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Redesigning Outpatient Clinics with a Doctor-goes-to-Patient Policy

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Contents

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Introduction (1)

- **Outpatient clinics**: patients do not stay overnight
  - Patients come for relatively short consultations and treatments
  - Expected growth in demand of care
    - Due to aging and increased illness
    - Growth in demand for ambulatory care, due to a shift to non-invasive, cheap, and effective short-stay treatments

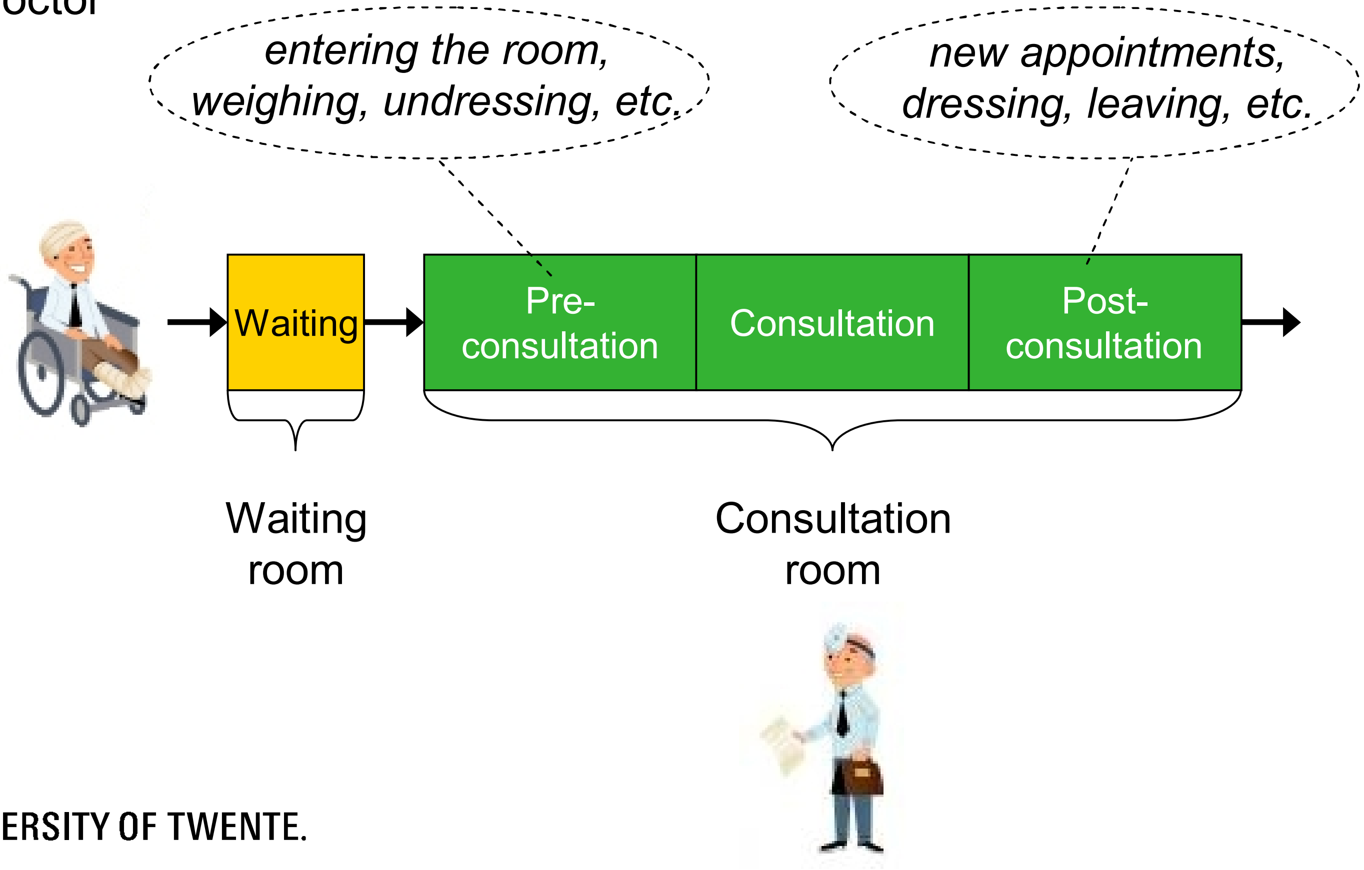
Introduction (2)

- Need for change in outpatient clinic design
- Increased awareness of scarcity of doctor time, materials, and hospital space

"Put this up in reception, nurse."

