Lean at Odense University Hospital

by lean-consultant Gitte Dahl and

lean-consultant Claus Y. B. Thor
Facts about Denmark

Population: 5,534,738 inhabitants

Area: 42,930 km²

Capital: Copenhagen - 1,080,000 inhabitants

Life expectancy: Women 80.41 years and men 75.65 years

Governance: Denmark has constitutionel monarchy

Number of islands: 446
Health care in the Region of Southern Denmark

The area of health constitutes the most cost-intensive assignment for the Region of Southern Denmark, with total expenses of approximately DKK 18 billion (app. 2.4 billion €).

There are 18 hospitals and 3 psychiatric centers in the region.
Facts about Odense Universitet Hospital

**Treatment capacity:**
- Beds: 1,329
- Treatments in 2009:
  - About 100,000 hospitalizations
  - About 800,000 outpatients

**Economy:**
- Operating budget in 2010: 5,8 mia. DK kr, about 0,77 billion Euro

**Employees:**
- About 9,500, of this about 1,400 physicians and about 5,000 nurses.
- 76 departments.
- About 1,600 educations sites, annually a flow of 2,500 persons.
Organization

Directors:
Every Director is responsible for a certain number of departments.

Staff functions:
Economy – Human Resources - Finance and Planning – Lean – etc.

Departments:
Department management consists of chief consultant and nursing officer
Under Pressure

Examples of political pressure:

• The Danish Quality Model (DDKM)
• 48-hours patients – cancer package
• Treatment guarantee within 4 weeks - Free, extended choice of hospital
The lean journey

- A push from the industry
- Began with a pilot project, but aims for the entire hospital
The Lean Journey on OUH

2006: External consultants, establishment of Lean Staff Education and three wards in pilot project

2007 – 2010
15 wards have participated in the "lean wave" of approx. 9-12 months (Push…) All project groups received training in twelve days
1 day course for basic staff and managers
Dissemination of results by the "show window"

2010- Focused lean efforts (Pull…) Basic courses and individually organized training
Dissemination of results is automatically sent to the board of directors
What is lean?

**PHILOSOPHY**

1. Identify what creates value from the patient’s perspective
2. Identify the steps that do not create value and eliminate them
3. Make the value-creating steps flow
4. Process pulled by the patient
5. Strive for perfection by continuous improvements

**PRINCIPLES**

- Heijunka
- A3
- VSM
- Flow-layout
- Målstyring
- TQM
- Planning
- Pareto
- Standardiseret arbejde
- 5 X why
- 5S
- Kanban
- Kaizen
- SMED
- Fishbone
- Right time
- Right first time

**TOOLS**
7 wastes in different sectors, businesses, what can we learn and share
1. Over-production

Industry - factory

Health care - hospital
2. Waiting

Industry - factory

Health care - hospital
3. Internal transport

Industry - factory

Health care - hospital
4. Over-processing

Industry - factory

Health care - hospital
5. Stock

Industry - factory

Health care - hospital
6. Unnecessary movements

Industry - factory

Health care - hospital
7. Scrap and failures

Industry - factory

Health care - hospital
Lean is about working smarter – not harder!
The purpose of lean:

- To create a culture where improvement of the workflow is a natural part of everyone's daily lives.
- To improve the patient-pathway,
- To achieve satisfaction among the staff members and higher activity ..... and development

Lean is driven by the management and supported by the staff members. The ideas for improvements must predominantly come from the staff members, because they are the ones who experience irregularities in everyday life.
Lean in a health care perspective

The patient experienced quality

The professional quality

The organizational quality
The quality of our systems and processes
What are we trying to accomplish?

How will we know that a change is an improvement?

What change can we make that will result in improvement?

"Plan"

"Do"

"Study"

"Act"

The model for improvement jf. IHI

The model for improvement jf. Lean

Map the patient’s journey through the system, process and detail!

1) Mapping the system

2) Mapping the procs

3) Mapping the detail

What makes the patient recover? Minimize or eliminate everything else!

Where in the process is the patient and the staff waiting? Make "flow"!

Where is the patient pushed through the system? Etablere "pull"

Is the daily operation developing? Create a culture for improvements!
Do you spend your time:

• correcting mistakes?
• looking for papers, apparatuses and persons?
• waiting for something to happen?
• apologizing or explaining why things don’t go as planned?
• obtaining informations, which have been given earlier?
• etc …

How much is this in daily operation?

