DATAGEDREVEN WERKEN

PROEVERIJ UTWENTE

Gréanne Leeftink

Anke Lenferink

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University of Twente

CHOIR

THT

CHOIR

Dr. Gréanne Leeftink

2009-2014: BSc en MSc Industrial Engineering and Management

2014-2017: PhD

- Integrale planning van kankerzorg

Sinds 2018: Assistant Professor Operations Management in Healthcare

- Researcher-in-residence in Isala
- Chair UT onderzoeksprogramma *Technology in Healthcare Transformations*

Objective:

$minimize \ \sum_{i \in I}(p_i * Td_i)$

Subject to:

$\sum_{j \in J_{is}} Z_{ij} = 1 \qquad \forall i, s$

$\sum_{i \in I_j} ZF_{ij} \leq UW_j \qquad \forall j$

$Z_{ij} \geq ZF_{ij} \qquad \forall i \in I_j$

$\sum_{i' \in FP_{is}} X_{i',i,s} + \sum_{j \in J_{is}} ZF_{ij} = 1 \qquad \forall i, s$

$\sum_{i' \in FS_{is}} X_{i,i',s} \leq 1 \qquad \forall i, s$

$X_{i,i',s} + X_{i',i,s} + \sum_{j \notin J_{is} \cap J_{i's}} Z_{i'j} \leq 1 \qquad \forall s, i, i' > i, (i,i') \in I_s, i'$

$Z_{i'j} \leq Z_{ij} + 1 - X_{i,i's} - X_{i',i,s} \quad \forall s, i, i' > i, (i,i') \in I_s, i' \notin NC_{is}$

$\sum_j \sum_b Q_{i,j,b} * bs_{j,b} \geq T_{i,s-1} + \sum_{j \in J_{i,s-1}} (Z_{ij} * (f_{ij} * t_{ij} + tt_{ij})) \quad \forall$

$T_{is'} \geq T_{is} + \sum_{j \in J_{is}} (Z_{ij} * (tb_j + tt_{ij})) \quad \forall i, s \in S^{batch}, s' \in ns_{is} \setminus S^{batch}$

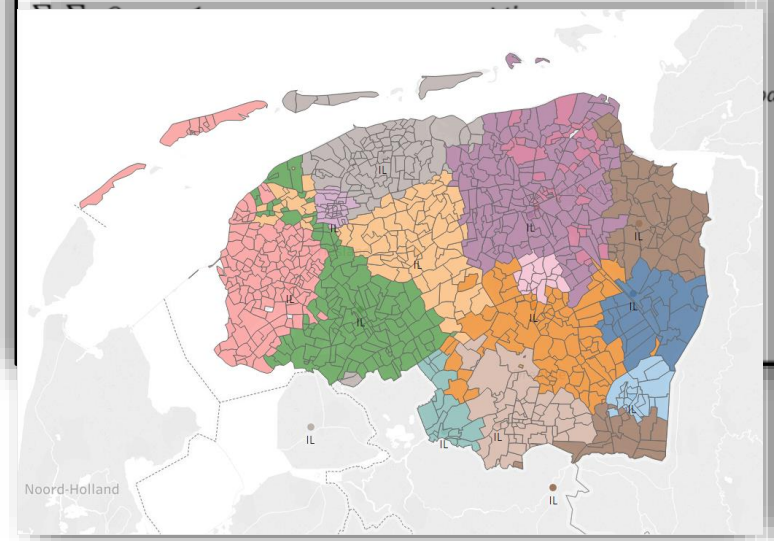
$T_{is'} \geq T_{is} + \sum_{j \in J_{is}} (Z_{ij} * (f_{ij} * t_{ij} + tt_{ij})) \quad \forall i, s \notin S^{batch}, s' \in n$

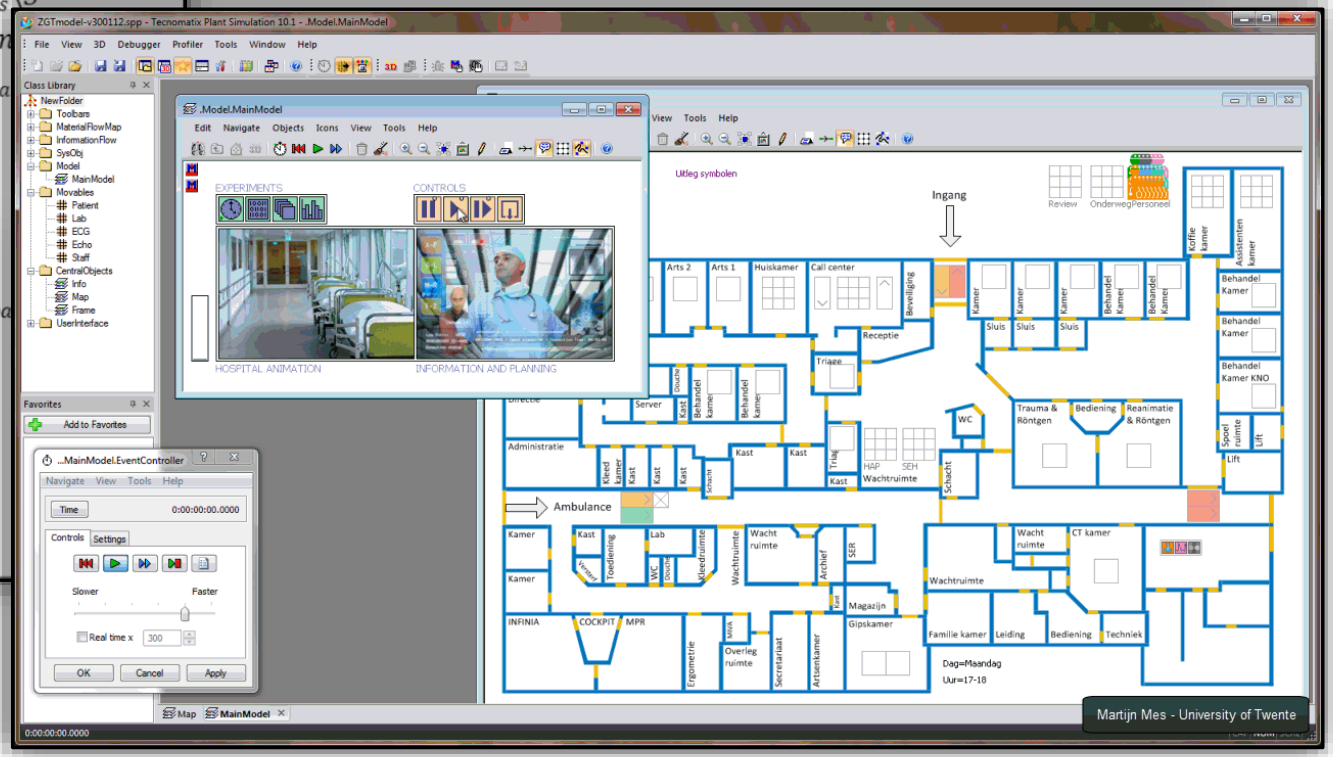
$M * \left(1 - X_{i,i',s}\right) + T_{i',s} \geq T_{is} + \sum_{j \in J_{is}} (Z_{ij} * f_{ij} * t_{ij}) \quad \forall s \notin S^{ba}$

$T_{is} \geq \sum_{j \in J_{is}} (ZF_{ij} * URT_j) \qquad \forall s, i$

$T_{i,s} \geq ORT_i \qquad \forall i, s = 1$

```
begin
  //determine if there are outpatient ORs. If so, schedule the outpatient surgeries first
  if NOT(ThereAreOutpatientORs) or (OutpatientSL.Count=0) then
     Continue; //there are no outpatient ORs or outpatient surgeries-> skip
  //fill the specialty's AuxORDays-list with ORdays for outpatient surgeries
  if Data.PatientTypeAllowedInORType(ptOutpatient, otInpatientOR)then
    ORdaySet := [otInpatientOR,otOutpatientOR]
  else
    ORdaySet := [otOutpatientOR];
  for s:=0 to Data.Specialties.Count-1 do
    Data.Specialties[s].FillAuxORdaysWithORdays(PeriodNr,-1,ORdaySet);
  SL.AddList(OutpatientSL);
end;
begin
  //fill the specialty's AuxORDays-list with ORdays for inpatient surgeries
  for s:=0 to Data.Specialties.Count-1 do
    Data.Specialties[s].FillAuxORdaysWithORdays(PeriodNr,-1,[otInpatientOR]);
  SL.AddList(InpatientSL);
end;
```





Onze website:

http://www.utwente.nl/en/choir

CHOIR

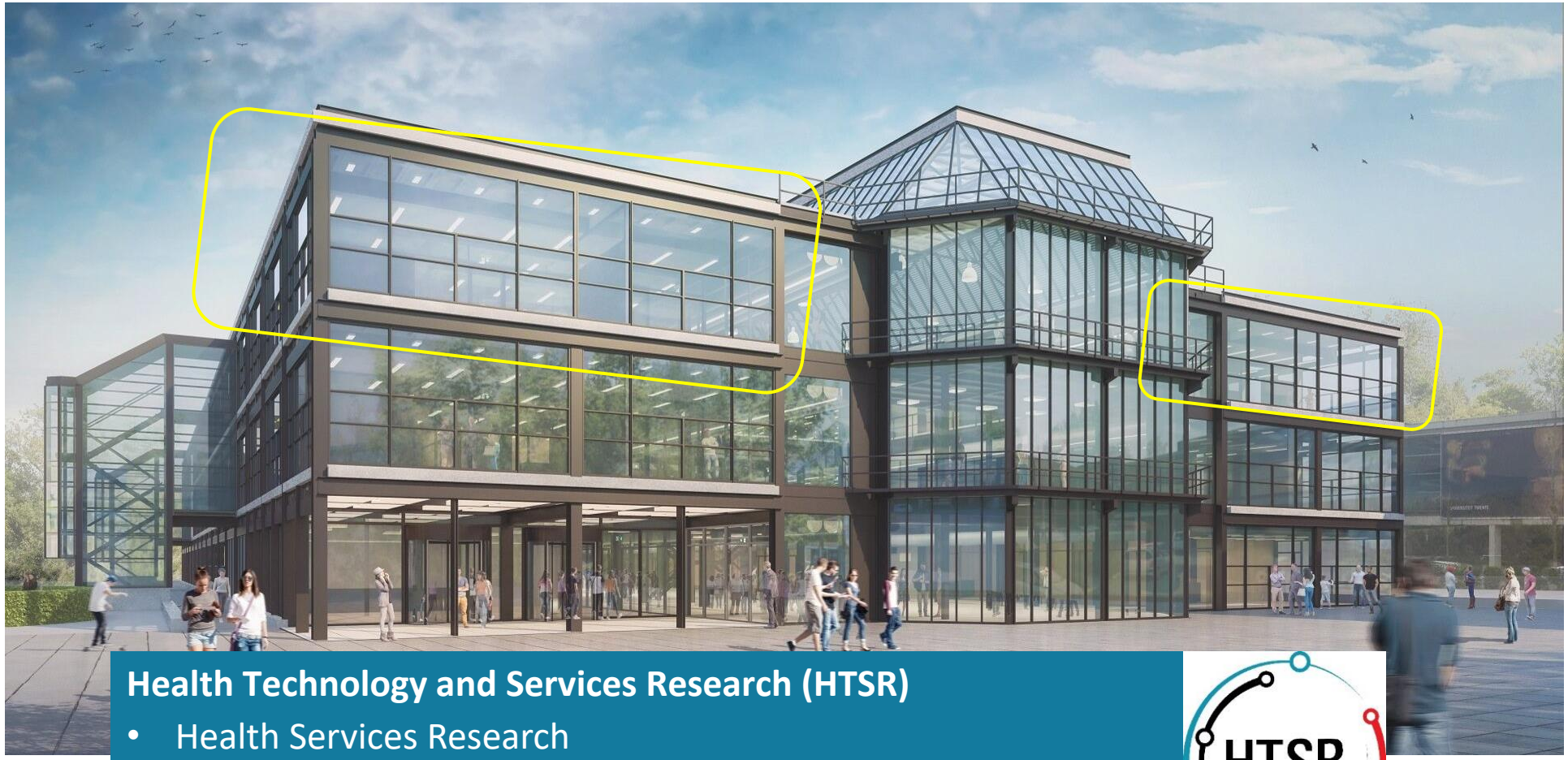
Center for Healthcare Operations Improvement and Research

Dr. Anke Lenferink

- Universitair docent & klinisch epidemioloog (2017-heden)
  - UT, Health Technology and Services Research (HTSR)
  - Chair Technology in Healthcare Transformations (THT) onderzoeksprogramma
  - Medisch Spectrum Twente, Department of Pulmonary Medicine
  - Rijnstate Hospital Arnhem, Clinical Research Centre

- Zelfmanagement interventie patiënten met COPD en comorbiditeiten (PhD 2017)
  - UT, MST, CWZ, Flinders University

- Klinisch coördinator RE-SAMPLE (2021-heden)
  - **RE**al-time data monitoring for **S**hared, **A**daptive, **M**ulti-domain and **P**ersonalised prediction and decision making for **L**ong-term pulmonary care **E**cosystems (www.re-sample.eu)
  - UT, MST



Health Technology and Services Research (HTSR)

- Health Services Research
- Health Preference Research
- Technology Assessment for Health Systems Engineering

Meer info: https://www.utwente.nl/en/bms/htsr/

TECHNOLOGY IN HEALTHCARE TRANSFORMATIONS

We need to join forces to make effective, efficient, and sustainable transformations!