Introduction (3)

- Patients make appointments at the outpatient clinic with a certain doctor



entering the room, weighing, undressing, etc.

new appointments, dressing, leaving, etc.

Waiting

Pre-consultation

Consultation

Post-consultation

Waiting room

Consultation room

Introduction (4)

- **PtD-policy** (Patient-goes-to-Doctor)
    - Classic approach
    - Doctor sits in the consultation room, and patient comes to doctor for the consultation
        - Pre-consultation, consultation, and post-consultation are done with the attendance of a doctor
    - A single room per doctor

Introduction (5)

- **DtP-policy** (Doctor-goes-to-Patient)
  - Patient sits in consultation room, and doctor comes to the patient for the consultation
    - Pre-consultation and post-consultation are done without the attendance of a doctor
  - More than one room is required per doctor
  - Travel time is incurred by the doctor, since the doctor has to travel between rooms

Motivation

- Increase patient throughput, since demand is expected to grow
- Increase utilization of scarce hospital space and doctor time
- Many hospitals in the Netherlands are currently considering this redesign of their outpatient clinics

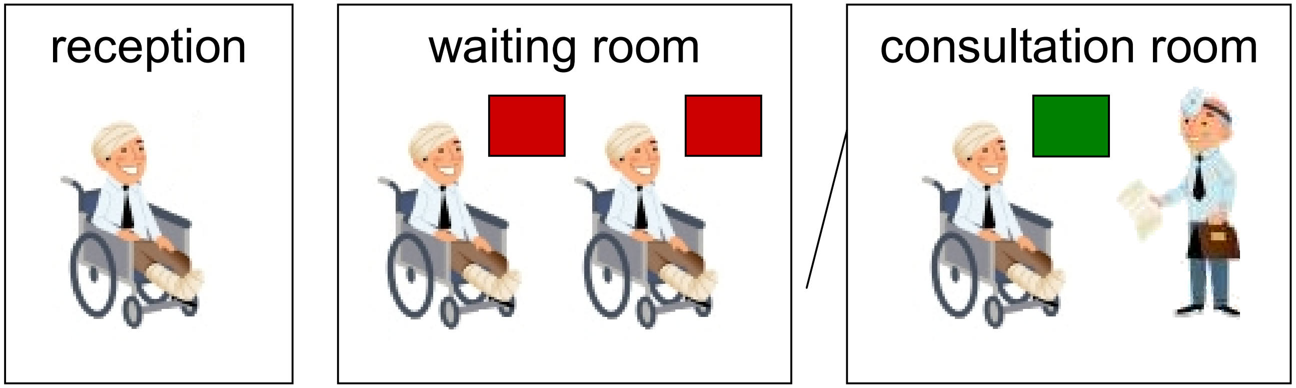
Research questions and approach

- **Research questions**
  - Which policy is better: PtD or DtP?
  - How many rooms per doctor in a DtP-policy?

- **Methods**
  - Analyse the departure process of both policies
  - Numerically solve probability equations to find the number of rooms
  - Discrete-Event Simulation (DES) to support results

Which policy is better: DtP vs. PtD? (1)