1 hour out of 7 hours per day ? = 14% !
2 hours out of 7 hours per day ? = 28% !
Lean-staben på OUH

Value Stream Mappning (VSM)
Mapping

• Achieve more factual knowledge about our workflows

We must not 'believe', we need to know!

- identify (potential) problems
- confirm hypotheses and theories
... And maybe explode a few myths
We regard things differently…

The woman on the train

- how Mr Smith regards her
- how little Paul regards her…
- how Ms Byrne regards her
- how Mr Petersson, who is on his way to the dentist, regards her

… but we need to regard things in the same way!
How can LEAN be used in a Department of Radiology
Our lean strategy

• Patient
  – short waiting time, fast patient care, service.

• Organisationen
  – high productivity, low costs, development, image

• Employee
  - working environment, job satisfaction, time for education and development
Value-stream-mapping - process

CT-scannings

Henvisning
---
Egen læge

Registrering
---
Sekretær

Visitation
---
Læge

Booking
---
Sekretær

Scanning
---
Radiograf

Beskrivelse
---
Læge

Skrivning
---
Sekretær

Godkendelse
---
Læge

Svar
---
Egen læge

---

1 min.
2 dage
5 min.
5 min.
10 dage
25 min.
1 dag
15 min.
1 dag
5 min.
1 dag
4 min.
---

60
3 uger
1 time
15

OUH
Odense Universitetshospital
Svendborg Sygehus
Region Syddanmark

Back
Map, analyse, find a solution

Week plan for registration and booking

<table>
<thead>
<tr>
<th>Time</th>
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Week plan for visitation

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Process template for registration, visitation and booking

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Mapping the pathway from start to end

VSM før:

NY VÆRDISTRØM - LYMFSØKEM

VSM efter

Kilde: OUH, Rehabiliteringsafdelingen, Lean-gruppen
Mapping the details
Some results

Time for in-service training and improvement of staff skills

Better working flow

Team and management get a better breadth of view

Everyone participates in the dialogue
Some results

Waiting time 2006 and 2009

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Some results

Total examinations

- 2006
- 2009
Quality in the health system
Quality in the health system

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- Clinical quality data base
- HSMR – Rate for mortality
- Measurements of productivity in health care ©

- Political demands
- Cancer package - 48 hours patients
- 4 weeks treatment guarantee
Measurements of productivity in health care

Productivity expresses how many health benefits that can be manufactured for money.

These measurements are used to compare productivity in health care.
Figur 3.4. Productivity in the Regions. Hole country = 100

- Capital: 96
- Zealand: 100
- South Denmark: 104
- Middle Jutland: 104
- North Jutland: 95
Development in transformation of day surgery

18 selected operation, IAAS (International Association of Ambulatory Surgery)
Lean-staben
på OUH
What is 5S?
A tool that helps to get a safe, structured and clean workspace - and to maintain and improve it.
Why 5S?

In order to create
- safety
- quality and
- efficiency
In the working processes
5S at Hans Christian Andersen Children’s Hospital
Step 1: SORT
Step 2: SYSTEMIZE
Step 3: SHINE (ENSURE)
Step 4: STANDARDIZE

Medicine

Depot and antiseptic articles, which still are in the medication room
5. Step - SELF DISCIPLINE
Lean-staben
på OUH

Results operating theatre dept. of orthopaedics
Results operating theatre dept. of orthopaedics

Reduced turnaround time with 8 minutes (64 000 min = 427 new operations)
SMED

SMED is a tool for minimizing the time spent in change-over (Or replacements), and also setting the standard for how the change-over shall be done

**Single digit Minute Exchange of Dies**
What is transition time for wheel change?

Activities:
- Pull over
- Besides looking
- Clear trunk
- Search tool
- Go with the hubcap
- 4 bolts loosened with key
- The car is raised by jacks
- 5 bolts with key
- Wheel of
- Finding spare tire (flat?)
- On with the spare tire
- 4 bolts with key
- Lower car
- After clamping bolts
- Tide up (wheels, tool)
- Off again

Time: about 30 minutes

….Can it be done better?
Four wheel change - and a little more…

Activities:
Into the pit
Lift car
4 bolts
4 wheels
fuel
4 wheels
4 bolts
Lower car
Off again

Time
about 7 seconds!
SMED reduce turnaround time

Before SMED

After SMED
SMED-method

1. Map the current situation
   Record every part of the process

2. Devide the proces in inner and outer timer

   - **Outer time**: Activities which can be done in another places.
   - **Inner time**: Activities which shall be carry out on sight.