HTSR

CHOIR

AGENDA

PROEVERIJ VAN ONDERZOEK RONDOM DATAGEDREVEN WERKEN

Case 1:

Virtuele zorgcentra

Case 2:

Doorstroom cliënten

Case 3:

Flexibele inzet van professionals

Case 4:

Zorg op maat - Dataverzameling

Case 5:

Zorg op maat - Data delen

Afronding:

Samenwerkingsvormen

Virtuele zorgcentra

TRANSFORMATION OF CARE

NEW STANDARD OF CARE IN ISALA: CONNECTED CARE

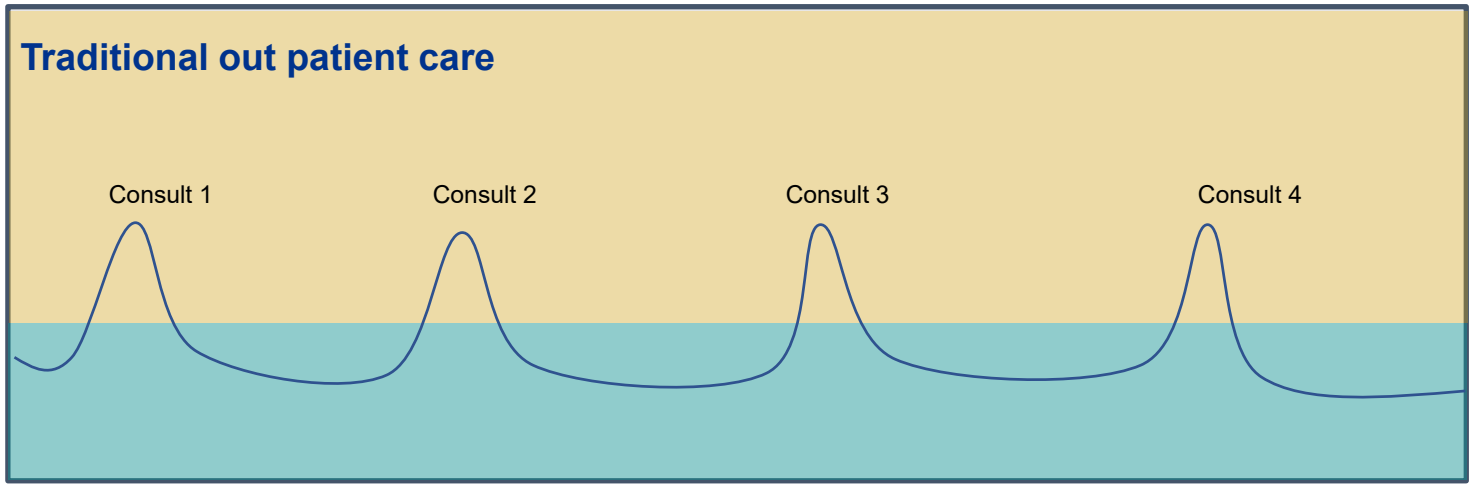
Education & Self Management

Telemonitoring

Isala@home

Mr. Johnson

Traditional out patient care



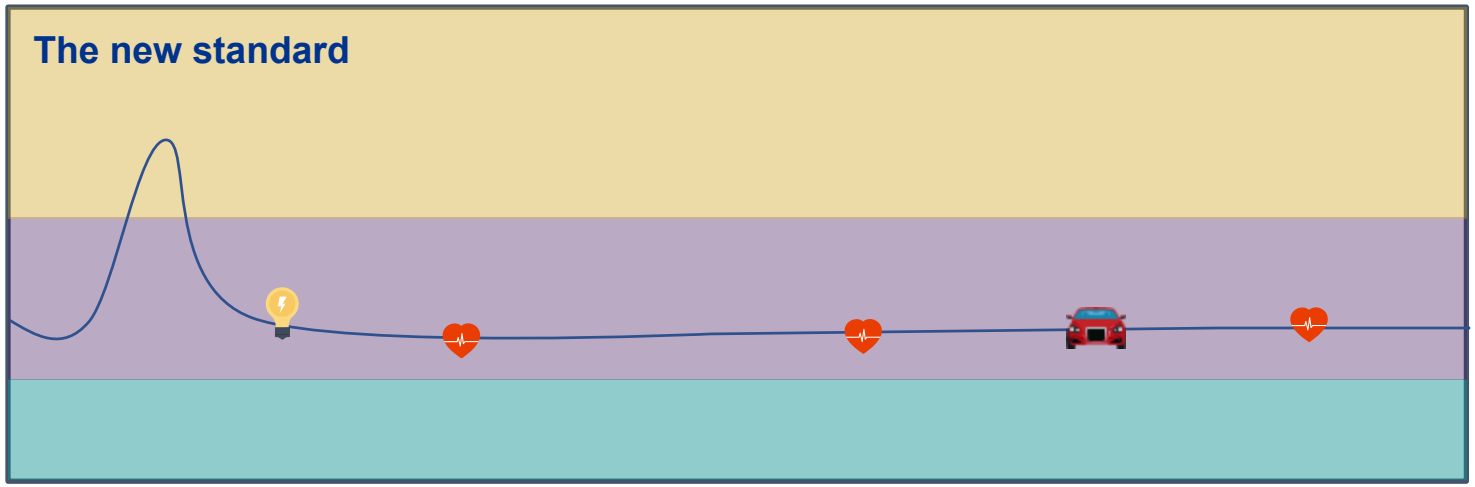
Isala

1

@home, primary care

Mr. Johnson

The new standard



Isala

Connected @home

1

@home, primary care

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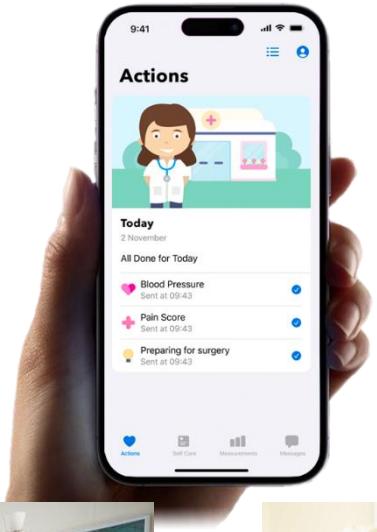
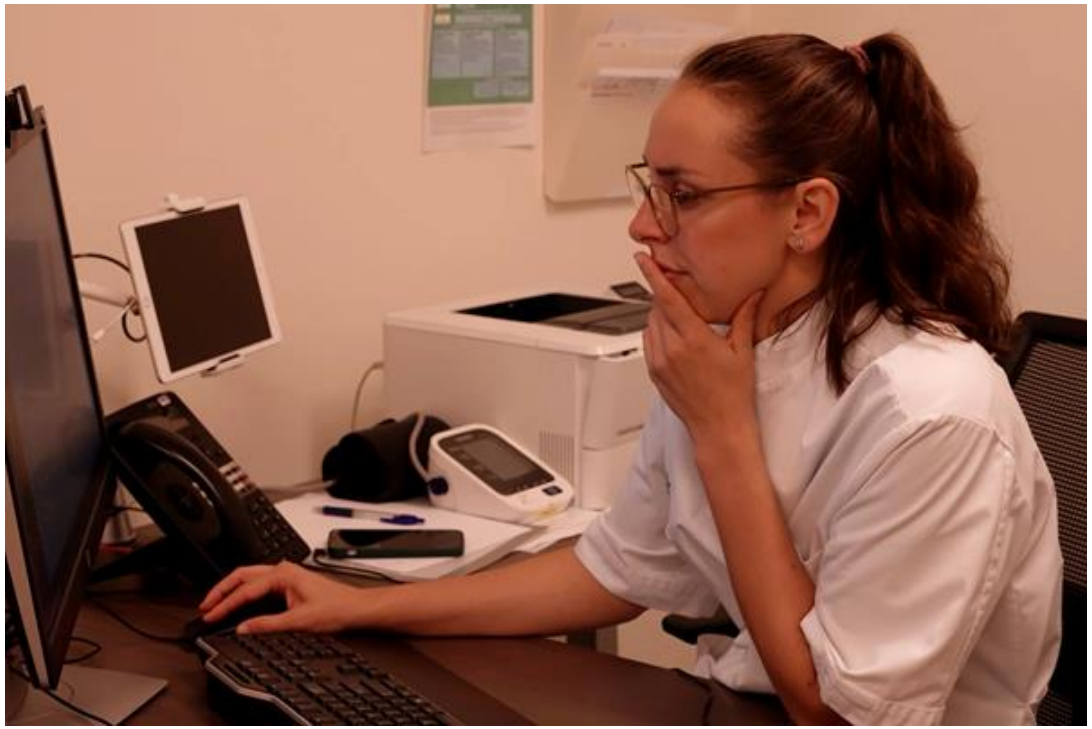
VIRTUAL CARE CENTER

REGIONAAL CONTROLECENTRUM, ZORGCENTRALE, MEDISCH COÖRDINATIE BUREAU





EXAMPLE: MONITORING CHRONIC PATIENTS TO PREVENT EXACERBATIONS

COPD&ASTMA, IBD, HARTFALEN, …

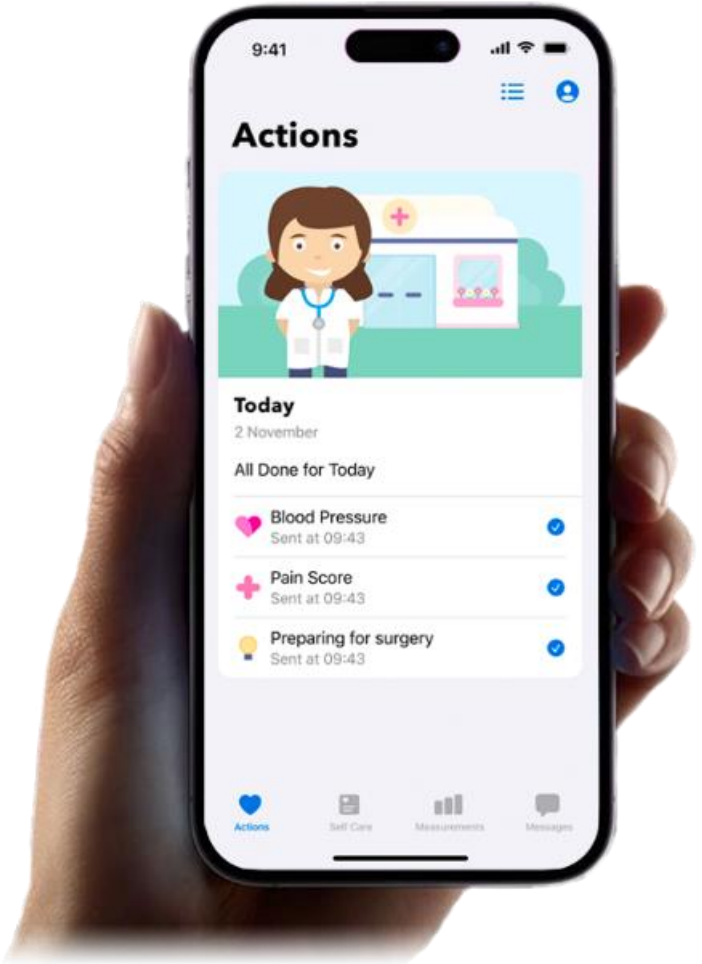
1. Patient fill out a survey every x time units + self-education lessons.