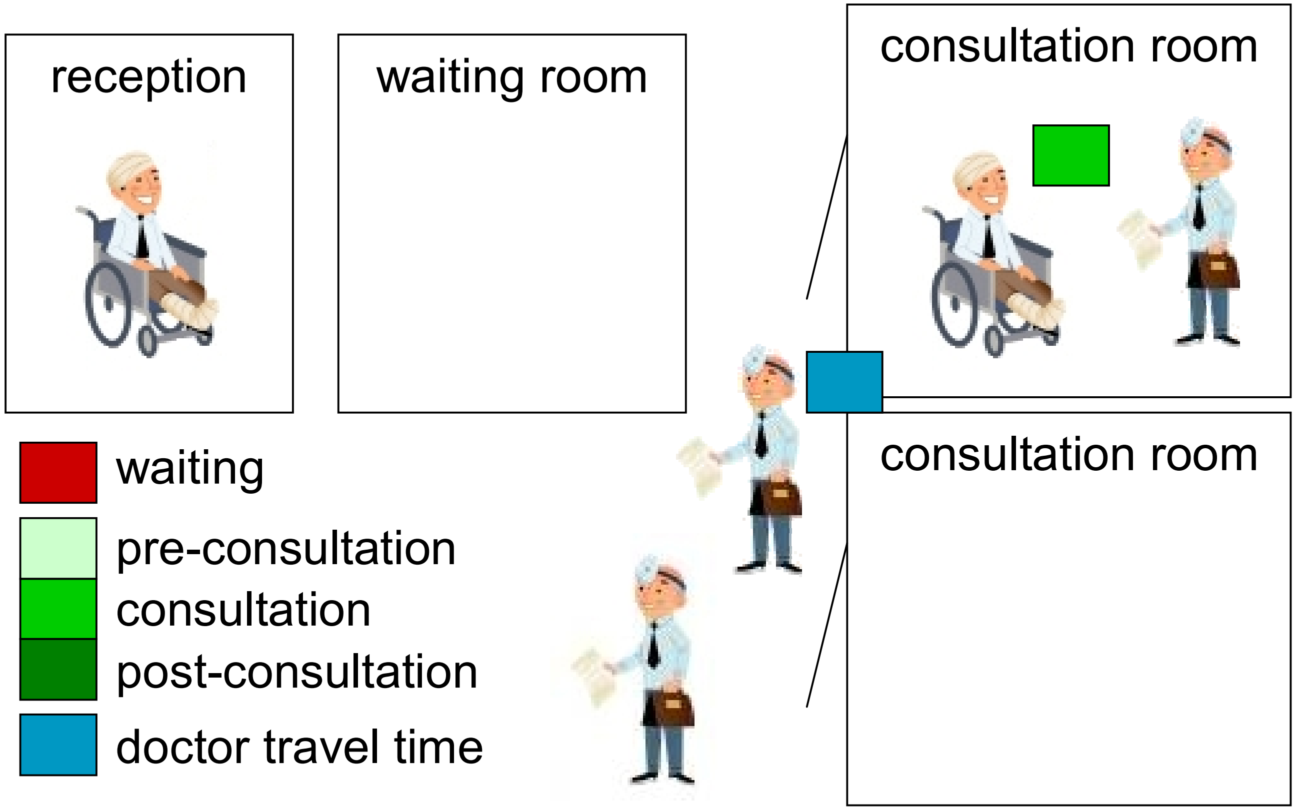
- Patient arrivals in a PtD-policy



🟥 waiting
🟩 pre-consultation
🟩 consultation
🟩 post-consultation

Which policy is better: DtP vs. PtD? (2)

