (11 employees)
- Congenital metabolic diseases (21 employees)

Analyses 2016: 6 216 760
- Research:
  - Mitokondrial research group
  - Eksperimental cancer therapy
  - Structural biology
  - Metabolic molekylar biology

Ullevål hospital:

Sections:
- Gneral Ullevål (111 employees)

  Analyses 2016: 4 052 981
- Reserch:
  - Tissue culture
  - Blood cell research

Across locations:

- Section for common functions (30 employees)
- Section for research (32 employees)
- Medical section (22 ansatte)

Aker hospital:

Sections:
- General Aker (37 employees)

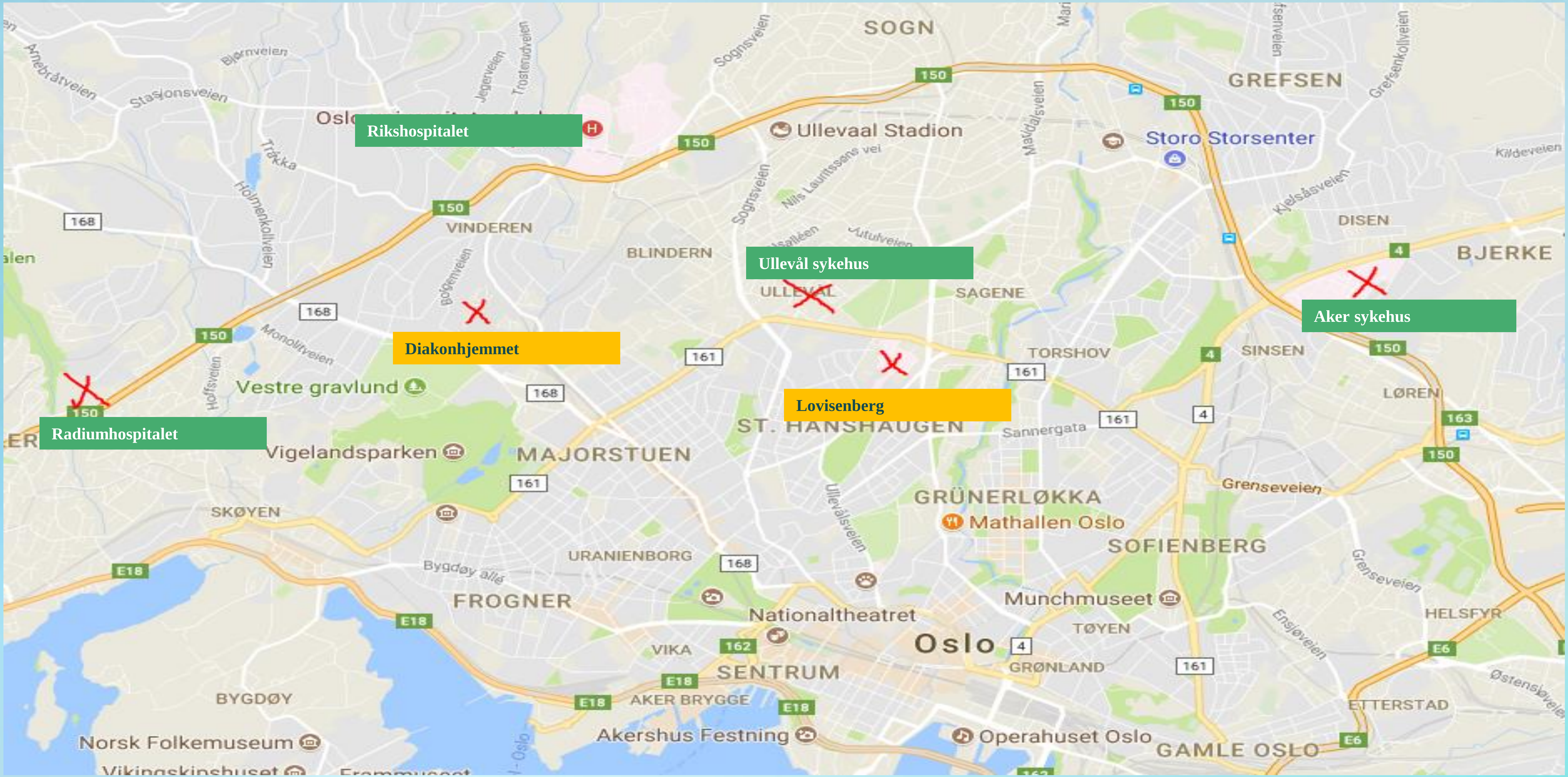
  Analyses 2016: 582 961
- Hormonlab (62 employees)