2. Application generates alerts.

3. (Specialised) nurses/physician assistants check the alerts (VCC or department specific), make decision:

- Send message to patient.
- Call patient.
- Signal medical specialist -> decide on further diagnostics, medication change, outpatient clinic visit, etc.

4. Patient visits medical specialist / specialized nurse at least x per year.

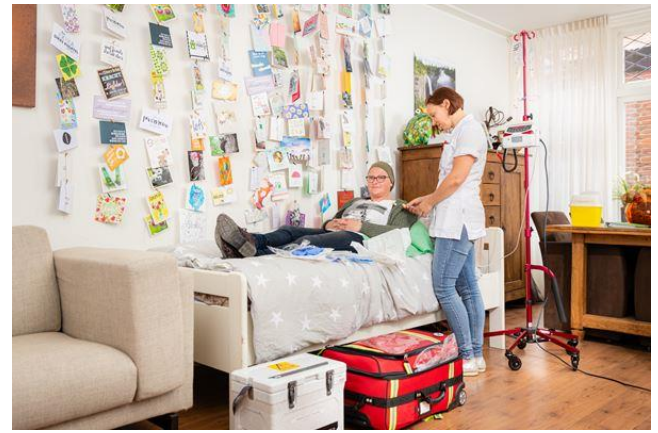


EXAMPLE: INFUSION TREATMENT @HOME/HUB

ONCOLOGY TREATMENTS (CURE WITH REGIMEN)

First 3 doses always in the main hospital.

Only for patients with treatments of <=30minutes and no toxic/dangerous drugs.



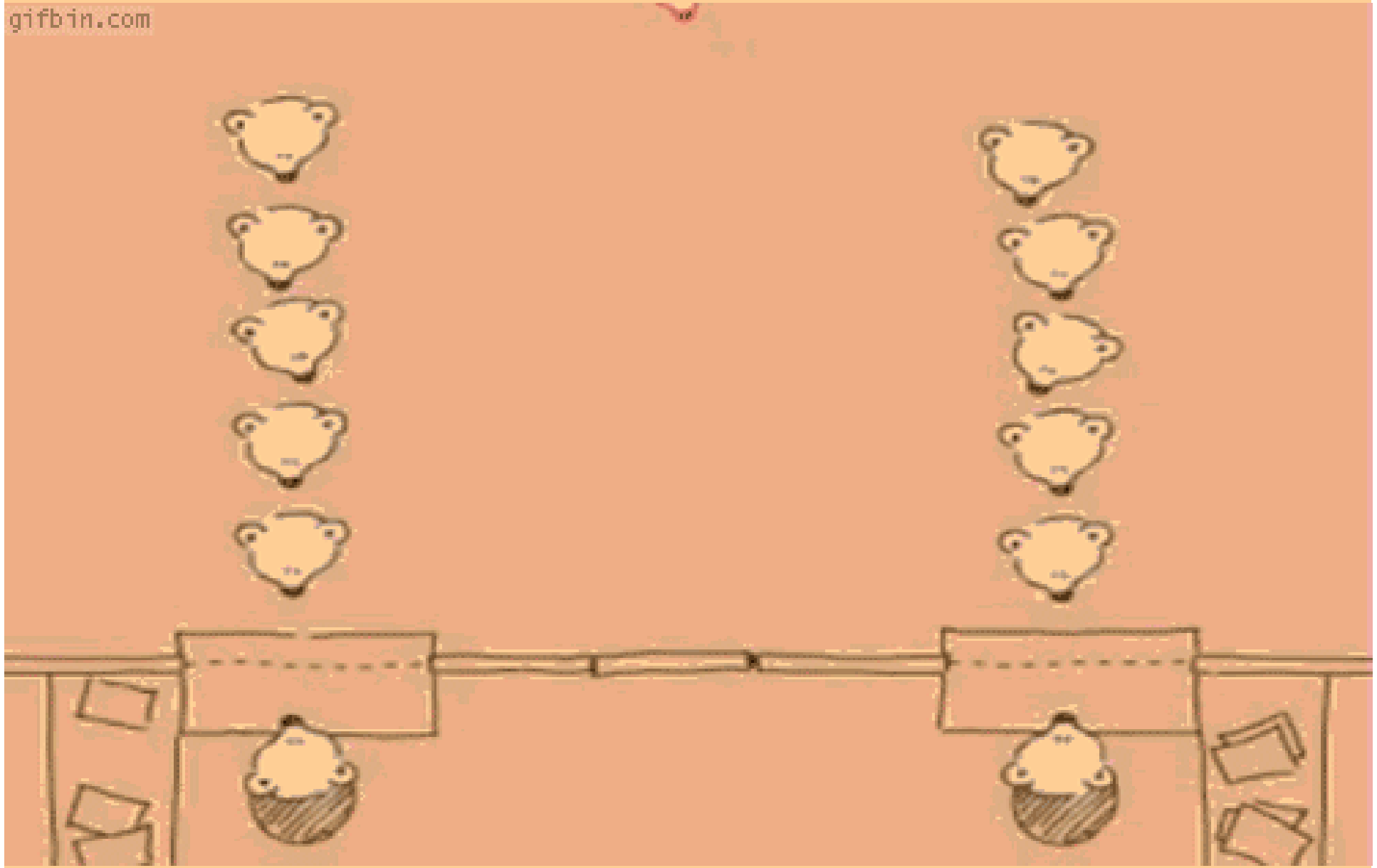
Three options:

- In main location
- In hub location
- In patient's home

ONDERZOEKSRICHTINGEN

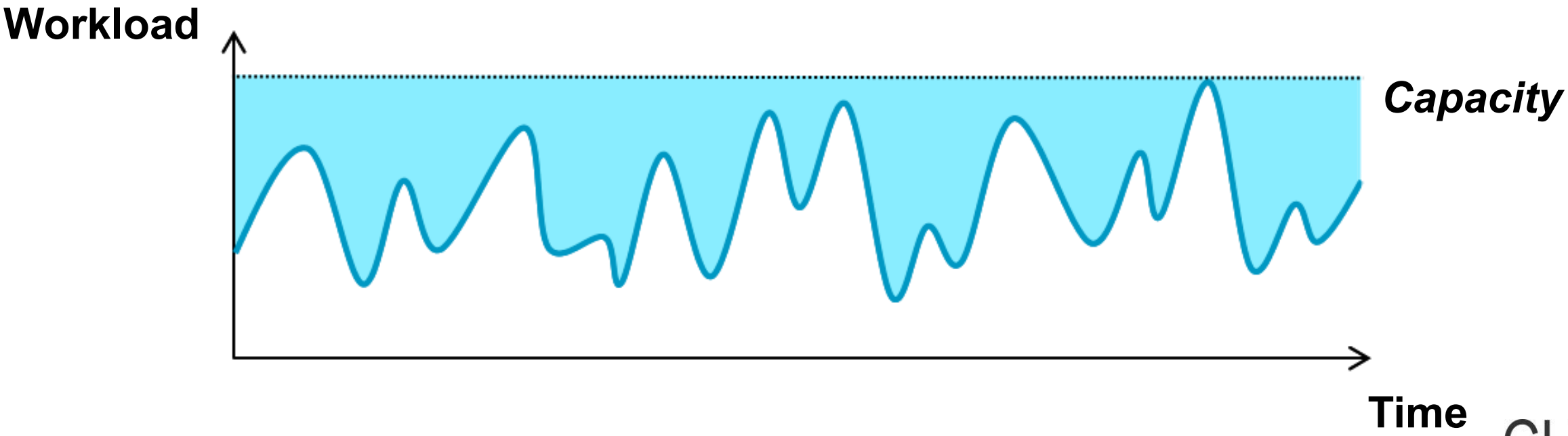
- Alarmeringen (en thresholds van de alarmeringen)
- Werkdruk van verpleegkundigen in VCCs
- Ervaringen van verpleegkundigen in VCCs
- Capaciteitsinrichting van VCC
- Planning en scheduling in VCC
- Doelmatigheidsanalyses
- Procesverbetering
- Organisatie: centraal vs decentraal, case-mix, locatie, ..
- En meer…

Doorstroom cliënten


gifbin.com

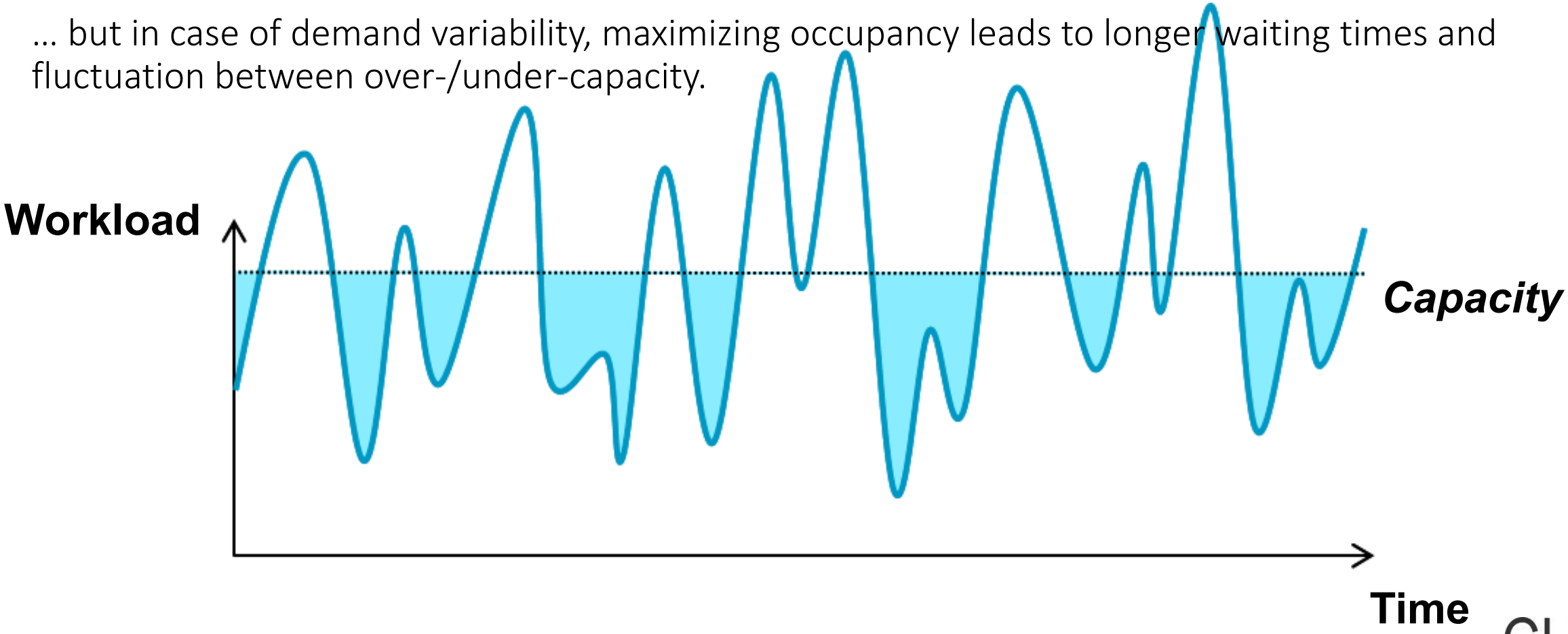
CAPACITY PLANNING AND MANAGEMENT

The goal is often to maximize occupancy/utilization...