- Patient arrivals in a DtP-policy when the system is empty



reception

waiting room

consultation room

consultation room

🟥 waiting

🟩 pre-consultation

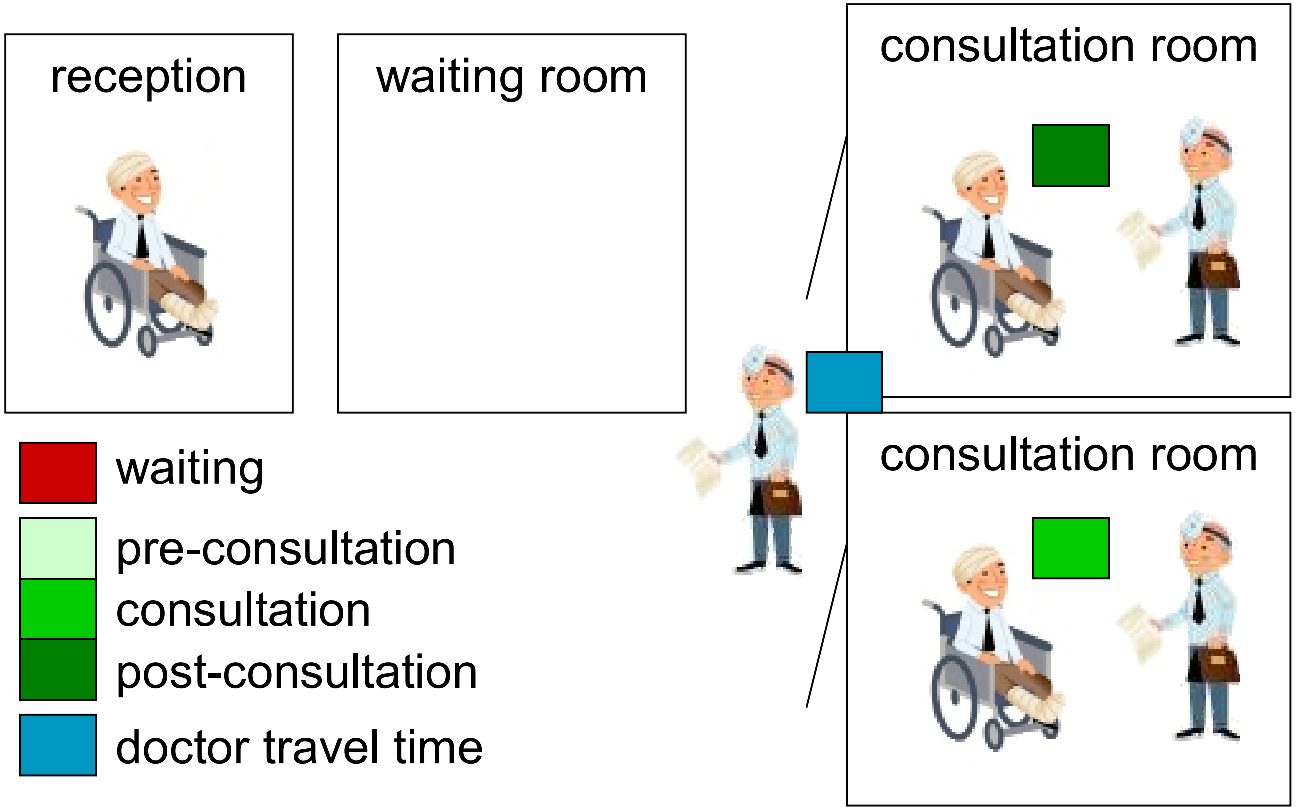
🟩 consultation

🟩 post-consultation

🟦 doctor travel time

Which policy is better: DtP vs. PtD? (3)

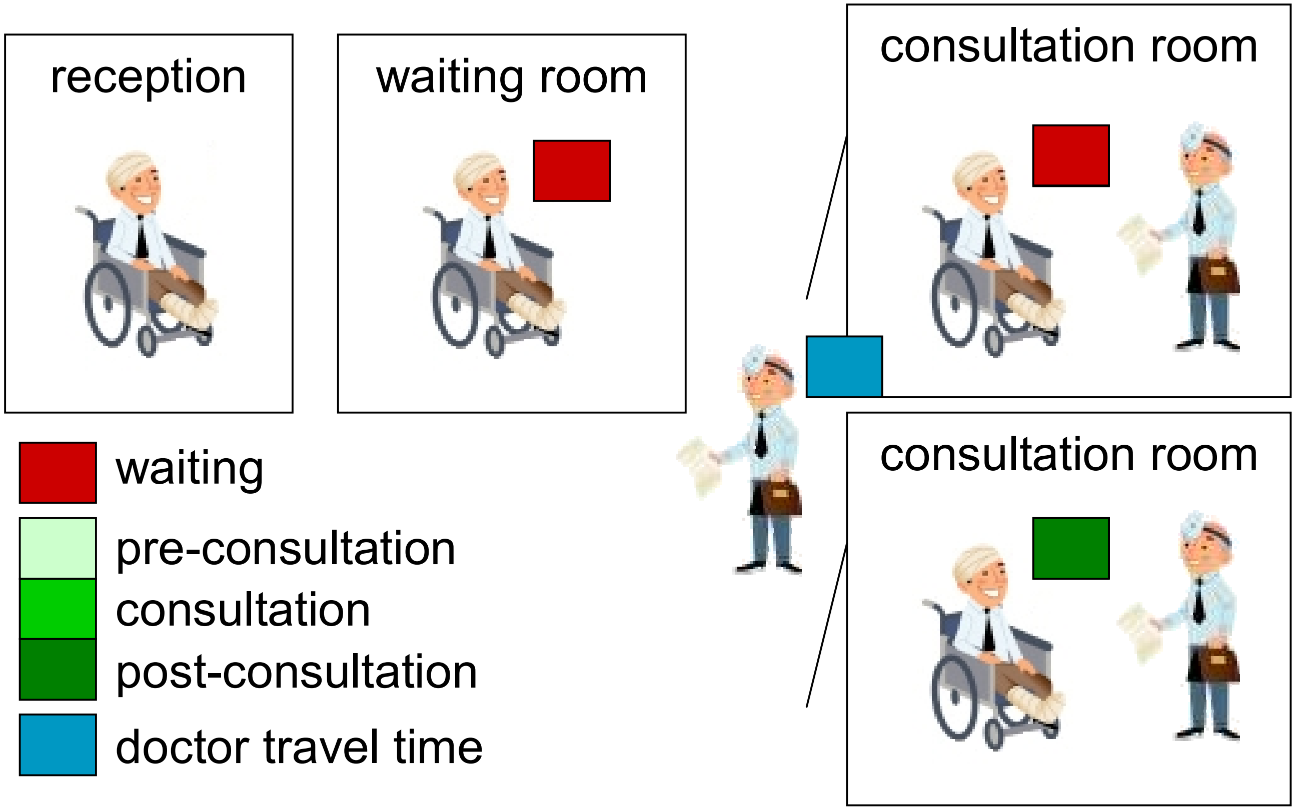
- Patient arrivals in a DtP-policy when the doctor is occupied