  Analyses 2016: 393 112

Radium hospital:

Sections:
- General RAD (46 employees)

  Analyses 2016: 1 002 081
- Research:
  - Cancer markers
  - Endocrinology and metabolism


Rikshospitalet
Ullevål sykehus
Aker sykehus
Diakonhjemmet
Lovisenberg
Radiumhospitalet
SOGN
GREFSEN
Ullevaal Stadion
Storo Storsenter
VINDEREN
BLINDERN
SAGENE
DISEN
BJERKE
TORSHOV
SINSEN
LØREN
Vestre gravlund
ST. HANSHAUGEN
Vigelandsparken
MAJORSTUEN
GRÜNERLØKKA
Mathallen Oslo
SOFIENBERG
SKØYEN
URANIENBORG
FROGNER
Nationaltheatret
Munchmuseet
TØYEN
HELSFYR
Oslo
GRØNLAND
VIKA
SENTRUM
AKER BRYGGE
BYGDØY
ETTERSTAD
Akershus Festning
Operahuset Oslo
GAMLE OSLO
Norsk Folkemuseum

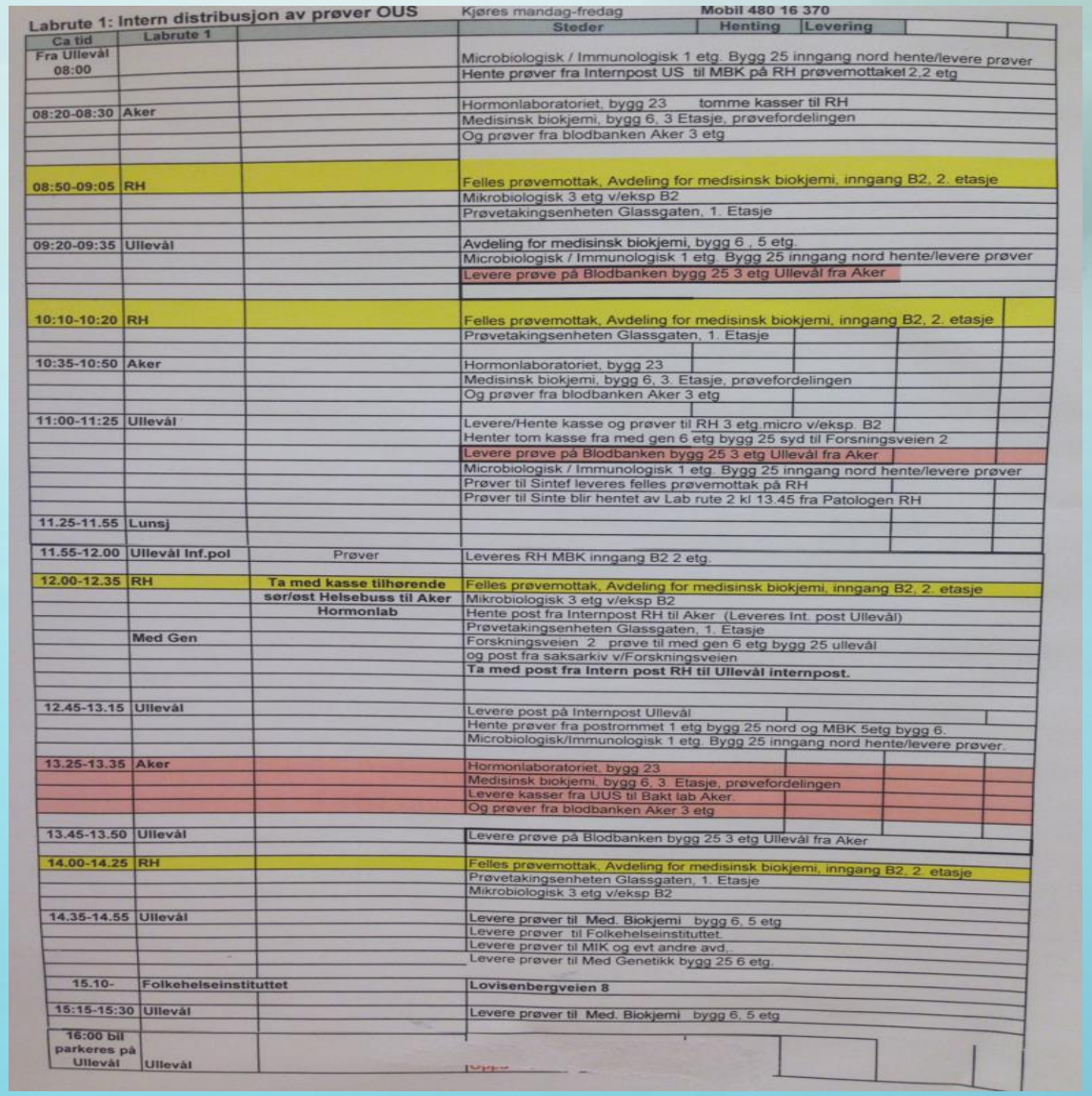
OUH has 22 localizations

Key figures 2017 Medical biochemistry at Rikshospitalet

- 9,25 mill + 2,9 mill PNA-analyses (RH+RAD) i 2016
  - 1 % reduction in in-hospital analysis in 2016 compared to 2015
  - 12,3 % increase in poliklinical analyses in 2016 compared to 2015
- 368 MNOK budget for 2017
- Ca 2 mnok/year in taxi for samples
- Ca. 405 employees fra mer enn 20 nasjoner
- 5 laboratories (4 open 24/7)
- 3 laboratory information systems

Schedule for blood sample transportation in OUH today

08.00 – start fra Ullevål
08:20-08:30 – Aker
08:50-09:05 – RH
09:20-09:35 – Ullevål
10:10-10:20 – RH
10:35-10:50 – Aker
11:00-11:25 – Ullevål
11:55-12:00 – Ullevål inf.pol
12:00-12:35 – RH
12:45-13:15 – Ullevål
13:25-13:35 – Aker
13:45-13:50 – Ullevål
14:00-14:25 – RH
14:35-14:55 – Ullevål
15:10 – Folkehelseinstituttet (Lovisenberg)
15:15-15:30 – levere siste prøver Ullevål
16:00 – Bil parkeres Ullevål



Labrute 1: Intern distribusjon av prøver OUS — Kjøres mandag-fredag — Mobil 480 16 370