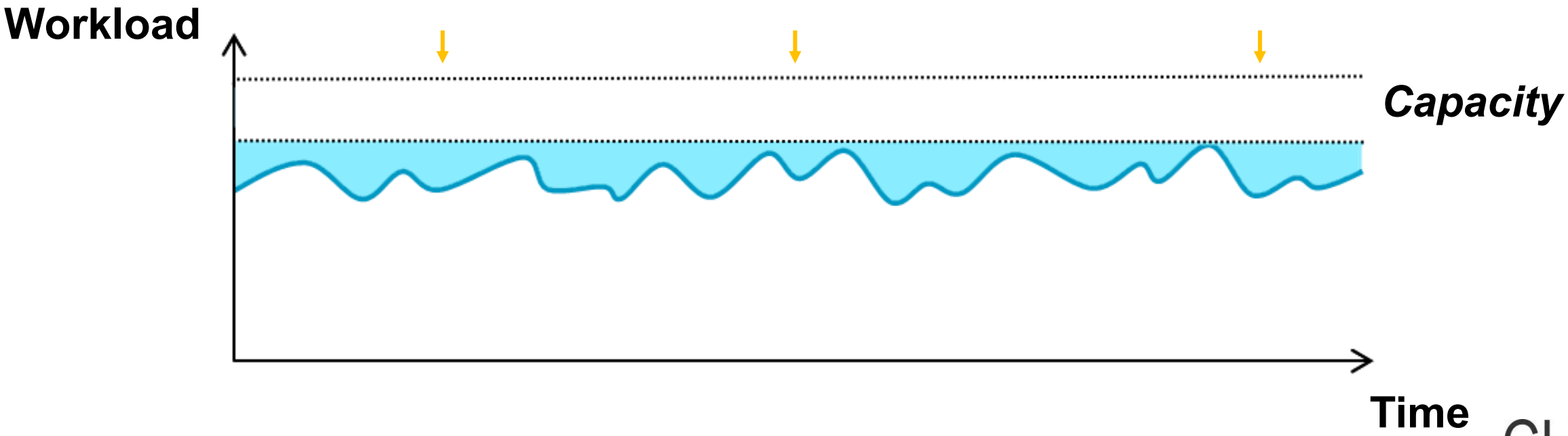
CAPACITY PLANNING AND MANAGEMENT

… but in case of demand variability, maximizing occupancy leads to longer waiting times and fluctuation between over-/under-capacity.



CAPACITY PLANNING AND MANAGEMENT

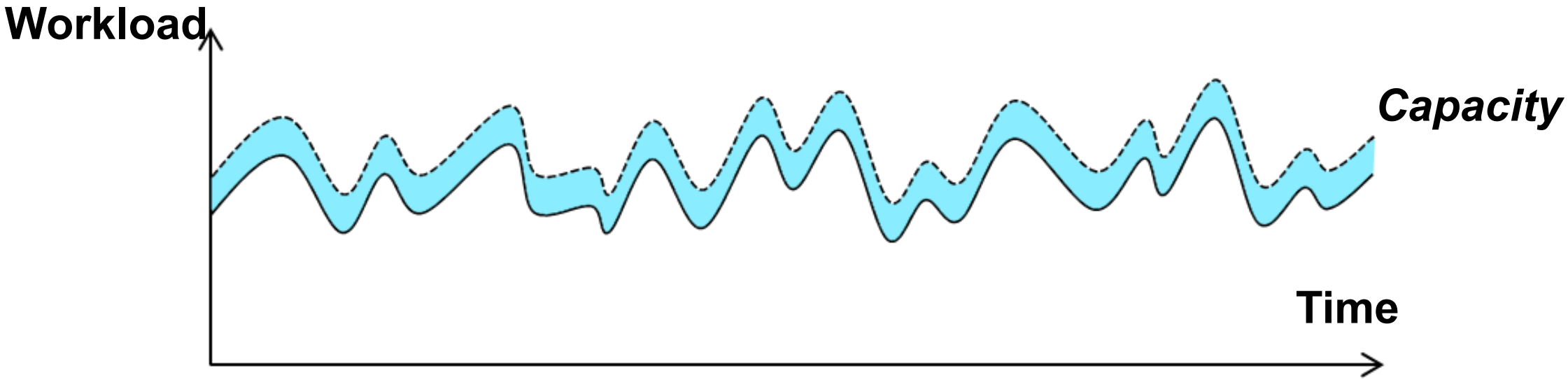
If we can manage the demand variability, we can increase occupancy with less capacity.



CAPACITY PLANNING AND MANAGEMENT

If we can not avoid variability, we can plan flexibility.

e.g. flexible personnel, block extra capacity, plan buffers, rescheduling, pooling of flexible resources



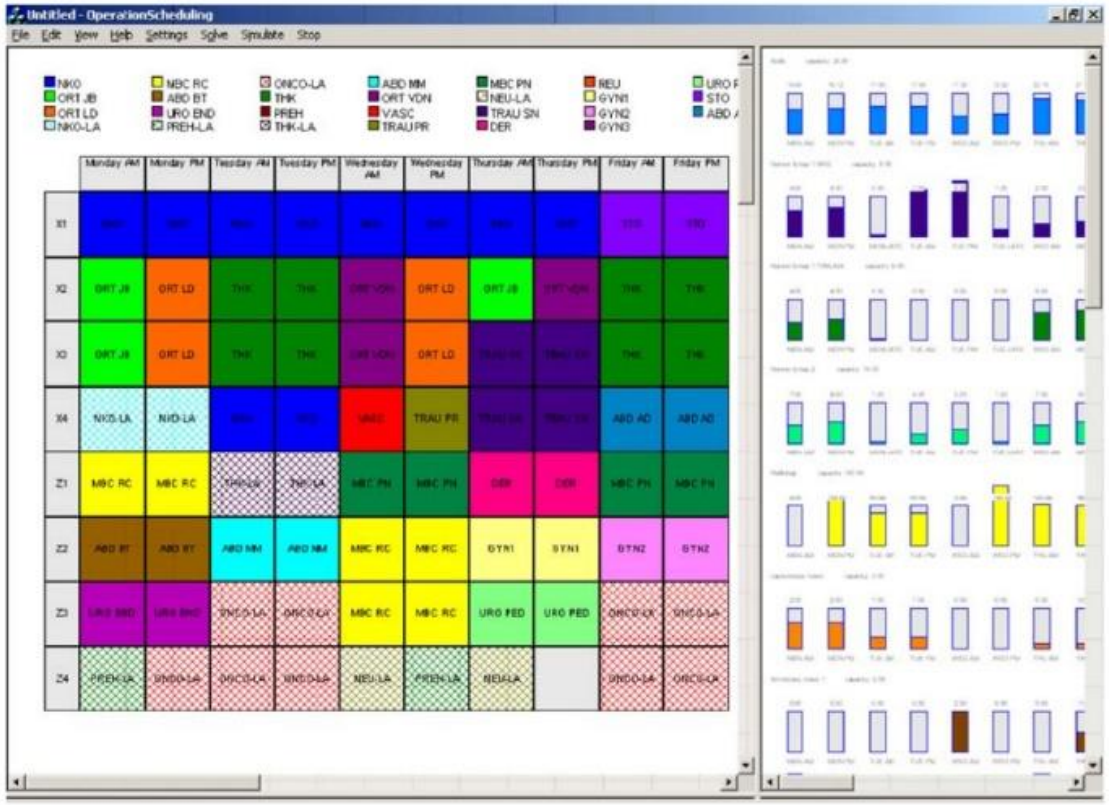
Voorbeeld 1: reduceren variabiliteit

PLANNING IS VARIABILITY MANAGEMENT!