🟥 waiting
🟩 pre-consultation
🟩 consultation
🟩 post-consultation
🟦 doctor travel time

Which policy is better: DtP vs. PtD? (4)

- Patient arrival in a DtP-policy when doctor and rooms are occupied



reception

waiting room

consultation room

consultation room

🟥 waiting

🟩 pre-consultation

🟩 consultation

🟩 post-consultation

🟦 doctor travel time

Which policy is better: DtP vs. PtD? (5)

- We would like to show that

$$\Pr(\underbrace{D'_n}_{\boxed{\substack{\textit{departure time of patient n} \\ \textit{in the DtP-policy}}}} \le \underbrace{D_n}_{\boxed{\substack{\textit{departure time of patient n} \\ \textit{in the PtD-policy}}}}) = 1 \qquad \forall x$$

- We call this:

DtP

$$D'_n \le D_n$$

PtD

Which policy is better: DtP vs. PtD? (6)

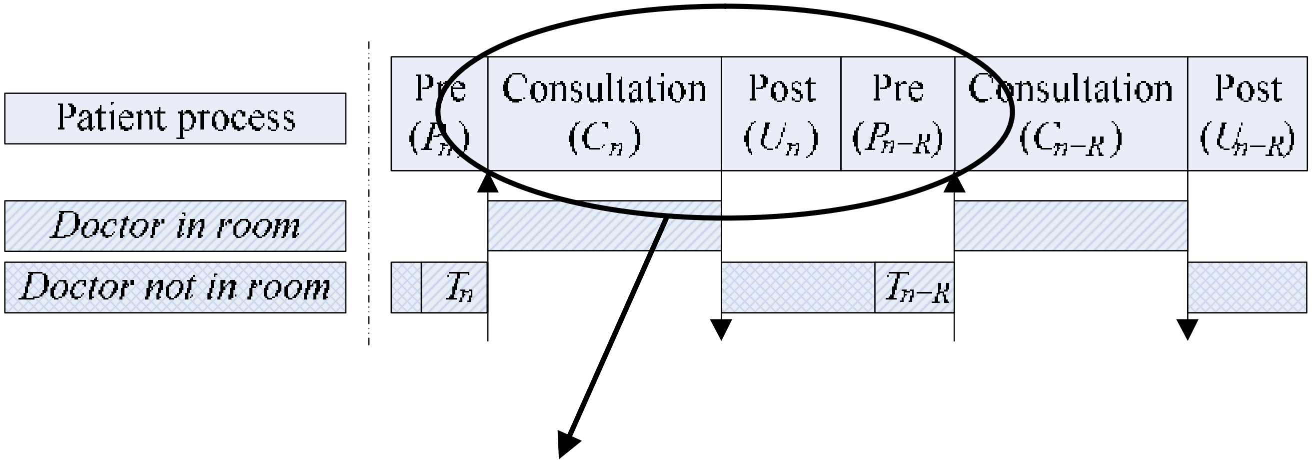
- In our paper, we analytically show that this is true for every patient *n* when:

$$\Pr(T_n \leq P_n) = 1$$

- Intuitively this is clear, since when all rooms are occupied when a patient comes in, both the doctor and the patient wait until a room becomes available. When one becomes available, the patient still has to finish (*P*), and the doctor has to finish travelling (*T*)
- We wish to extend this analysis with the simulation (in progress)