3. Relocate inner and outer processes

4+5 Streamline and optimize the processes
Lean program for an operating theatre

Focus 1: Management

Focus 2: Project group

Focus 3: Working group

Focus 4: Employee involvement

Focus 5: Facts

Focus 6: Organised theatre

Focus 7: Visibility

Focus 8: Planning

Focus 9: Consumables and Equipment

Focus 10: Culture

Focus 11: Preparation

Focus 12: Start-up

Focus 13: Training

Focus 14: Turnaround

Focus 15: Shift of responsibility

Focus 16: Recovery

Continuous improvement
Foundation
Enables
Process

Dept. of Radiology:
  – VSM

Dept. of Neurology:
  – Case: quality

H.C. Andersen's Children's Hospital:
  – Case: 5S

Dept. of Orthopaedics:
  – Facts
  – Case: outpatient section
  – Case: Operating theatre
  – Case: Secretariat

Dept. of Cardiology

Waste – Industry and Health Care
Lean-staben på OUH

Value Stream Mapping (VSM)
Mapping

- Achieve more factual knowledge about our workflows

We must not 'believe', we need to know!

- identify (potential) problems
- confirm hypotheses and theories
... And maybe explode a few myths
What is mapping?

Mapping is an observation of how activities, routines, performance of tasks, etc. go off.

Various topics can be in focus: patient, staff, room/ward, equipment, paper flow etc.

There are many ways to mapp!
We regard things differently…

The woman on the train

- how Mr Smith regards her
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… but we need to regard things in the same way!
How can LEAN be used in a Department of Radiology
Department of Radiology

Budget: 18 million euro
200 employees
40 students / medical and radiographer
190,000 examinations/ treatments
40 % acute patients
All specialities in radiology
Our lean strategy

• Patient
  – short waiting time, fast patient care, service.

• Organisationen
  – high productivity, low costs, development, image

• Employee
  - working environment, job satisfaction, time for education and development
Value-stream-mapping - process

Henvisning  ---  Egen læge

Registrering  ---  Sekretær

Visitation  ---  Læge

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Scanning  ---  Radiograf

Beskrivelse  ---  Læge

Skrivning  ---  Sekretær

Godkendelse  ---  Læge

CT-scannings

Svar  ---  Egen læge

1 min.  5 min.  5 min.  25 min.  15 min.  5 min.  4 min.  1 dag  1 dag  1 dag  1 dag  1 dag

2 dage  0 dage  10 dage  1 dag  1 dag  1 dag

2 uger  3 uger  60 uger  15 uger
Map, analyse, find a solution

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Some results

![Bar chart showing total examinations from 2006 to 2009. The chart indicates a significant increase from 2006 to 2009.]
Quality in the health system

- Patient experient quality ©
- National Indicator Project (NIP) ©
- Patient Society

- Clinical quality data base

- HSMR – Rate for mortality
- Measurements of productivity in health care ©

-Political demands
- Cancer package - 48 hours patients
- 4 weeks treatment guarantee
LUP – Neuro-medical outpatient department

- 34 parameters
- Reviewed with the Director
- Sets up local targets for improvement

Example
- Waiting time before and under the visit
- Assessment of written information
- Medication errors
- Involvement of the patient
- Whether the patient feels well-informed
The National Indicator Project (NIP) makes quality measurements that give insight into how well the regions and individual hospital departments is to treat, care and rehabilitate patients with particular diseases.
## Case: NIP Dept. of Neurology

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<thead>
<tr>
<th></th>
<th>Trombocyt hæmmer senest 2. døgn</th>
<th>CTC i 1. døgn</th>
<th>Physio-Therapy 2th day</th>
<th>Ergoterapi senest 2. døgn</th>
<th>Ernærings vurdering ved indlæggelse</th>
<th>Vandtest ved indlæggelse</th>
<th>Duplex senest 4. døgn</th>
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<tr>
<td><strong>Aim</strong></td>
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<td><strong>2008</strong></td>
<td>69 %</td>
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<td>88 %</td>
<td>89 %</td>
<td>96 %</td>
<td>83 %</td>
<td>95 %</td>
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CTC i 1. døgn

HANDLING: ARMENE I VEJRET - AKUT HENVISNING-PROCEDURE & INDSATS I RADIOLOGISK AFD VIRKER
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Productivity expresses how many health benefits that can be manufactured for money.

