

4th Nordic meeting of Managers of
Clinical Engineering Departments in University Hospitals,
Helsinki 12.5.2003

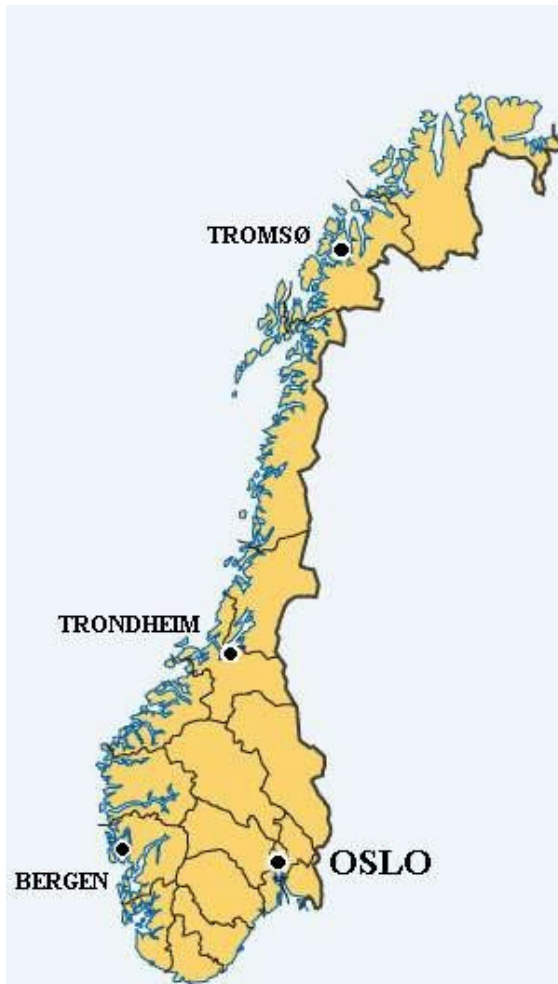
Economic indicators for a Clinical Engineering Department (...or actually CES- C.E. Services...)

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My lecture addresses:

- Presentation of some key figures from Rikshospitalet University Hospital Clinical Engineering Department – CED, and CES (services)
- Results from a recent regional study of the CES cost in Norway's Health Region South (“Helse Sør”)
- Some points of issue concerning the efficiency of services in an “acute & immediate response” environment



Recently in Norway:

Responsibility for all Norwegian hospitals transferred to the Government 1 January 2002.

- Ownership of the hospitals is transferred to the Government sector, thereby placing responsibility with one owner.
- The hospitals are organised as enterprises. This means that they will be separate legal subjects and will thus not be an integral part of the central government administration.

5 University Hospitals (2 in Oslo), within

5 Regional Health Enterprises

Rikshospitalet is the main hospital in Health Region South (1/4 of Norwegian population lives in the region), with substantial national responsibilities



Rikshospitalet

Universitetsklinikk

Specialities: National responsibility for organ transplantation and children heart surgery. Neurosurgery, basic medical research, R&D new medical methods.

Academic medical education, University of Oslo

40% of patients are children



Clinical Engineering Department Rikshospitalet



31+ engineers, technicians, researchers

Process-oriented organisation according to ISO9001-2000 and Nordmedteks recommendation "Good Clinical Engineering Practice"

13.000+ records, NKKN version of GMDN - Global Medical Devices Nomenclature, Meridá inventory database system (Haukeland University Hospital)

Annually 6000 "jobs" registered - service or preventive maintenance

Procurement process 2001: 64 mill NOK

The screenshot shows a software window titled "MÉRIDA - Meny". It contains a complex form with various fields for data entry, including patient information, equipment details, and administrative data. The form is organized into several sections with labels in Norwegian.