Ca tid	Labrute 1		Steder	Henting	Levering
Fra Ullevål 08:00			Microbiologisk / Immunologisk 1 etg. Bygg 25 inngang nord hente/levere prøver Hente prøver fra Internpost US til MBK på RH prøvemottakel 2.2 etg		
08:20-08:30	Aker		Hormonlaboratoriet, bygg 23 tomme kasser til RH Medisinsk biokjemi, bygg 6, 3 Etasje, prøvefordelingen Og prøver fra blodbanken Aker 3 etg		
08:50-09:05	RH		Felles prøvemottak, Avdeling for medisinsk biokjemi, inngang B2, 2. etasje Mikrobiologisk 3 etg v/eksp B2 Prøvetakingsenheten Glassgaten, 1. Etasje		
09:20-09:35	Ullevål		Avdeling for medisinsk biokjemi, bygg 6 , 5 etg. Microbiologisk / Immunologisk 1 etg. Bygg 25 inngang nord hente/levere prøver Levere prøve på Blodbanken bygg 25 3 etg Ullevål fra Aker		
10:10-10:20	RH		Felles prøvemottak, Avdeling for medisinsk biokjemi, inngang B2, 2. etasje Prøvetakingsenheten Glassgaten, 1. Etasje		
10:35-10:50	Aker		Hormonlaboratoriet, bygg 23 Medisinsk biokjemi, bygg 6, 3. Etasje, prøvefordelingen Og prøver fra blodbanken Aker 3 etg		
11:00-11:25	Ullevål		Levere/Hente kasse og prøver til RH 3 etg micro v/eksp. B2 Henter tom kasse fra med gen 6 etg bygg 25 syd til Forsningsveien 2 Levere prøve på Blodbanken bygg 25 3 etg Ullevål fra Aker Microbiologisk / Immunologisk 1 etg. Bygg 25 inngang nord hente/levere prøver Prøver til Sintef leveres felles prøvemottak på RH Prøver til Sinte blir hentet av Lab rute 2 kl 13.45 fra Patologen RH		
11.25-11.55	Lunsj				
11.55-12.00	Ullevål Inf.pol	Prøver	Leveres RH MBK inngang B2 2 etg.		
12.00-12.35	RH	Ta med kasse tilhørende sør/øst Helsebuss til Aker Hormonlab	Felles prøvemottak, Avdeling for medisinsk biokjemi, inngang B2, 2. etasje Mikrobiologisk 3 etg v/eksp B2 Hente post fra Internpost RH til Aker (Leveres Int. post Ullevål) Prøvetakingsenheten Glassgaten, 1. Etasje		
	Med Gen		Forskningsveien 2 prøve til med gen 6 etg bygg 25 ullevål og post fra saksarkiv v/Forskningsveien **Ta med post fra intern post RH til Ullevål internpost.**		
12.45-13.15	Ullevål		Levere post på Internpost Ullevål Hente prøver fra postrommet 1 etg bygg 25 nord og MBK 5etg bygg 6. Microbiologisk/Immunologisk 1 etg. Bygg 25 inngang nord hente/levere prøver.		
13.25-13.35	Aker		Hormonlaboratoriet, bygg 23 Medisinsk biokjemi, bygg 6, 3. Etasje, prøvefordelingen Levere kasser fra UUS til Bakt lab Aker. Og prøver fra blodbanken Aker 3 etg		
13.45-13.50	Ullevål		Levere prøve på Blodbanken bygg 25 3 etg Ullevål fra Aker		
14.00-14.25	RH		Felles prøvemottak, Avdeling for medisinsk biokjemi, inngang B2, 2. etasje Prøvetakingsenheten Glassgaten, 1. Etasje Mikrobiologisk 3 etg v/eksp B2		
14.35-14.55	Ullevål		Levere prøver til Med. Biokjemi bygg 6, 5 etg Levere prøver til Folkehelseinstituttet. Levere prøver til MIK og evt andre avd. Levere prøver til Med Genetikk bygg 25 6 etg.		
15.10-	Folkehelseinstituttet		**Lovisenbergveien 8**		
15:15-15:30	Ullevål		Levere prøver til Med. Biokjemi bygg 6, 5 etg		
16:00 bil parkeres på Ullevål	Ullevål				

Expectation of UAVs

- Precontition: running minimum 99 % 24/7
- Faster analysis results
- Improved patient logistics
  - Diagnostical data available earlier
  - Predictable time from sampling to analysis
  - Reduction in the number of hospital visits
- Environmentally friendly
- Allows the reduction of number of laboratories
- Reduced costs

Helse Vel project NR Partnere

- OUH
- FFI
- Meteorological institute
- Sintef
- Dronebud

- UAV producer

What do you need to know when introducing a new method?

- Is it harmful to the patients?
- Is it better than excisting methods?
  - For everybody, or just a subgroup?
  - In which way is it better?
    - Better Clinical outcome (Survival, Morbidity)
    - Same clinical outcome, but less burden to the patient
    - Same clinical outcome, same burden, but cheaper
- Consequences for hospital organization
  - Favourable outcomes dependent on changes in organization
- Consequences for the society
  - More expencive for the hospital, but cheaper for the society
  - More expencive for the hospital and the society, but better for the patient

Study design for validating new methods

Clinical studies

- Mortality
- Morbidity
- Durability

Patient experience

- Quantitative studies

  Quality of life

  Pain

  Functional scores

- Qualitative studies

  Semistructured intervews

Economical studies

- Cost-utility studies

  Cost/Qaly

The economical challenge – how can we estima the value of individualised treatment?