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Productivity

Development in treatments and bed days

Operations, 10,000 pers.  Outpatients, 100,000 pers  Bed days, 100,000
Development in transformation of day surgery

18 selected operation, IAAS (international Association of Ambulatory Surgery)
Lean-staben på OUH
SORT
SYSTEMIZE
SELF-DISCIPLINE
SHINE (ensure)
STANDARDIZE
What is 5S?

A tool that helps to get a safe, structured and clean workspace - and to maintain and improve it.
Why 5S?

In order to create
- safety
- quality and
- efficiency
In the working processes
5S at Hans Christian Andersen Children’s Hospital
The process at H7

Meeting with Lean-staff
Selection of participants from H7
Management
Planning stage (create space, order, safety)
Success criteria for process
Questionnaire to colleagues before start-up
Important with outside person → "legitimate" to call everything into question
Success criteria medication room

Managerial the medication room was high-priority:
- Silent area in the medication room from week 37
- Antiseptic artikles removed from the medication room from week 37
- Boxes on top of cupboards removed
- Tables with raise and lower function skal kunne sænkes
Step 1: SORT
Step 2: SYSTEMIZE
Step 3: SHINE (ENSURE)
Step 4: STANDARDIZE

Medicine

Depot and antiseptic articles, which still are in the medication room
5. Step - SELFDISCIPLINE
Fakta om Orthopædkirurgisk afdeling

Main Task
- Treatment
- Training and education
- Research and development

Budget 2007: about 30 mio. Euro

Staffing: about 450 pers. Of this 75 physicians

Activity:
- 36.500 bed days
- 8.200 hospitalized
- 48.000 outpatient treatment
- 8.300 operations of hospitalized
- 2.510 operations of outpatients
- 59.200 emergency visits
Results from dept. of Orthopaedics - outpatients

Outpatients section:

– Created space for clump foot patients (287 ptt.)
– New program for shoulder patients (246 ptt.)
– Performance management space utilization (potentiale 3690 ptt.)
– Drop-in (reduced with 1750 hours) (3 days instead of 5 says)
– Splint in stead of plaster (40 timer)
– Satisfaction tube: 1145 forslag
Case: Drop-in at outpatient section Dept of Orthopaedics

Aims:
- Reduce waiting time
- Create flow
- FIFO
### Traditional scheduling

**Scheduling with fixed times**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:15</td>
<td>A. Andersen</td>
</tr>
<tr>
<td>08:30</td>
<td>B. Bentsen</td>
</tr>
<tr>
<td>08:45</td>
<td>C. Christensen</td>
</tr>
<tr>
<td>09:00</td>
<td>D. Dahl</td>
</tr>
<tr>
<td>09:15</td>
<td>E. Eriksen</td>
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<tr>
<td>09:30</td>
<td>F. Frandsen</td>
</tr>
<tr>
<td>09:45</td>
<td>PAUSE</td>
</tr>
<tr>
<td>10:00</td>
<td>G. Gunnersen</td>
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<tr>
<td>10:15</td>
<td>H. Hansen</td>
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<tr>
<td>10:30</td>
<td>I. Ibsen</td>
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<tr>
<td>10:45</td>
<td>J. Jensen</td>
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<tr>
<td>11:00</td>
<td>K. Klausen</td>
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<tr>
<td>11:15</td>
<td>L. Larsen</td>
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<tr>
<td>11:30</td>
<td>M. Mortensen</td>
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<tr>
<td>11:45</td>
<td>N. Nielsen</td>
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<tr>
<td>12:00</td>
<td>FROKOST</td>
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<tr>
<td>12:30</td>
<td>O. Olsen</td>
</tr>
<tr>
<td>12:45</td>
<td>P. Pedersen</td>
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### Reality…..

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>08:15</td>
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</table>

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**Waiting time**

Breaks in the plan

Do not get breaks

Stress

---

And what about the ward round? who shot be the next activity
### "Drop-in" – Patients meets in time blocks

<table>
<thead>
<tr>
<th>Time</th>
<th>Patients</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.00-10.00</td>
<td>15 patients</td>
<td>Of these 5 to X-ray</td>
</tr>
<tr>
<td>10.00-11.30</td>
<td>11 patients</td>
<td>Of these 5 to X-ray</td>
</tr>
<tr>
<td>11.30-12.15</td>
<td>Lunch (expected 11.45)</td>
<td></td>
</tr>
<tr>
<td>12.15-14.00</td>
<td>13 patients</td>
<td>Of these 5 to X-ray</td>
</tr>
<tr>
<td>14.00-14.30</td>
<td>Acute</td>
<td></td>
</tr>
</tbody>
</table>
Drag a number.....