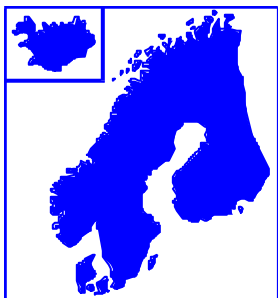


MÉRIDA
Systemet for TotalLogistikk i helsesektoren

Management of the CED and Medical technology management

There are three essential targets to hit and control in order to achieve a cost-effective, efficient and safe use of medical devices:

- Safety issues
- Quality systems, organisation and competence
- Economy



NORDMEDTEK

NORDIC CO-OPERATIVE GROUP FOR
MEDICAL TECHNOLOGY

NORDIC GUIDELINES FOR GOOD CLINICAL ENGINEERING PRACTICE

Version 4, June 2002
Complies with ISO 9001-2000

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NORDIC GUIDELINES GCEP MAIN PROCESSES FOR CLINICAL ENGINEERING PRACTICE

The main processes are designed to satisfy the demands from the main CED customer(s). The processes are divided into different activities designed to improve the medical services. The main processes are parts of the infrastructure for successful use of medical devices in diagnoses, treatment and care. They are:

1. Strategic planning
2. Procurement
3. Device management and support in clinical use
4. Disposal of medical devices
5. Knowledge management
6. Research and development of medical devices



To perform safety assessments and inspection, preventive maintenance and documentation is a costly process that not can be compromised in the management of medical equipment. In an “enterprised model” of running business, where the “customer” is invoiced in some kind of transfer pricing system, the associated services must be basic, i.e. they can not be voluntary “to buy”. A “flow of cost” is initiated by the procurement of the equipment, and in the keeping of a defined safety standard – even if the equipment is not used.

Thus, the cost of providing CES must comply all aspects of the service, not only the maintenance cost.

Why establish indicators on CED/CES?

Organisation of hospitals as enterprises since 01.01.2002

- Laws on accounting and taxation, initial balance, capital depreciation
- We are experiencing very tight budgets - especially in investments – reorganisation of internal services and merging of hospitals and functions
- Extreme focus on the economic side of health care, even if the owner (The Government) states that the balanced scorecard thinking shall be in focus.

”Recipe 2006”: Transformation strategy for HR South

- Strategies for restructuring and emphasis in the period 2003 - 2006
- Strong search for areas of improved profitability
- Increased focus on cost-benefit analysis
- Data describing economic parameters is being demanded
- ”All means are allowed”: Outsourcing, merging, cooperation, standardisation, efficiency improvement, scale advantage, increased productivity – to decrease the cost!

Benchmarking, comparison of services

CED/CES indicators, some proposals in relevant areas

- Medical devices population vs. value:
 - Equipment categories*, procurement cost, number, mean age, age spectrum
- Clinical engineering services vs. cost:
 - CED budget (total, maintenance, staff, other)
 - CES budget in other departments
 - Extraordinary grants
- CED staff:
 - No. of employees per category**
 - Staff budget per category**
 - Man-labour year per category**

*: according to an agreed definition.

**: e.g.: management, maintenance, R&D, procurement, teaching, mechanical engineering



Device population lifetime in equipment categories

(Data from a comparison study by Jensen, 2001 as a basis for the official initial balance of Norwegian hospitals).

Comment: This categorization was made for a specific purpose, and needs to be revised and refined (esp. "Unspecified" - e.g. Dialysis equip. is in this group, but have a projected life span of 4 - 7 years).

Depreciation and estimated lifetime Medical equipment Nordic datasets for estimated lifetime

	RH Health Region II (N)-1	Huddinge AB (SE)-2	Landspítali (IS)-3	Landspítali (IS)-3	Landsting Föreningen (SE)-4	Norwegian official Initial balance
Reference year	1998	?	1998	2001	2000	2002
Radiological equipment	10	7			7	10
Endoscopic equipment	4	5				4
Ultrasound, imaging equip.	7	5			7	7
Analysis and lab.equipment	9	5	7 (10)	5 (7)		9
ECG/Intensive care equipment	8	5			7	8
Unspecified Med. Equipment	11	5				11
Surgical instruments	15					15
Radiation therapy equipment	12					12