Value based health care

$$\text{Value} = \frac{\text{Health outcomes that matter to patients}}{\text{Costs of delivering the outcomes}}$$

Michael Porter 2015

Creating a Value-Based Health Care Delivery System
The Strategic Agenda

1. Organize Care into Integrated Practice Units (IPUs) around Patient Medical Conditions

– For primary and preventive care, organize to serve distinct patient segments

2. Measure Outcomes and Costs for Every Patient

3. Move to Bundled Payments for Care Cycles

4. Integrate Care Delivery Systems

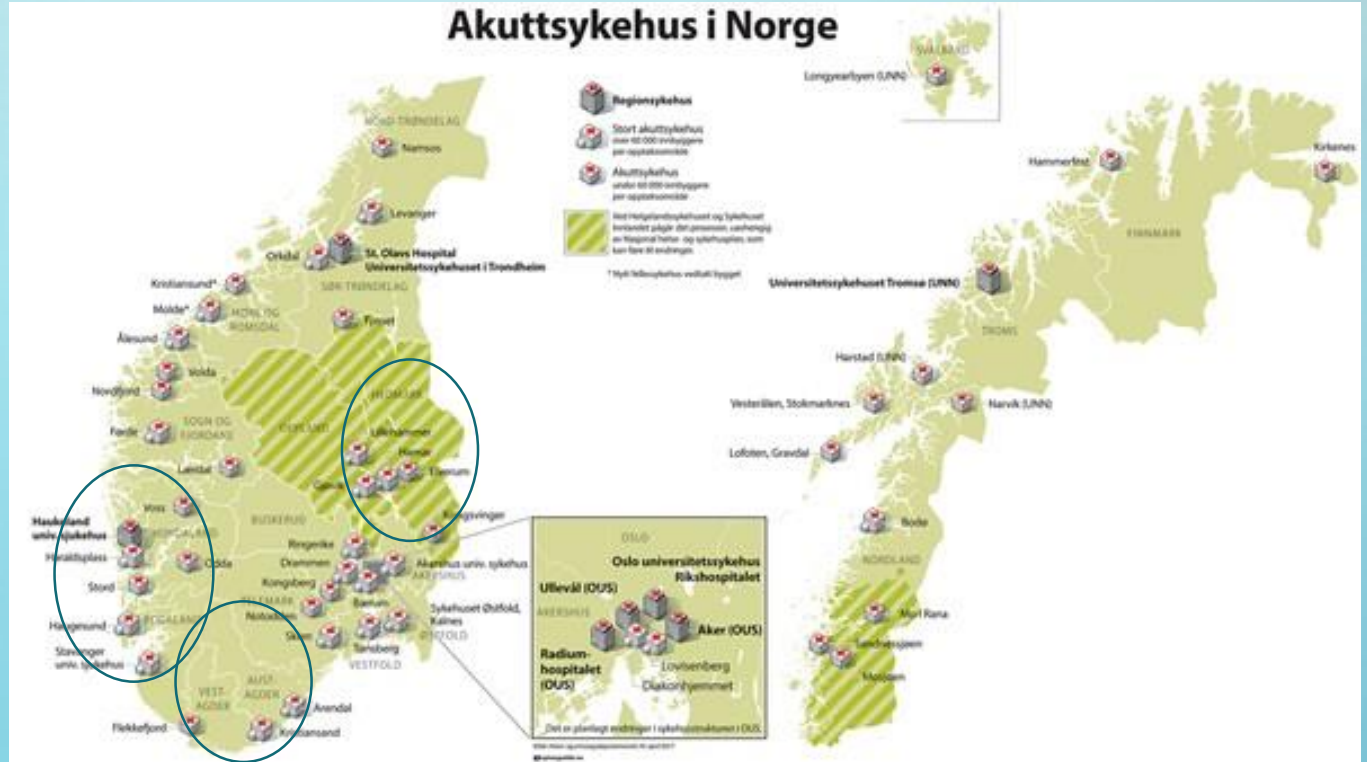
5. Expand Geographic Reach

6. Build an Enabling Information Technology Platform

Michael Porter 2015

Development of the project

- Transport of biological meatrial between medical centres and hospitals
- Transport pf radioactive isotopes and drugs
- Collaboration with Sykehuset Innlandet, sykehuset Sørlandet andHelse Vest
- Collaboration with Posten



The digital revolution – from horse to car

Initially they tried to make the car behave like a horse

The digital revolution – from horse to car

Changed infrastructure: Roads, gaz stations, Increased mobility, transportatio

New legislation: Road Traffic Act: Speed limits, b alcohol limits etc.

New police force: Traffic police