... First in – First out
<table>
<thead>
<tr>
<th><strong>Secretaries</strong></th>
<th><strong>Nurses</strong></th>
<th><strong>Physicians</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Booking of patients:</strong></td>
<td><strong>Patients on the day:</strong></td>
<td><strong>Booking of patients:</strong></td>
</tr>
<tr>
<td>• Aim always smoothing the booking over the week</td>
<td>• If the patient meet without a time or on a wrong day keep the original time unless there is a time in the schedule.</td>
<td>• As far as possible mark +/- number of days for next attendance.</td>
</tr>
<tr>
<td>• Book is always the first hours of the day first, within 48 hours the following treatments booked on X-ray times</td>
<td>• If the patient meet earlier than the blocktime, they shall wait to the blocktime start unless there is room in the blocktime.</td>
<td><strong>Patients on the day:</strong></td>
</tr>
<tr>
<td>• Acute patients can be booked in free slots during the day, alternatively 2pm-2:30pm</td>
<td>• According to acute- and free slots use the list in medical ward, the nurse mark when the slot is used,</td>
<td>• The first patients meets from 8.15am therefor it is important that the physisan starts 8.15am</td>
</tr>
<tr>
<td><strong>Patients on the day:</strong></td>
<td></td>
<td>• If the patient meet without a time or on a wrong day keep the original time unless there is a time in the schedule.</td>
</tr>
</tbody>
</table>
Results:

- Turnaround time reduced with 20%
- High patient satisfaction—”Meets after own choice”
- Breaks secured
- Planned akuttider
- Mere ro – mindre stress
- Implementeret for 20-25% af alle patienterne
- Tilfredshedsrør: 1145 forslag fra patienterne
Results operating theatre dept. of orthopaedics

Reduced turnaround time with 8 minutes (64 000 min = 427 new operations)
SMED

SMED is a tool for minimizing the time spent in change-over (Or replacements), and also setting the standard for how the change-over shall be done

Single digit Minute Exchange of Dies
What is transition time for wheel change?

Activities:
- Pull over
- Besides looking
- Clear trunk
- Search tool
- Go with the hubcap
- 4 bolts loosened with key
- The car is raised by jacks
- 5 bolts with key
- Wheel of
- Finding spare tire (flat?)
- On with the spare tire
- 4 bolts with key
- Lower car
- After clamping bolts
- Tide up (wheels, tool)
- Off again

Time:
- About 30 minutes

....Can it be done better?
Four wheel change - and a little more…

Activities:
Into the pit
Lift car
4 bolts
4 wheels
fuel
4 wheels
4 bolts
Lower car
Off again

Time
about 7 seconds!
SMED reduce turnaround time

Before SMED

After SMED
SMED-method

1. **Map the current situation**
   Record every part of the process

2. **Divide the process in inner and outer timer**
   - **Outer time**: Activities which can be done in another place.
   - **Inner time**: Activities which shall be carried out on sight.

3. **Relocate inner and outer processes**

4+5 **Streamline and optimize the processes**
Results secretariat – Dept. of orthopaedics

Large volumes
Need for standardization

Many processes:
- 36,500 bed days (at least as many notes)
- 8,200 hospitalizations = discharges and comments
- 48,000 outpatient settings (just as many notes)
- 8,300 surgical operations – hospitalized patients (many day surgeries)
- 2,510 surgical operations - outpatients
- 59,200 consultations to the emergency room

A little sum:
One saved process per comment of 5 minutes = 683 hours/year

One saved process per note (outpatient department) of 1 minute = 800 hours/year
A half-saved bed day/patient = 11 beds

Billig ekstra plads:
3,27 m² a 3,300 kr/m²
The secretariat in Odense

"Reach the bottom in the heap of medical records"

- The bottom of the heap is reached everyday
- With almost the same use of medical sekretaries (from 68,8->69,8, +1,5%)
- Overall satisfaction, fewer interruptions and peace

Simultaneously improved compliance with quality standards as regards comments and triages

*) Diagnostic Related Groups
Visibility – the physical in lean thinking

Operator assessments

"Reach the bottom"