How many rooms in a DtP-policy? (1)

- *Assumption*: there is always a patient waiting to go into a consultation room whenever a rooms is available
- The number of rooms is indicated by *R*
- Process in a consultation room:



- Cycle time for a doctor to be back in the room where he started the cycle

How many rooms in a DtP-policy? (2)

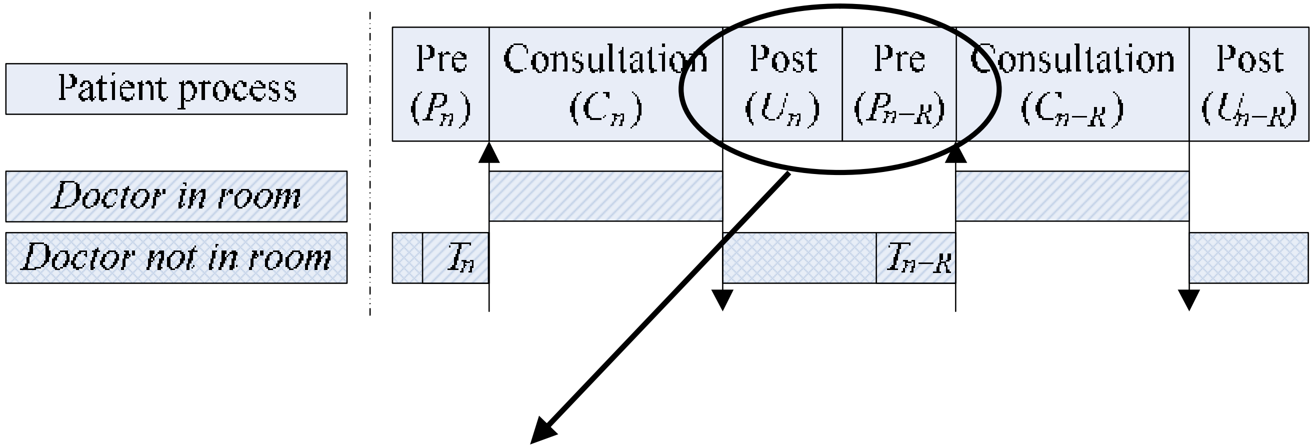
- If we use expectations, we get for the number of rooms:

$$\left\lceil \frac{\text{total time 1 patient in room}}{\text{doctor time per patient}} \right\rceil = \left\lceil \frac{E[P]+E[C]+E[U]}{E[C]+E[T]} \right\rceil \qquad \text{(Eq. 1)}$$

- The variation in service times is important to consider as well
  - The literature reports on a coefficient of variation (CV = σ / μ) of 0.35 to 0.85

How many rooms in a DtP-policy? (3)

- Process in a consultation room:



- Time the doctor should spend consulting patients in other rooms plus the travel time to these patients, and the travel time back to the room