PLANNING IS USING FLEXIBILITY TO MITIGATE VARIABILITY IN SUPPLY AND DEMAND

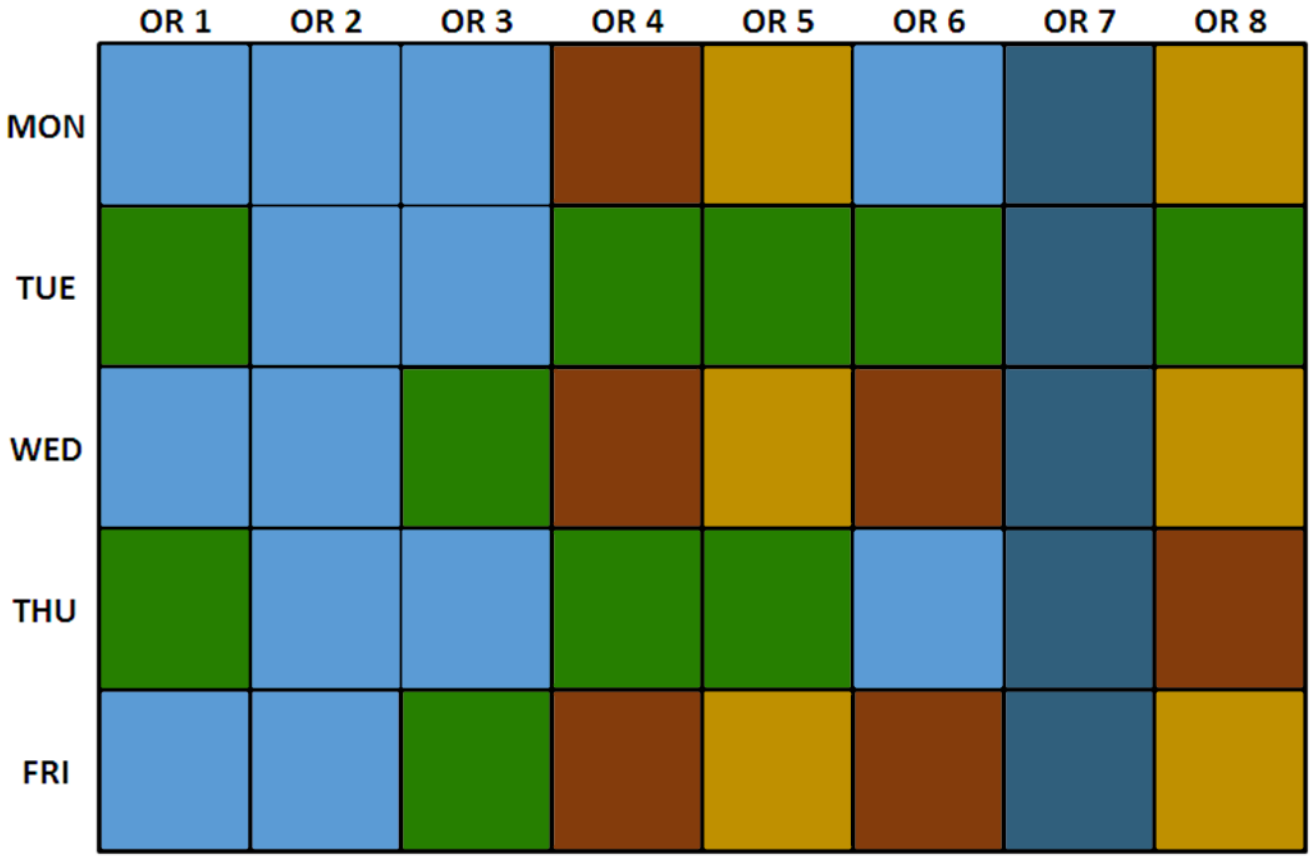
Natural variation

Artificial variation



EXAMPLE: MASTER SURGERY SCHEDULING AND IMPACT ON WARDS

A STUDY IN THE ANTONIE VAN LEEUWENHOEK HOSPITAL

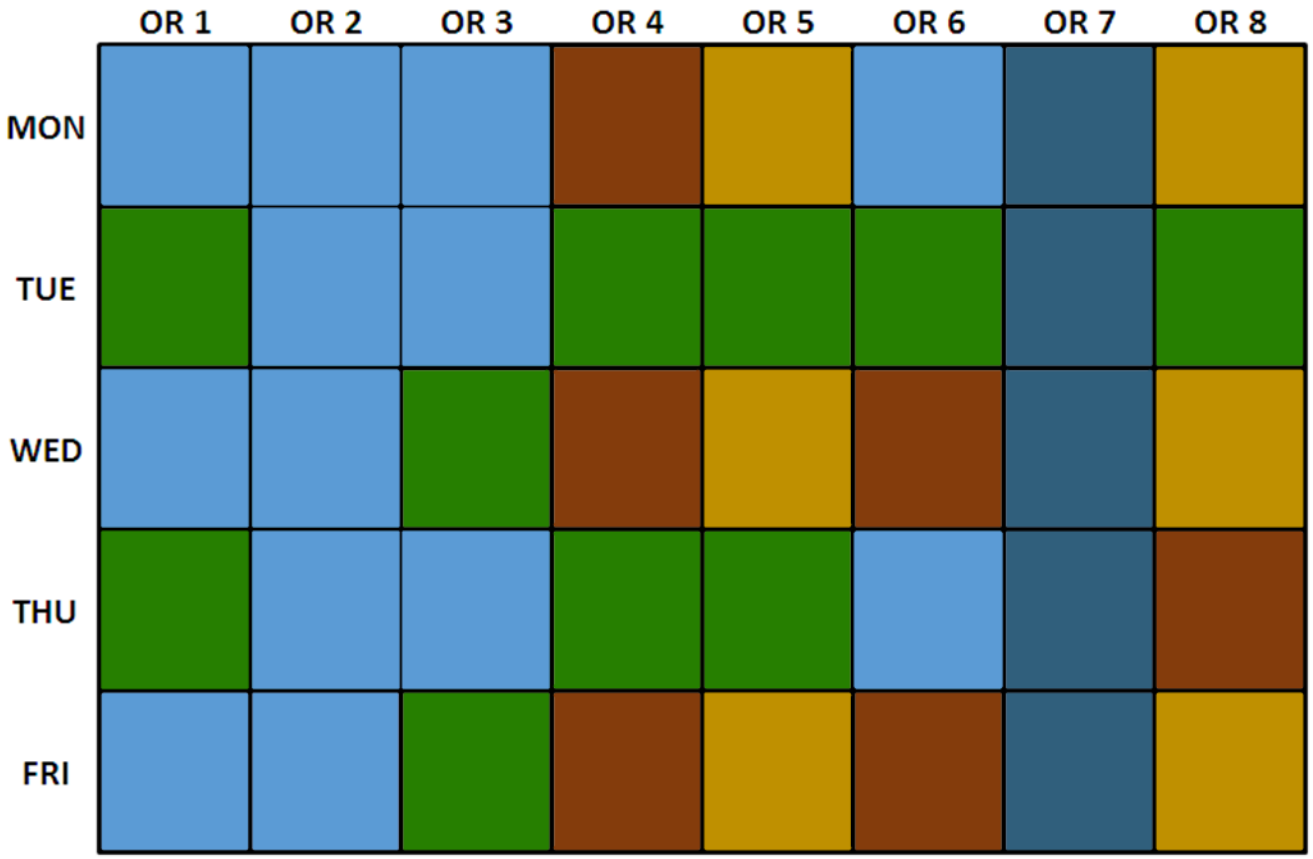


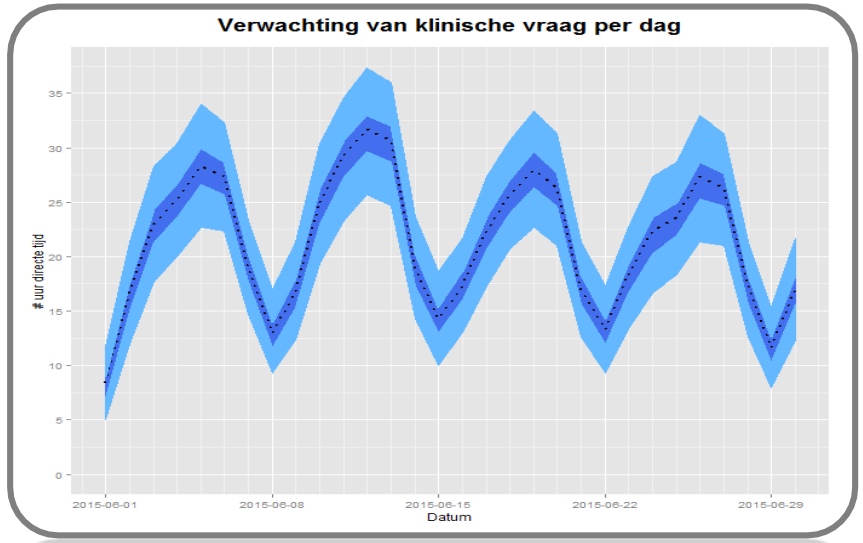
What are the odds that 1 patient will be operated? Or 2? Or 3 …?

What are the odds that a patient stays in the ward for 1 day? Or 2 days? Or 3 days …?

EXAMPLE: MASTER SURGERY SCHEDULING AND IMPACT ON WARDS

A STUDY IN THE ANTONIE VAN LEEUWENHOEK HOSPITAL



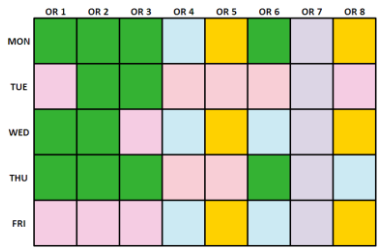


P.T. Vanberkel (2011), *Interacting hospital departments and uncertain patient flows: theoretical models and applications*, University of Twente

HOW THE OPERATING ROOM IMPACTS THE WARDS

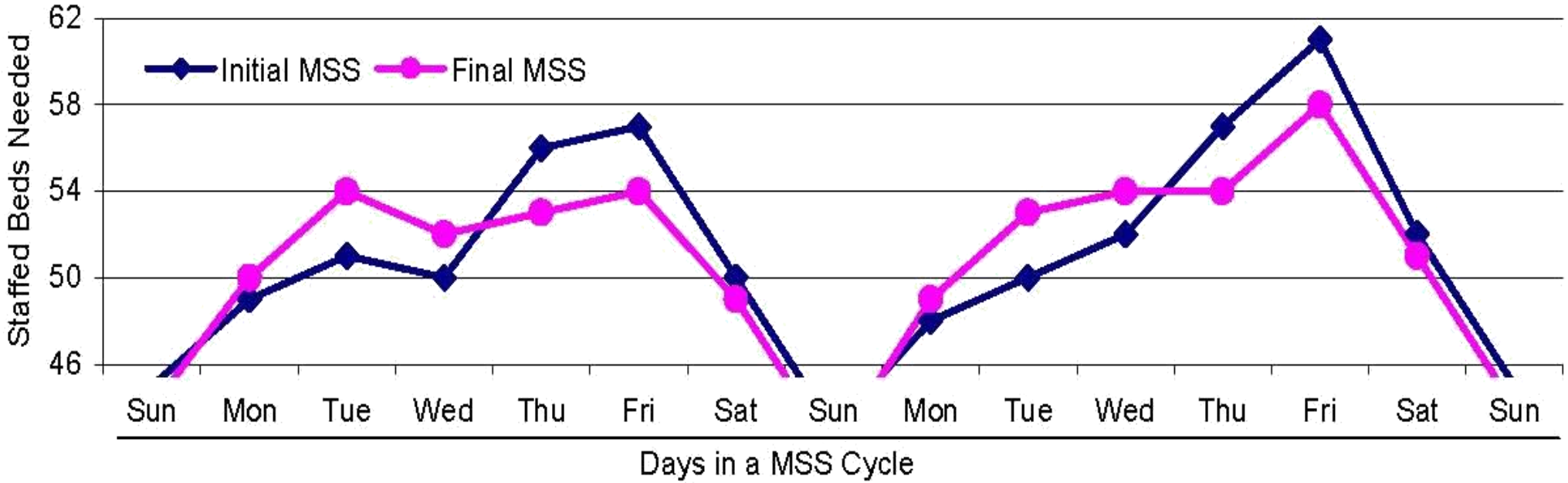
OUTCOMES

Peter Vanberkel



Additional 8th OR possible with current ward capacity (both beds and staff)

NKI-AVL
The Netherlands Cancer Institute
Antoni van Leeuwenhoek Hospital



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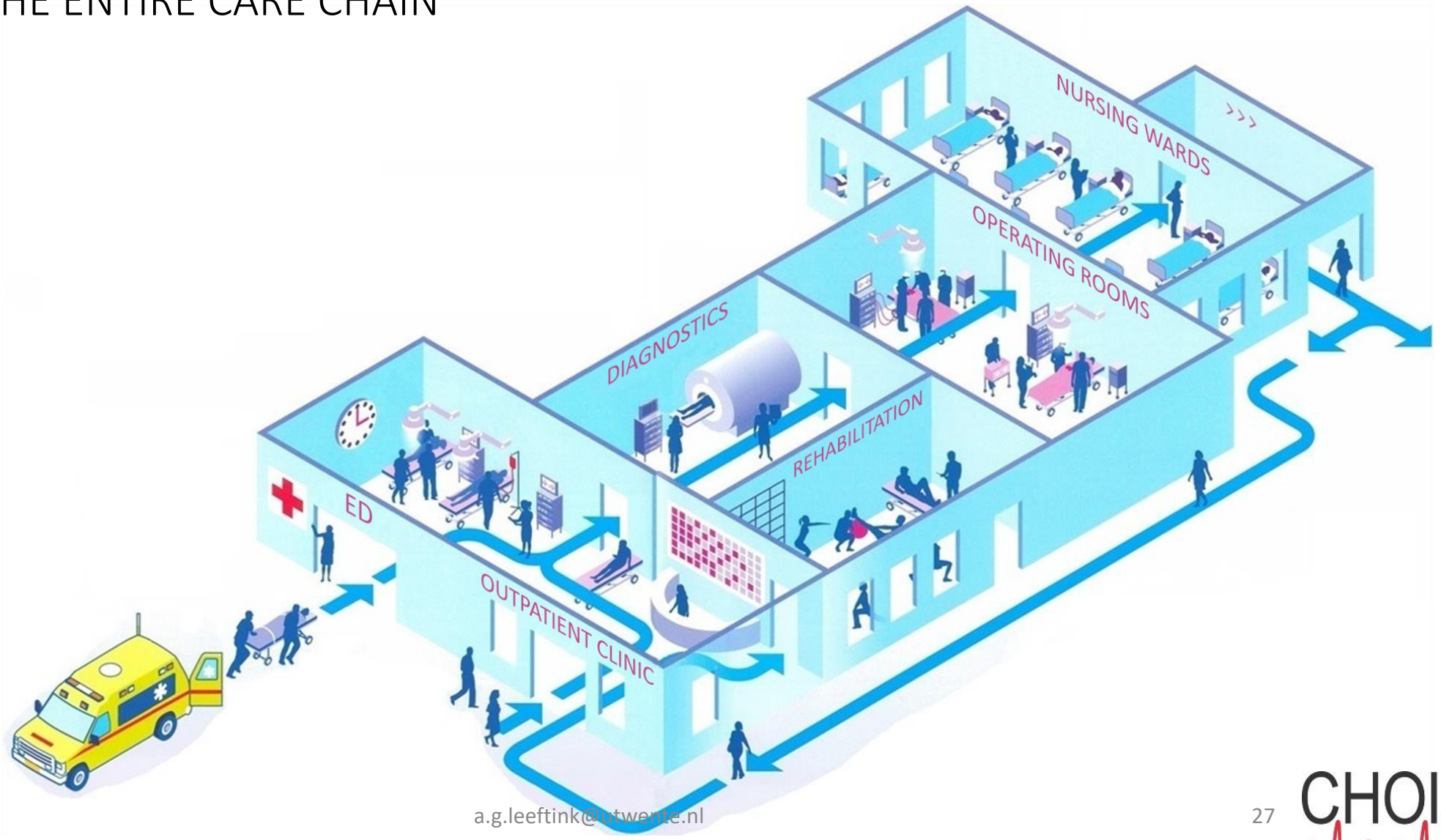
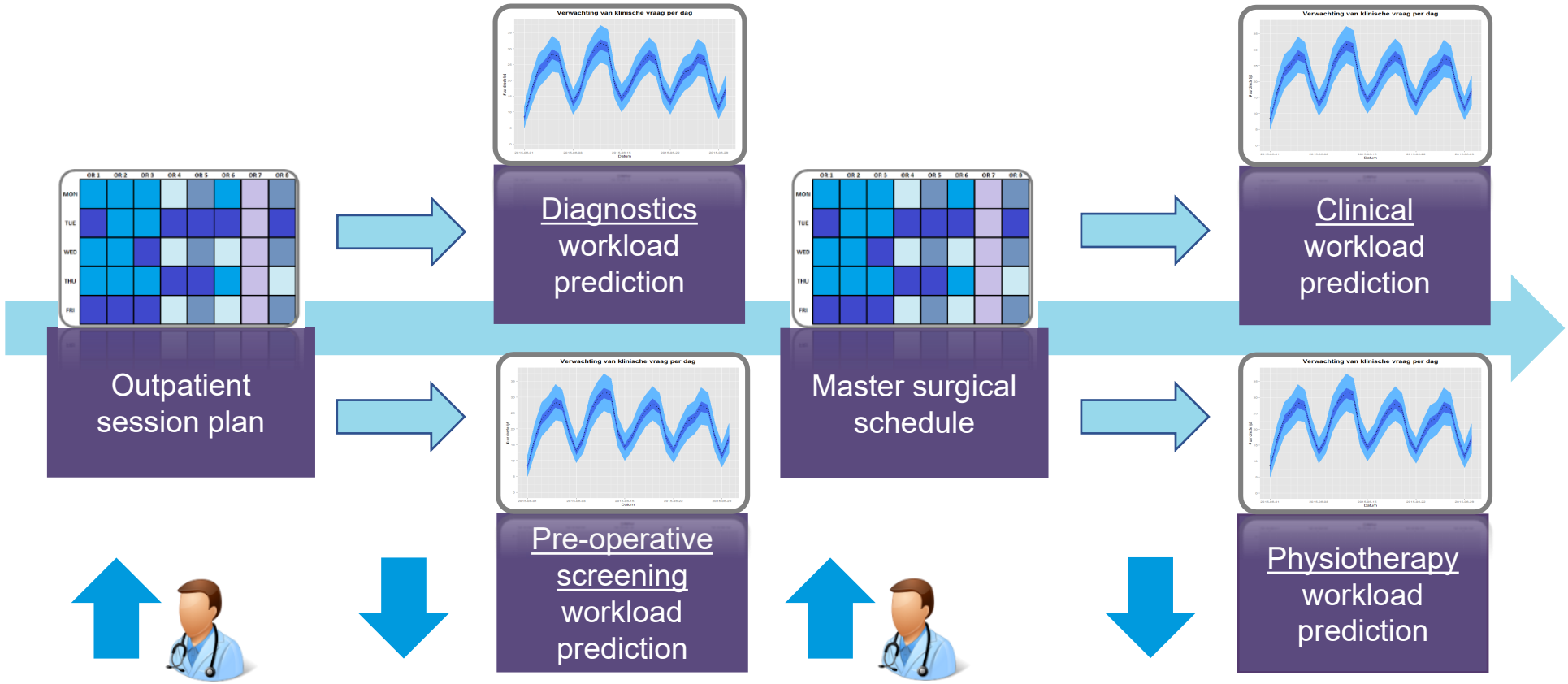
INTEGRAL PERSPECTIVE ON HEALTHCARE SYSTEM