Low-tech solutions

- We actually do, what we think we do
- We actually do, what’s agreed
- Visibility on quality
Some results from the Dept. Of Cardiology

**EKKO: patients for ambulant examination**
- Reduced waiting time from 16 to 7 weeks
- 450 more EKKO examinations per year
- Systematic supervision of junior doctors

**Patients for sub-urgent examinations**
- hospitalization timer reduced from 3.5 to 2.6 bed days
- 98% of the patients’ waiting time was reduced to <72 timer
Forbedringer

Små løbende forbedringer (”Kaizen”)  
Større trinvise innovationer (”Kaikaku”)  
”Ny teknologi”  
”Ny aktivitet”  
”Ny samarbejdsaftale”
Bottom-up: White-board-meetings

- Meeting structure
- Proposals
- Priority
- Responsibility
- Documentation
Focus 1: Management

Focus on the strategic importance of the operating theatres to your organisation and the role of all boards in providing the right conditions and framework for success.
The five leadership virtues

1. Anchor the benefit in the ward
2. Create a trend and create a sense
3. Create engagement
4. Act on measurements
5. Understand the value streams

Kilde: Den gode leanleder – Børsens forlag
“Everybody wants improvements, but nobody like change”

Søren Kierkegaard, Danish Theologian and Philosopher, 1813-1855
The change equation

<table>
<thead>
<tr>
<th>Urgency for change</th>
<th>Clear objectives</th>
<th>Capacity for change</th>
<th>Actionable first steps</th>
<th>Effective improvement</th>
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<th>Capacity for change</th>
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<th>Slow start</th>
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<th>Actionable first steps</th>
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<table>
<thead>
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<th>Clear objectives</th>
<th>Capacity for change</th>
<th>Actionable first steps</th>
<th>Great frustration</th>
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</table>

<table>
<thead>
<tr>
<th>Urgency for change</th>
<th>Clear objectives</th>
<th>Capacity for change</th>
<th>Actionable first steps</th>
<th>Uncoordinated efforts</th>
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</table>
Challenges during and after the project

Before: Management
Communication
Involvement

During: Management
Communication
Involvement

After: Management
Communication
Involvement
Maintainance
Hvad skal der til for at lykkes?

Anerkende og acceptere at:

20% lean-redskaber

80% forandringsledelse
Focus 2: Project Group

Focus on leadership of the accelerated development.

- An interdisciplinary project team training,
- defining goals and framework,
- selection of focus area,
- definition of local goals and measurement criteria,
- ensuring high quality planning and implementation of local activities.
Focus 3: Working group

Setting up working groups as needed:

1) Participants identified by the management.
2) Ideal if the participants are those who have detailed knowledge and ownership of processes.
3) Participants must be willing to:
   - Contribute with their expertise and experience.
   - Listen to and evaluate the contributions from others.
   - Be honest and constructive.
   - Commitment to deliver selected contributions between the meetings/workshops.
Focus 4: Employee involvement

Focus on a systematic collection, prioritizing and delegation of ideas for the development of daily operations.

'Who does what and when' in relation to ideas for improvements that can be implemented within 1-3 weeks (tasks) and 1-3 months (projects).
The relation between people

- Acknowledge your experience
- Put yourself in the other’s place
- Trust your senses
- Become aware of position of power
- Cultivate the informal relationships

The best solutions are created together – not individually!
Focus 5. Facts

Focus on the individual surgical teams setting goals / measurement criteria and that these are used proactively. This promotes a fact-based development of operations.
Diagram 2: Operationer m/ anæstesi fordelt over ugen og dagen

<table>
<thead>
<tr>
<th>Operationer</th>
<th>Anæstesi</th>
<th>Operationer</th>
<th>Anæstesi</th>
<th>Operationer</th>
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<td></td>
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<td>00:05</td>
<td></td>
<td>00:04</td>
<td></td>
<td>00:16</td>
</tr>
</tbody>
</table>

**Fokus 6: Visualisering**
Der sættes fokus på, hvordan aktiviteten på stuerne kan visualiseres, så den forrige, igangværende og efterfølgende arbejdsproces kan være på forkant med udviklingen i dagsprogrammet. Denne fase vil fremme en proaktiv adfærd, så kvalitets-, sikkerheds og driftsmæssige risici kan minimeres i takt med, at de opstår.