References

- 1-RH Health Region II, 1998, Norway: Det regionale helseutvalg II, 4.2.1998 (in Norwegian)
- 2-Huddinge AB, Sweden: Data from enterprise initial balance due to Price Waterhouse Coopers.
- 3-Landspítali, 1998, Iceland: Initial opening balance of enterprise Landspítali. From Gisli Georgsson.
- 4-Landstingförbundet, Sweden 2000: Depreciation for counties and regions, from Nils-Gunnar Holmer

Medical devices population RH

Data base dump 29.04.2002

Accumulated procurement cost, incl. UiO, no index

Year	No	Cost (eks. VAT)	Incl. VAT
1955	1	12 500	15 500
1955	1	8 333	10 333
1960	7	66 825	82 863
1962	2	67 624	83 854
1965	10	477 662	592 301
1966	1	10 333	12 813
1967	1	10 000	12 400
1968	13	260 173	322 615
1969	7	76 041	94 291
1970	52	460 927	571 549
1971	9	186 569	231 346
1972	17	453 481	562 316
1973	11	100 101	124 125
1974	12	108 164	134 123
1975	33	374 381	464 232
1976	18	277 856	344 541
1977	52	547 507	678 909
1978	49	1 343 429	1 665 852
1979	32	521 472	646 625
1980	129	2 457 422	3 047 203
1981	33	984 019	1 220 184
1982	37	751 115	931 383
1983	71	1 901 262	2 357 565
1984	94	5 229 809	6 484 963
1985	266	6 002 484	7 443 080
1986	166	5 577 875	6 916 565
1987	157	7 220 782	8 953 770
1988	215	7 356 921	9 122 582

Medical devices population vs. value

Key points Rikshospitalet data set:

- New hospital finished in year 2000
- Accumulated procurement cost is presented, with no indexing or calculation of reinvestment cost
- Age spectrum is spread, with top in year 1999

Accumulated procurement cost, incl. UiO, no index			
1989	254	12 550 809	15 563 003
1990	454	12 880 190	15 971 436
1991	247	11 849 380	14 693 231
1992	355	19 578 048	24 276 780
1993	412	17 555 707	21 769 077
1994	392	23 519 687	29 164 412
1995	631	25 251 298	31 311 610
1996	630	68 189 776	84 555 322
1997	604	27 394 389	33 969 042
1998	1535	90 816 435	112 612 379
1999	4030	283 105 921	351 051 342
2000	1651	82 243 213	101 981 584
2001	648	31 821 759	39 458 981
2002	81	4 436 675	5 501 477
	Total (NOK):	754 038 354	935 007 559



Cost of Clinical Engineering Services RH (2002)

Applied on the 13.000+ population of Rikshospitalets medical equipment inventory register, the key figures are:

- Accumulated procurement cost: 935 mill NOK
- Capital depreciation cost in 2002: 95 mill NOK

Running cost of all RH CED processes (incl. preventive maintenance based on manufacturers spec or deviations based on internal risk assessment, subcontracted maintenance and unexpected breakdown, R&D and procurement): 28 mill NOK
Subcontracted PM on radiological equipment: 15 mill NOK

⇒ Total cost of running all CED processes and maintaining all medical equipment at Rikshospitalet: 43 mill NOK

CES benchmarking. Results from a study i HR South 2002

- Example data collection form (in Norwegian):

[Datainnsamlingskjema](#)

- Report (in Norwegian): "*Økonomiske indikatorer innenfor fagområdet medisinsk-teknikk i år 2002*" – "*Economic indicators for Clinical engineering services 2002*".
 - Authors Øystein Jensen & Trond Strømme.
 - Basic data collection as a cooperation among the 9 largest hospitals in the region.