WE CONSIDER THE ENTIRE CARE CHAIN



HOW TO CONTINUE WITH THESE MODELS?

SCHEDULE BASED PREDICTIONS OF WORKLOAD OFFER A GENERIC FRAMEWORK FOR JOINT OPTIMIZATION



Integral production and session planning

Voorbeeld 2: simulatie patiëntenproces

PATIENT CARE PATHWAYS

SAVINGS IN IDLE TIME CAN BE BETTER USED BY PLANNING ADDITIONAL APPOINTMENTS; WALK-IN VS APPOINTMENTS

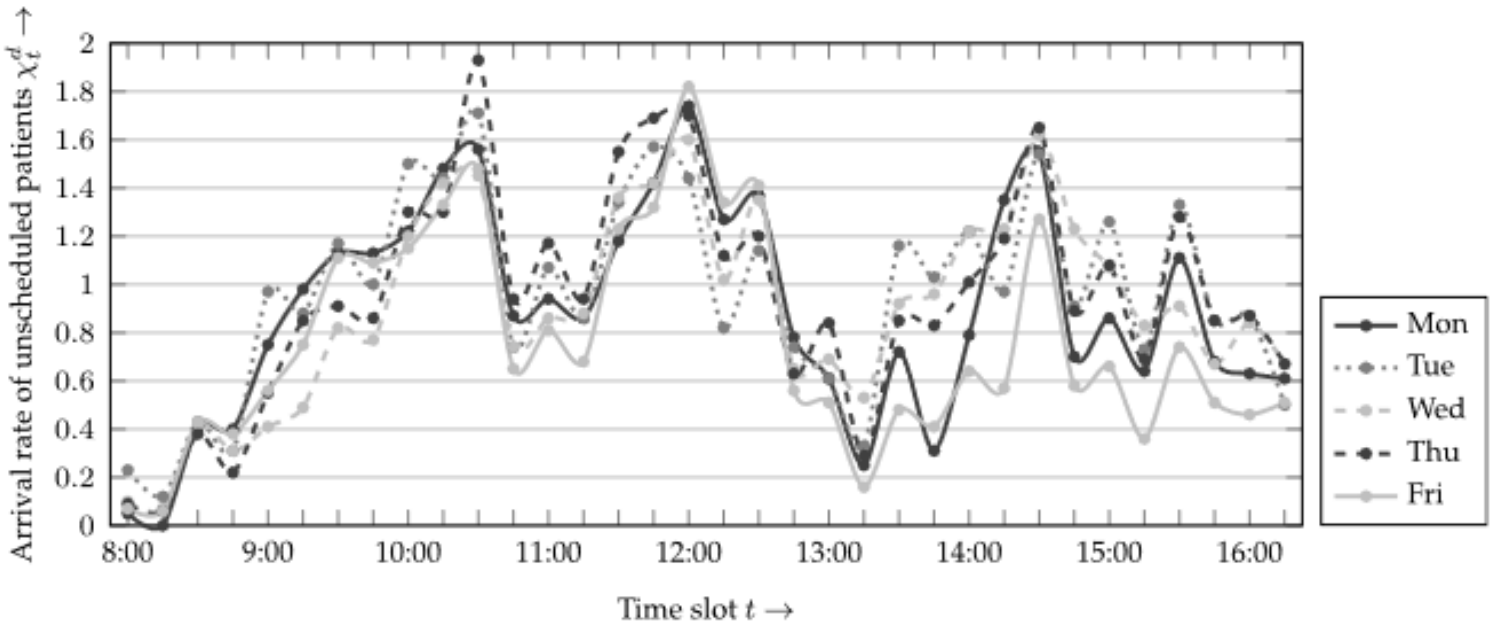


Fig. 5. Unscheduled patient arrival rates per slot per day for the case study.

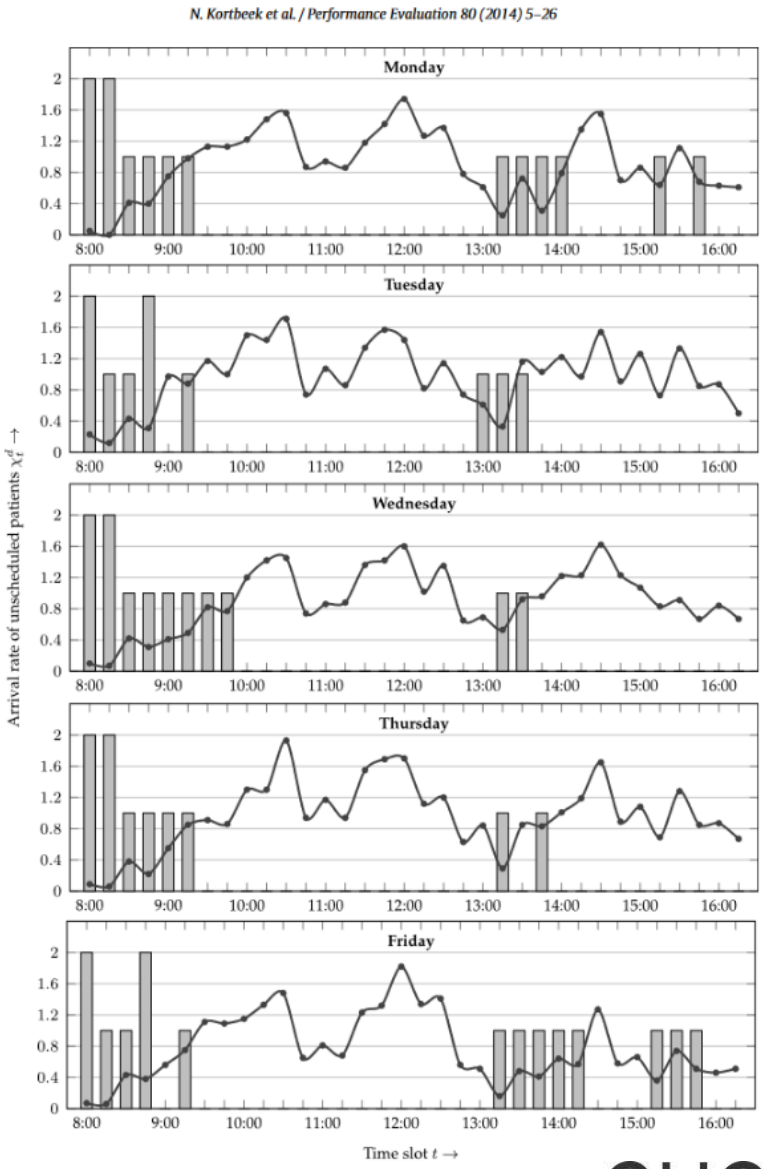


Fig. 6. The CAS versus the unscheduled patient arrival rates.

Kortbeek, N., Zonderland, M. E., Braaksma, A., Vliegen, I. M., Boucherie, R. J., Litvak, N., & Hans, E. W. (2014). Designing cyclic appointment schedules for outpatient clinics with scheduled and unscheduled patient arrivals. *Performance evaluation*, *80*, 5-26.

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PATIENT CARE PATHWAYS

JOINT OPTIMIZATION OVER SPECIALTIES RESULTS IN

21% SAVINGS OF IDLE, WAITING, AND OVERTIME

$$\min E[Q(x,\xi)],$$

s.t.

$$Y_{s,t} \le c_s \quad \forall t \in T \setminus \{1\}, s$$
$$Y_{s,1} = c_s \quad \forall s \in S^*,$$
$$Y_{s,t} \in \mathbb{Z}^+ \quad \forall t \in T, s \in S^*$$

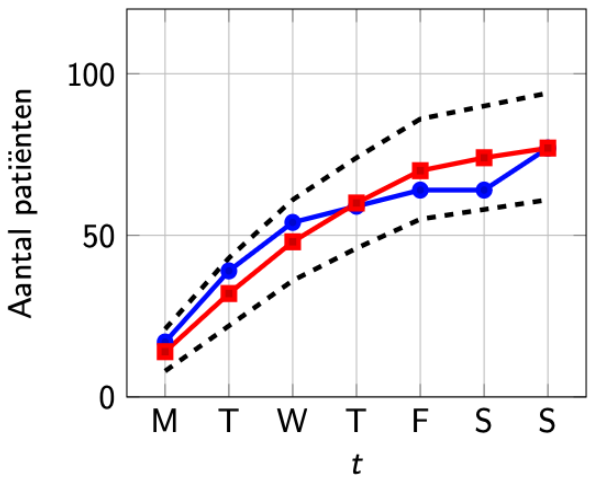
$$Q(x,\xi) = \min \epsilon_1 \sum_{s \in S^*} O_s^\xi \qquad \sum_{s \in S^*} I_s^\xi,$$

s.t.