Kilde: OUH, Afdeling D, Lean-gruppen
Distribution of patients during the week
Outpatient activity 2009

- Number of patients
- Week
- UCL = 325.8
- $\bar{x} = 201.5$
- LCL = 77.1

Odense Universitetshospital
Svendborg Sygehus

Region Syddanmark
Focus 6. Organised theatre – 5S

Focus on the arrangement of the operating theatres so they better support the working processes that take place in the operating theatres. This will reduce the waste, which occurs when equipment and consumables are not in the right place.
Focus 7. Visibility

Focus on how the activity of the theatres are made visible, so that the previous, current and subsequent working process is at the forefront of today's program. This promotes a proactive behaviour so that quality, safety and operational risks can be minimized as they arise.
Visible management

Are we really doing, what we think we did?
Are we doing what we have agreed?
Visibility on quality
Do we know the output? What kind of objectives do we call attention to? How do we succeed? How do we improve? Who does it, how to do it?

The staff and the head of department succeed in this task by working together.
Focus 8. Planning

Focus on the critical elements in planning processes. Invite those directly involved to:

– Improve the flow of information
– Ensure execution of each process on time
– Reduce errors and delays
– Eliminate unnecessary repetitions
Planning
"Every system is perfectly designed to achieve the result it gets"

If capacity > demand
...then waiting list = 0
If capacity < demand
...then waiting list = carve out
If capacity = demand ... then waiting list > 0

Why?
Because capacity is set at the average demand and do not pay attention to it’s variance.
Example
Erlang C formula

The Erlang C formula also assumes an infinite population of sources, which jointly offer traffic of $A$ Erlangs to $N$ servers. However, if all the servers are busy when a request arrives from a source, the request is queued. An unlimited number of requests may be held in the queue in this way simultaneously. This formula calculates the probability of queuing offered traffic, assuming that blocked calls stay in the system until they can be handled. This formula is used to determine the number of agents or customer service representatives needed to staff a call centre, for a specified desired probability of queuing.

$$P_W = \frac{\sum_{i=0}^{N-1} \frac{A^i}{i!} + \frac{A^N}{N!} \frac{N}{N-A}}{\frac{A^N}{N!} \frac{N}{N-A}}$$

where:

- $A$ is the total traffic offered in units of Erlangs
- $N$ is the number of servers
- $P_W$ is the probability that a customer has to wait for service

It is assumed that the call arrivals can be modeled by a Poisson process and that call holding times are described by a negative exponential distribution.
The closer to 100% Capacity utilisation, the higher probability for waiting lists …as well as errors, stress and ineffectiveness.
Focus 9. Consumables and Equipment

Focus on stocks of commodities and equipment:

- How big stocks are needed and how often should be reordered?
- What kind of warehouse and replenishment systems are there?
Focus 10. Culture

Focus on interdisciplinary teamwork in the operating theatres.

Conducted training in lean and "the human dimension", including cultural awareness, change management, conflict management and communication.
Focus 11: Preparation

Focus on preparing patients for surgery including information, documents and activities that must happen in the operating theatre to 'drag' the next patient to surgery without delay and in 'flow'.

![Consequence of ready or not](chart.png)
Focus 12: Start-up

Focus on starting-up the operation:

– What is needed in order to standardize the process and make it repeatable?

– The goal is to ensure that any job is started in the right way and at the right time, minimizing rework and delays.
Focus 13: Training

Focus on what training is needed to ensure flow and optimum skills development.
Focus 14: Turnaround

Focus on replacement of patients in the operating theatre:

- Where begins and where ends the process?
- What elements includes the process?
- Which sub-processes must take place in the operating theatre and what can be done outside?
Focus 15: Shift of responsibility

Focus on a safe and efficient transfer of patients from one function to another.

By this the patient safety is promoted, 'right the first time' and 'reworking' is minimized.
Focus 16: Recovery

Focus on recovery process, including information flow and activities that must take place to transfer a patient from operating theatre to recovery rooms safely, efficiently and without delays.
7 wastes in different sectors, businesses, what can we learn and share
1. Over-production

Industry - factory

Health care - hospital
2. Waiting

Industry - factory

Health care - hospital
3. Internal transport

Industry - factory

Health care - hospital
4. Over-processing

Industry - factory

Health care - hospital
5. Stock

Industry - factory

Health care - hospital
6. Unnecessary movements

Industry - factory

Health care - hospital
7. Scrap and failures

Industry - factory

Health care - hospital