[Vedlegg 3 Prosjektrapport P3.doc](#)

Summary of findings

Value MDevices in Region South	Accumulated procurement cost (incl VAT)	Calc. Reinvestment cost (incl. VAT.) [1]
(2002-data)	2,62 bill. NOK	3,81 bill NOK

[\[1\]](#) Calculated reinvestment cost

Calculated reinvestment cost of MD has in Norway for many years been calculated according to a "Rikshospitalet/Haukeland"-model. This is an algorithm that increase the calculated cost by a price index 7,2% per year up to age 10 years, and afterwards keep the reinvestment cost constant. The model was proved to be reasonably correct on data sets from the 1980's. A comparison on newer data sets form the 1990's show a definitely lower price increase on actual equipment, typ. < 3% per year. All data presented in the report is accumulated procurement cost (historic value), with no price indexing.

Calculated reinvestment cost algorithm

Based on data from 1975 – 1990, the **Rikshospitalet/Haukeland (RH/HUH) index model** predicts the reinvestment cost:

Reinvestment cost: C_{re}

Actual procurement cost for a device: C_o

Age, whole years: Y

$$C_{re} = C_o \cdot (1,072)^Y; Y = 0 \dots 10$$

$$C_{re} = 2 C_o; Y > 10$$

i.e. the annual growth of cost is 7,2% to ten years,
then constant eq. doubled procurement cost

Key data summary - 1

Clinical Engineering Services HR South: (2002-data)

Total budget: 104,3 mill NOK

- PM and clinical support: 70,7 mill NOK
- Staff: 33,6 mill NOK (80 man-years)

Indicator 1 economy:

**Tot. Budget divided by accumulated
procurement cost of MD**

4,0% (variation 3,5% – 4,9%)

Indicator 2 economy:

**Externally supplied services and PM
subcontracting**

76,0% (variation 71% - 82%)

Key data summary - 2

Comparison external: Airline industry

SAS: Airplanes 45 bill SEK, maintenance 5,5 bill SEK 12%

Braathens: Airplanes 5,2 bill NOK, maintenance 0,5 bill NOK 10%

Comparisen internal CED and external: MD vendors and representatives

Cost per hour CED: 620 NOK/h (40% overhead, 50% invoicable time, excl. rent of space)

Vendors typ: 1100 – 1500 NOK/h

Cost of total subcontracted PM by vendor divided by the equipment value typ. approx. 10%

A recent Swedish comparison*: 20 bill SEK tot. MD value in Sweden, typ. level of service cost is 5 – 10%

* Stefan Olsson. Prioriteringsmodell för forebyggande underhåll av medicinteknisk utrustning. Department of Biomedical engineering. Lund University 2002. ISSN 1104-5841.

Key data comparison

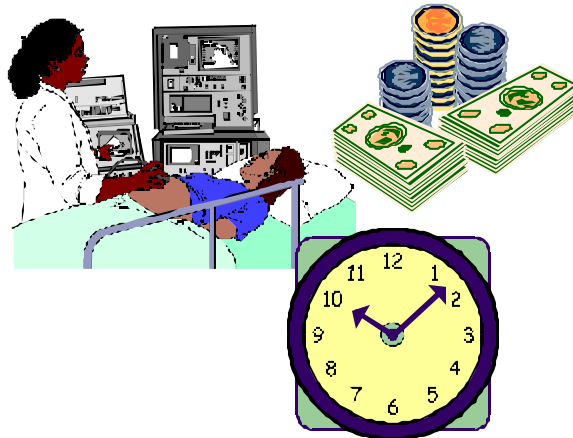
An international study performed around **1990** by Monique Frize (1) in co-operation with IFMBE (International Federation for Medical and Biological Engineering) show among several other indicators, that:

A majority of studied teaching hospitals around the world spend 3 – 5% of equipment value in the CED budget. In Nordic countries no hospitals spend more, and only 17% spend less. (A summary is presented in Bronzino (2)).

References

- Frize M. "Results of an International survey of Clinical Engineering departments. Part II: Budgets, Staffing, Resources and Financial Strategies", Med. Biol. Engin. Comput., 28:160-165, 1990.
- Bronzino J D (ed.). "Management of Medical Technology. A Primer for Clinical Engineers". ISBN 0-7506-9252-9, Butterwoth-Heinemann 1992.