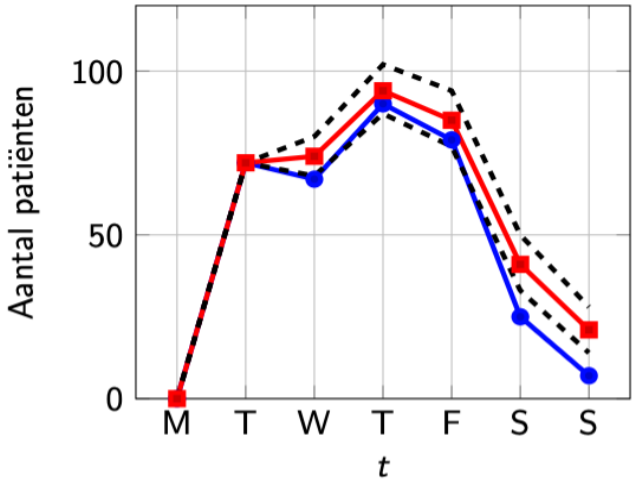
$$\sum_{t \in T} X_{s,t}^\xi = x_s^\xi \quad \forall s \in S^*,$$
$$X_{1,t}^\xi = 0 \quad \forall t \ge |T|,$$
$$\sum_{s \in S^*} X_{s,t}^\xi = c_1 \quad \forall t \in T,$$
$$L_{s,t}^\xi \ge X_{s,t}^\xi + Y_{s,t} - c_s \quad \forall s \in S^*, t = 1,$$
$$L_{s,t}^\xi \ge L_{s,t-1}^\xi + X_{s,t}^\xi + Y_{s,t} - c_s \quad \forall t \in T^*, s \in S^*,$$
$$O_s^\xi \ge L_{s,|T|}^\xi \quad \forall s \in S^*,$$
$$W_s^\xi \ge \sum_{t \in T} L_{s,t}^\xi + \sum_{\tilde{t} \in \tilde{T}} L_{s,\tilde{t}}^\xi \quad \forall s \in S^*,$$
$$I_s^\xi \ge c_s|T| + O_s^\xi - \sum_{t \in T} \left(Y_{s,t} + X_{s,t}^\xi \right) \quad \forall s \in S^*,$$
$$\textit{all variables} \in \mathbb{Z}^+.$$

Voorbeeld 3: voorspellen verwachte ontslagdatum

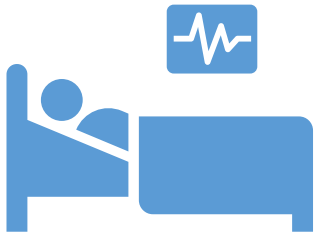
RESULTS: PREDICTED CENSUS DECOMPOSED

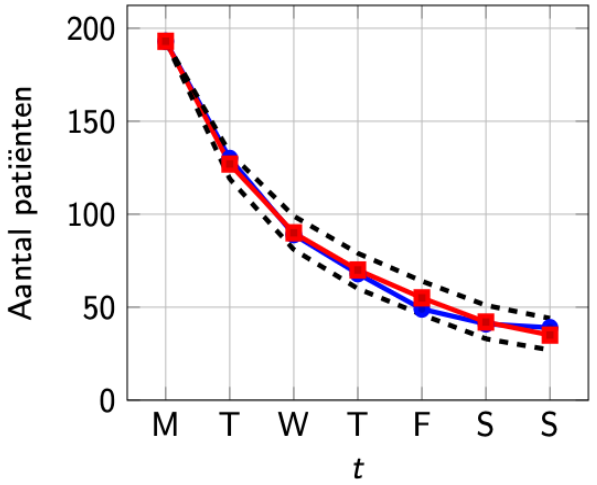


Emergency patients accurately predicted (within 95%-CI)



Elective patients follow pattern, but overestimation in weekend





Remaining patients already present in the wards accurately prediced

IMPLEMENTATIE: DASHBOARD MET ONTSLAG-INFORMATIE

REAL-TIME STUURINFORMATIE IN DIAKONESSENHUIS

Flexibele inzet van professionals

CAPACITY SHARING IN NEONATAL CARE

THE DUTCH NEONATAL NETWORK TAKES CARE OF 4100 NEONATAL PATIENTS PER YEAR

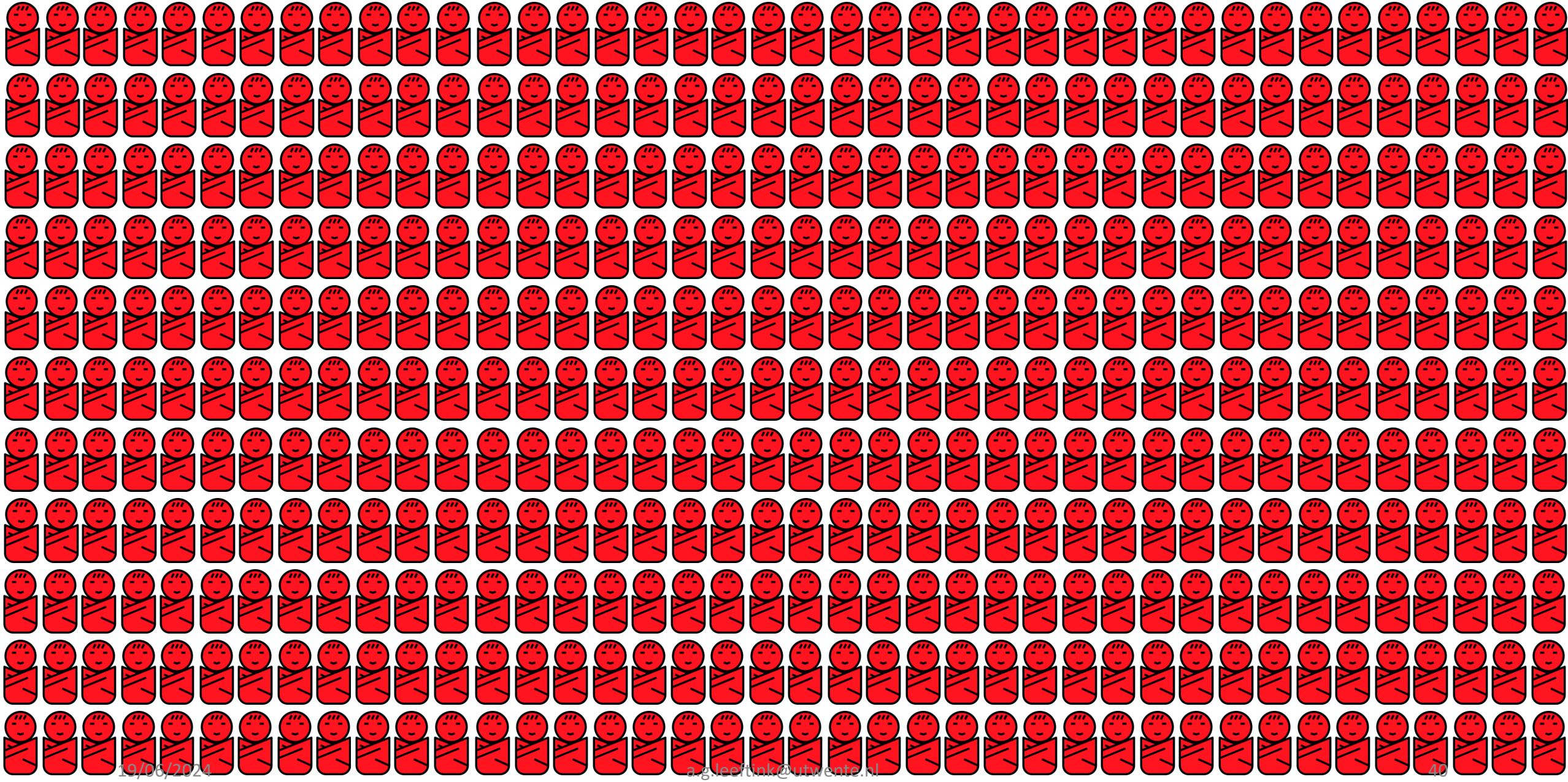
CAPACITY SHARING IN NEONATAL CARE

NO CAPACITY IN THE CATCHMENT AREA? A PATIENT IS TRANSPORTED TO ANOTHER LOCATION

PLANNING IS VARIABILITEITSMANAGEMENT!

… A LITTLE FLEXIBILITY GOES A LONG WAY

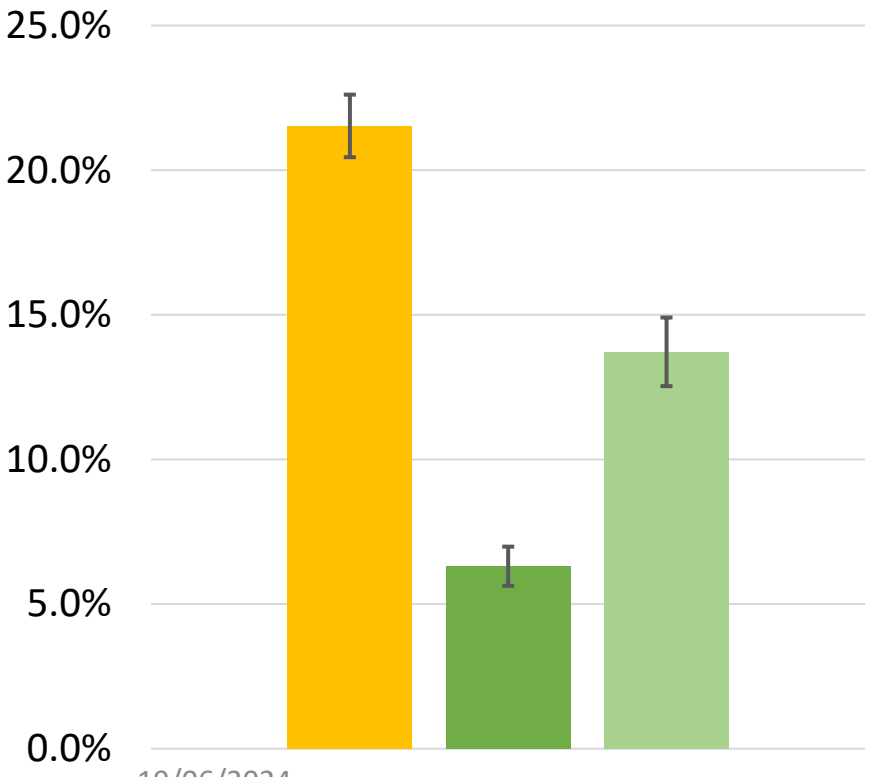
Wat zijn andere opties voor het introduceren van flexibiliteit in het zorgnetwerk?