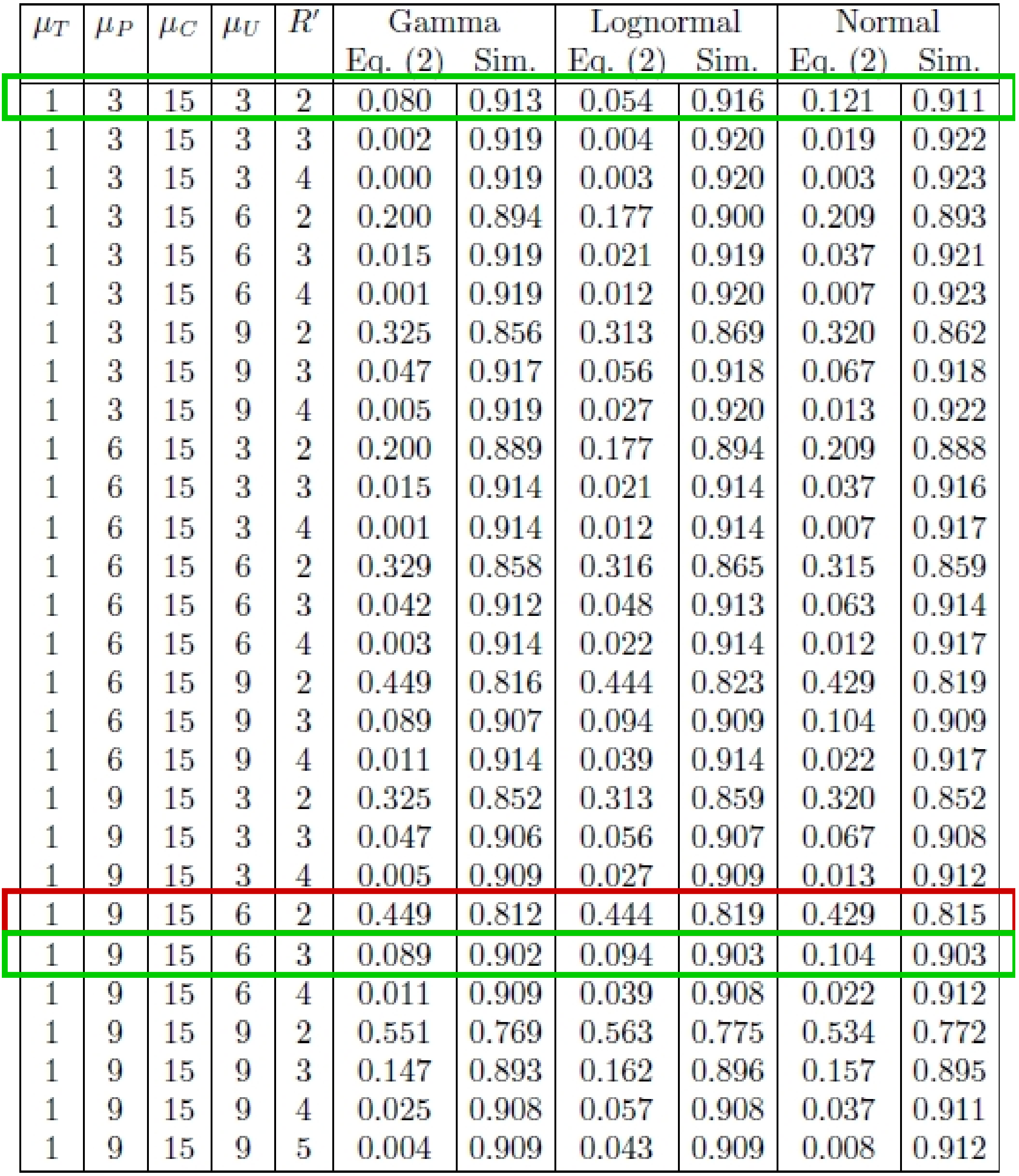
How many rooms in a DtP-policy? (4)

- We would like to maximize the patient throughput for one doctor within certain costs
- Therefore, we minimize the probability the doctor has to wait for the next patient in a room to be ready:

$$\Pr(\underbrace{\sum_{j=n+1}^{n+R-1} C_j + \sum_{k=n+1}^{n+R} T_k}_{\textit{time the doctor spends in other rooms}} \le \underbrace{U_n + P_{n+R}}_{\textit{time until next patient n+R is ready for consultation}}) \le \overbrace{\alpha}^{\textit{waiting probability threshold, set by management}} \qquad \text{(Eq. 2)}$$

Outcomes (1)