A small "sigh" on efficiency and invoiceable time ...



Que-equation (external efficiency)

T_r : response time

(from call to finished job)

T_s : service time

(time to do the job)

u : utilisation

(utilised time, factor 0,0 - 1,0)

f : "time increase factor

(due to que)

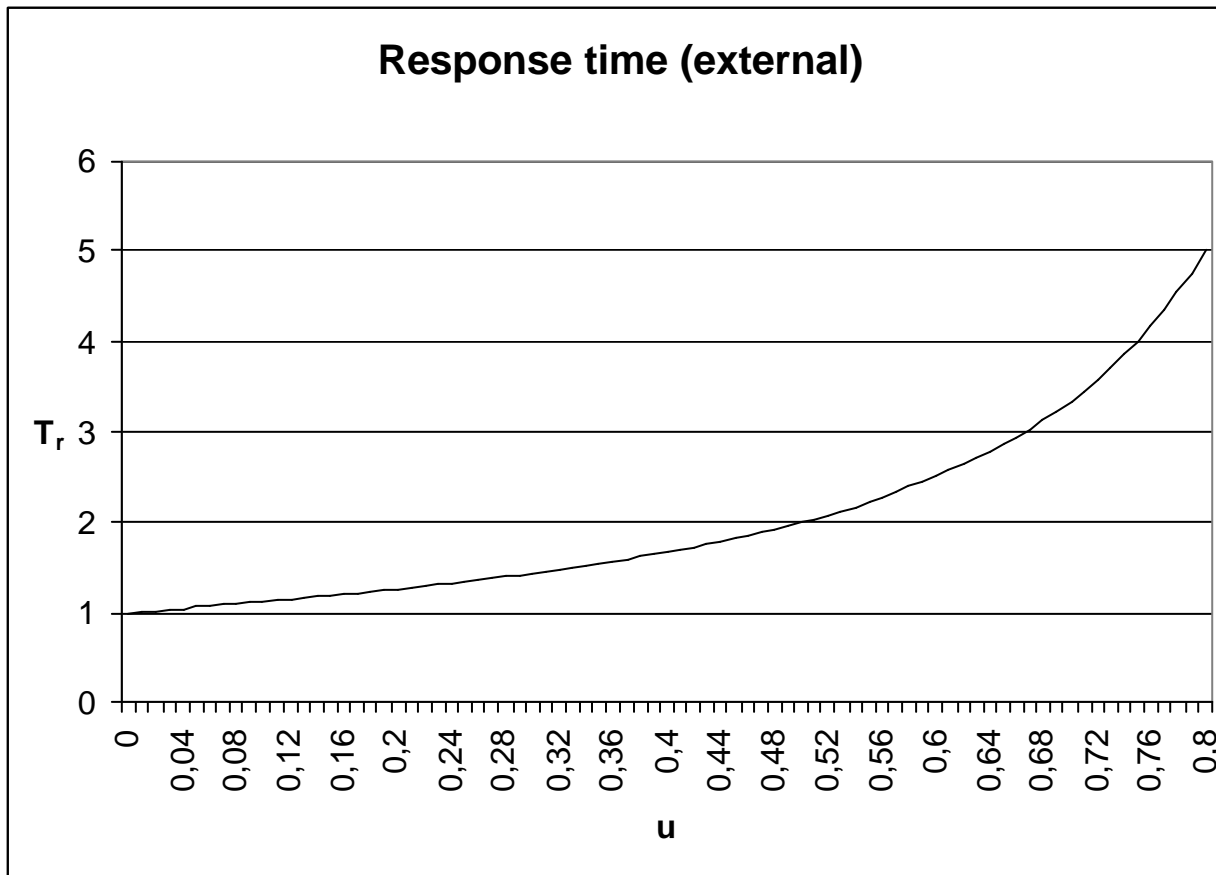
$$Tr = Ts + Ts \left(\frac{u}{1-u} \right)$$

$$Tr = Ts \left(1 + \frac{u}{1-u} \right);$$

$$f = \left(1 + \frac{u}{1-u} \right)$$

$$\Rightarrow Tr = Ts \cdot f$$

(Ref.: prof. Tore Høie, BI)