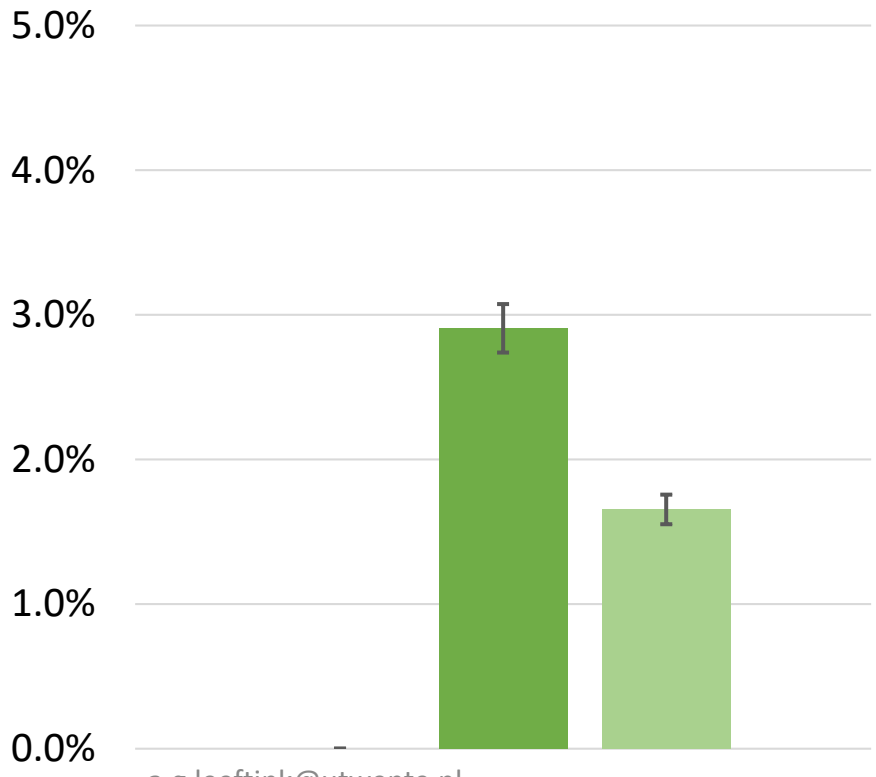
CAPACITY SHARING IN NEONATAL CARE

… A LITTLE FLEXIBILITY GOES A LONG WAY

Percentage of patients transported



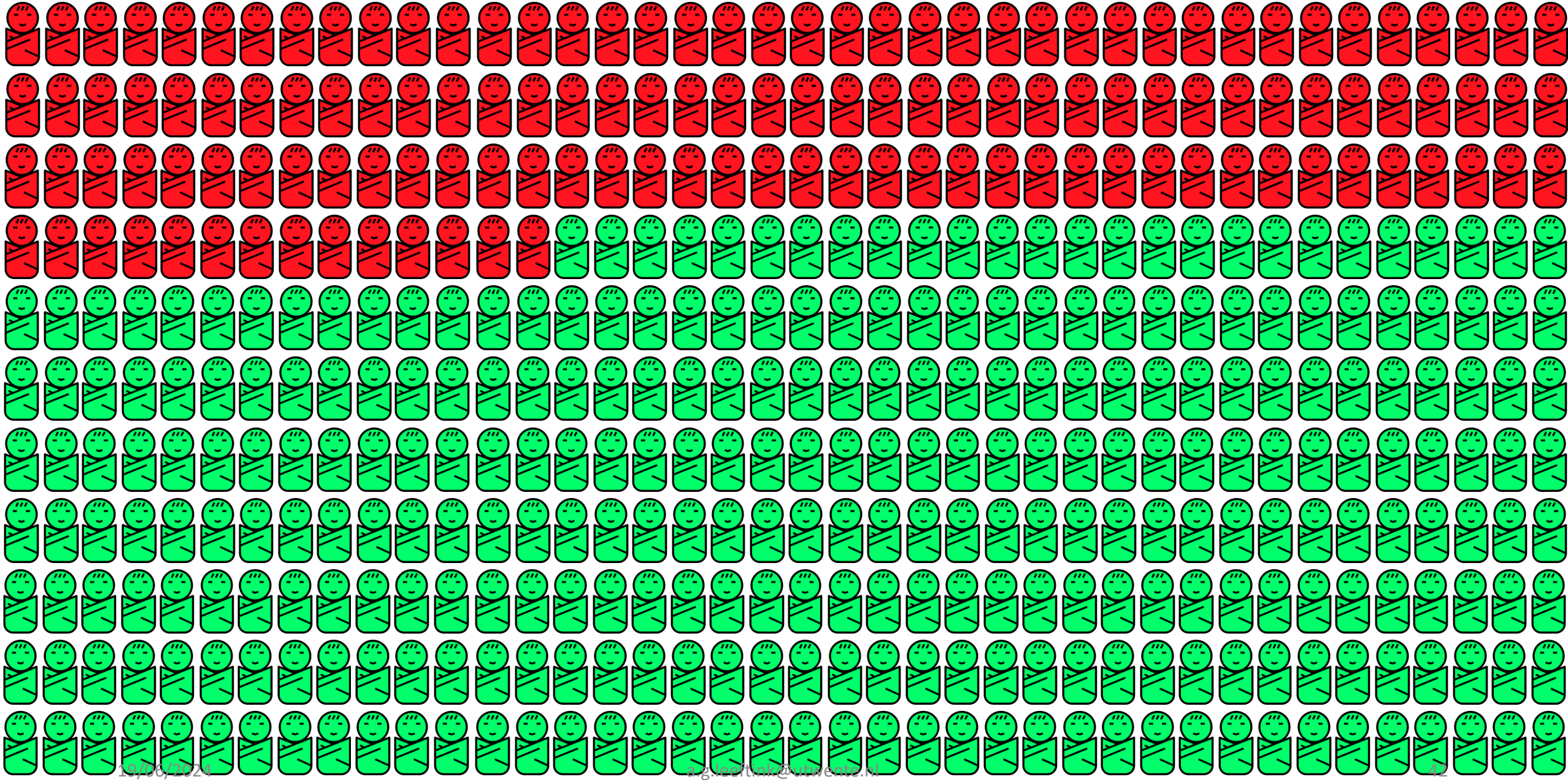
Percentage of nurses not working in their home-base NICU



Current situation without capacity sharing

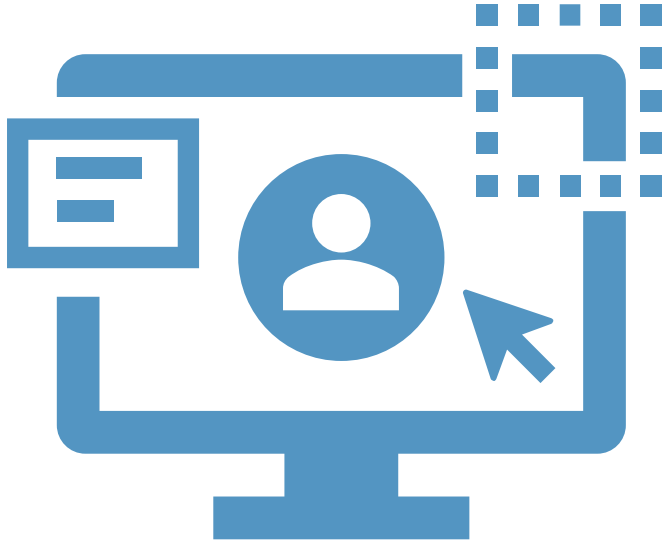
40-50% capacity sharing for all NICU locations

20% capacity sharing for 5 centrally located NICU locations



CAPACITY SHARING IN NEONATAL CARE

CHALLENGES BEFORE IMPLEMENTATION



WAT VINDEN VERPLEEGKUNDIGEN VAN WERKEN IN EEN FLEXPOOL?

WAT ALS JE NIET IN EEN FLEXPOOL WERKT? EN WAT ALS JE WEL IN EEN FLEXPOOL WERKT?

- Verpleegkundigen met ervaring in een flexpool zijn veel positiever over flexibel werk dan verpleegkundigen zonder ervaring.
- Uitdagingen: teamgevoel, communicatie, verschillen in protocollen en procedures.
- Persoonlijke resources: aanpassingsvermogen, zelfvertrouwen, communicatieve vaardigheden.
- Werk resources: flexibiliteit, waardering, ontwikkelmogelijkheden.

Zorg op maat - Dataverzameling

Zorg op maat - Data delen

Samenwerkingsvormen

Prof.dr.ir. Erwin Hans

UNIVERSITY OF TWENTE.

1996: MSc Toegepaste Wiskunde

2001: PhD Planning & Procesoptimalisatie

2005: Oprichting CHOIR

2013: Hoogleraar Operations Management in de Zorg

2022: Departementshoofd High-Tech Business & Entrepreneurship

CHOIR

ONDERZOEK, ONDERWIJS EN VALORISATIE

Onderzoek (vraaggestuurd, impact-gedreven, interdisciplinair):

- PhD studenten en staf (zie utwente.nl/choir)
- BSc & MSc studenten (zie essay.utwente.nl)
- Interdisciplinaire afstudeercirkels

Onderwijs:

- BSc & MSc programma's @ UT
- Cursussen voor zorgprofessionals, bestuurders
- Inspiratielezingen, workshops op verzoek

Valorisatie:

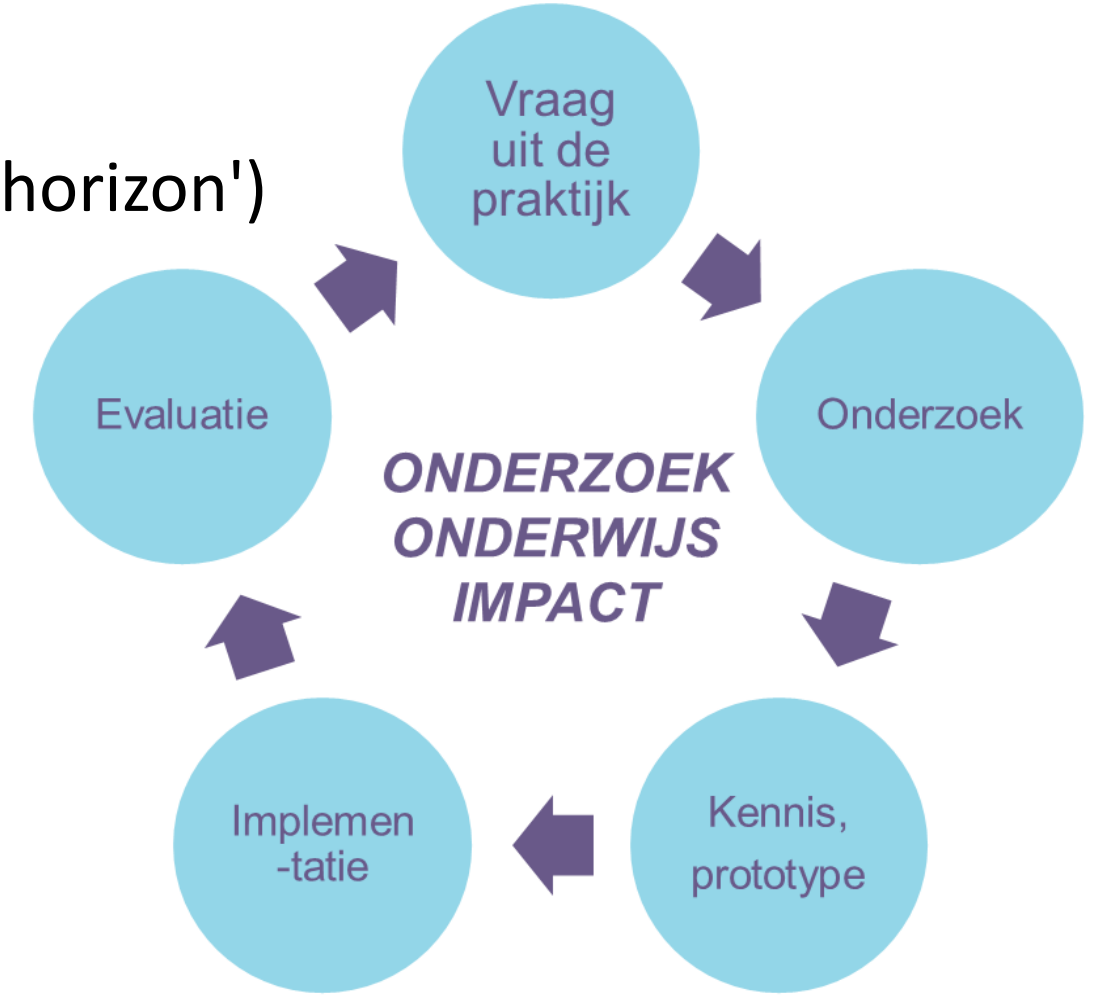
- Spin-offs, waaronder Rhythm/ORTEC
- Adviesraad

rhythm
University of Twente spin-off

CHOIR

STRATEGISCHE AANPAK

- Langdurige onderzoeksagenda ('stip op de horizon')
- Ecosysteem van
  onderwijs, onderzoek en impact
- Samenwerking met hogescholen en ROC's
- Financiering



Meer informatie over CHOIR en THT vind je hier:
www.utwente.nl/en/choir/research/
www.utwente.nl/en/bms/tht

BEDANKT VOOR JULLIE AANDACHT

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