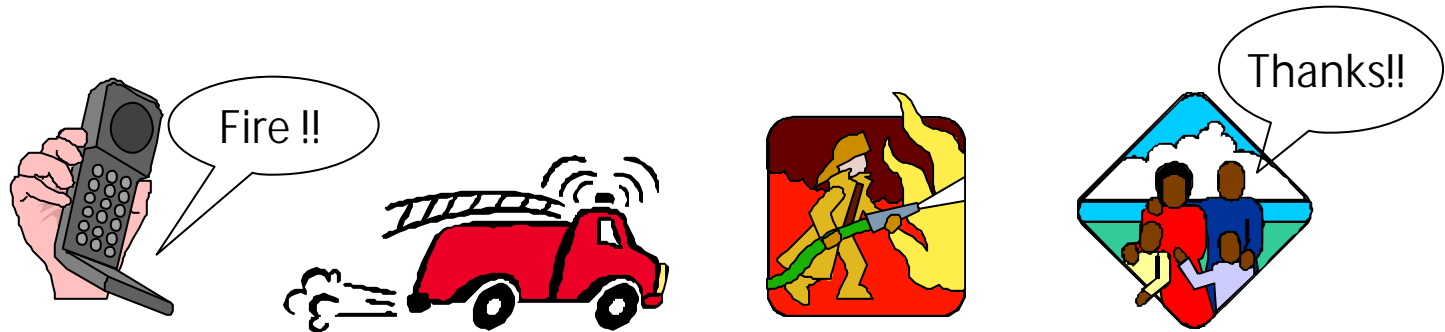


(Ref.: prof. Tore Høie, BI)



External vs. internal efficiency

- Example firestation



- External efficiency high: immediate response in acute situations
- Internal efficiency low: facilitates high external efficiency in acute situations

CED as a service provider

- Fast response to acute user demands: high external efficiency. Satisfied customers.
- The external efficiency is important to the user since it connects to the production line.
- To ensure a common view of which efficiency the user wants (and eventually will pay for), a negotiated contract (SLA, service level agreement) is necessary between the user department and the service provider.

So, how to divide the cost between the users, clinics and medical production line?

There are several unresolved problems, and different strategies.

- There is no modifier to users needs unless it cost money. Cost starts to run when equipment is acquired and kept in safe, working order during its lifetime.
- Transfer pricing is not necessarily the answer, varying amount of service may be demanded from a department or user during different periods of time (i.e. the breakdown of an expensive CT x-ray tube).
- The solution is probably a contracted Service Level Agreement between the CED and clinical department. On a cost-per-use? CED owns the equipment, and the user has a contracted number of e.g. examinations in a kind of “insurance”.

Future challenges:

The concept of the enterprised model for running a university hospital and its medical equipment is very inspiring. The capital depreciation method allows a reinvestment plan to be put in action. Though – this implies that the depreciated capital really is invested in new equipment. Many details remain, and many problems to be resolved; i.e. pricing and ownership models, but they are minute problems compared to keeping up the reinvestment in Norwegian hospitals.

It is essential to realize that a university hospital must be run with more perspectives than cost. With introduction of the recognized *Balanced Scorecard* approach, it is possible to bring into view both the financial perspective, the customer perspective, internal-business-process perspective and learning-and-growth perspective. This targets future performance of the organisation. The Norwegian Health Enterprises reform is still in its infant stage.

Acknowledgments

I appreciate my colleagues Trond Strømme, Jan Olav Høgetveit and André Nygård for profound discussions and contributions, as well as the collective contributions to the analysis of CEDs quality indicators of the NORDMEDTEK group referenced in the Nordic guidelines at the web-site.