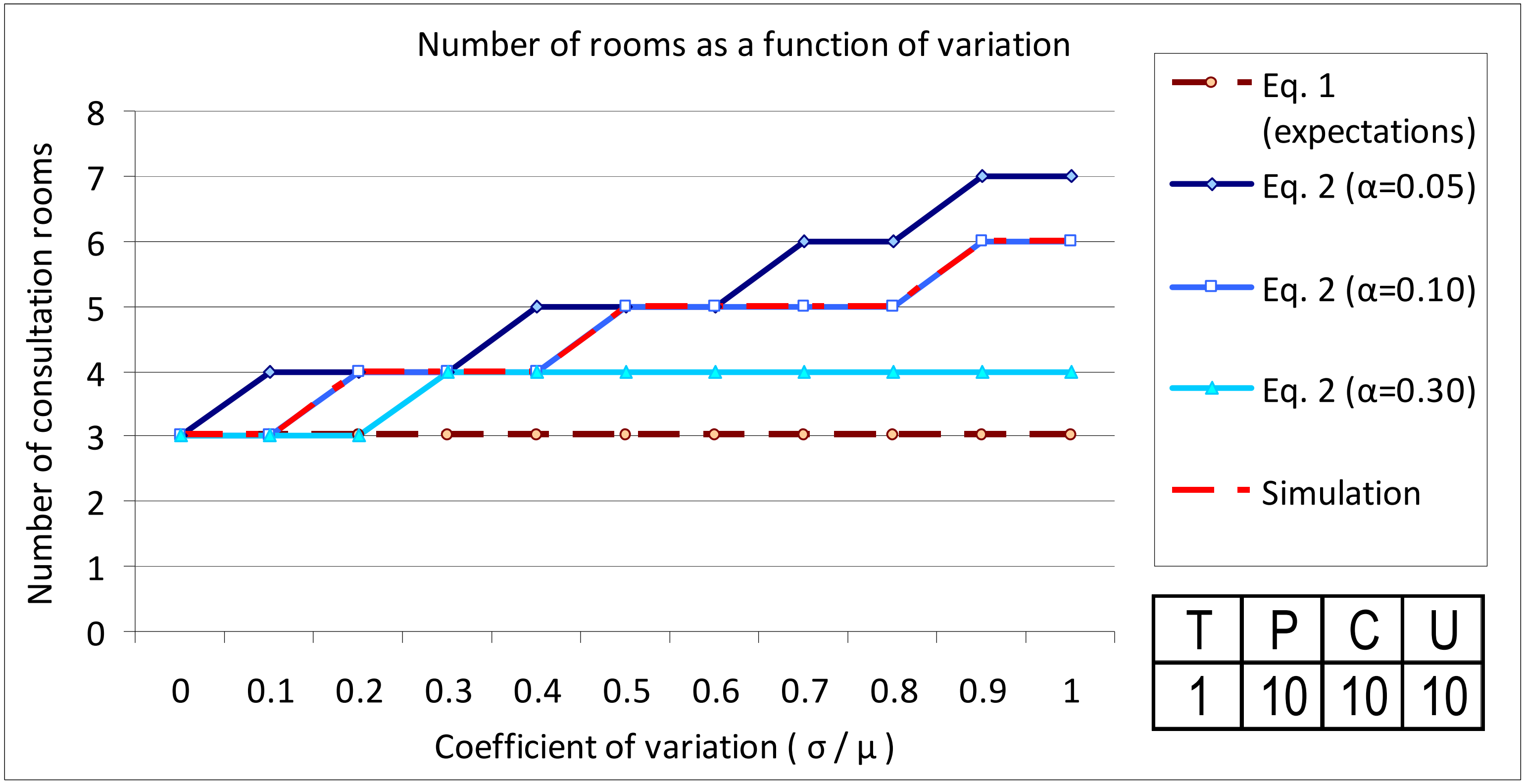
- Pick a certain α and select the number of rooms where the result of Eq. 2 is smaller in the table
- CV = 0.6 for all



μ_T	μ_P	μ_C	μ_U	R'	Gamma		Lognormal		Normal	
					Eq. (2)	Sim.	Eq. (2)	Sim.	Eq. (2)	Sim.
1	3	15	3	2	0.080	0.913	0.054	0.916	0.121	0.911
1	3	15	3	3	0.002	0.919	0.004	0.920	0.019	0.922
1	3	15	3	4	0.000	0.919	0.003	0.920	0.003	0.923
1	3	15	6	2	0.200	0.894	0.177	0.900	0.209	0.893
1	3	15	6	3	0.015	0.919	0.021	0.919	0.037	0.921
1	3	15	6	4	0.001	0.919	0.012	0.920	0.007	0.923
1	3	15	9	2	0.325	0.856	0.313	0.869	0.320	0.862
1	3	15	9	3	0.047	0.917	0.056	0.918	0.067	0.918
1	3	15	9	4	0.005	0.919	0.027	0.920	0.013	0.922
1	6	15	3	2	0.200	0.889	0.177	0.894	0.209	0.888
1	6	15	3	3	0.015	0.914	0.021	0.914	0.037	0.916
1	6	15	3	4	0.001	0.914	0.012	0.914	0.007	0.917
1	6	15	6	2	0.329	0.858	0.316	0.865	0.315	0.859
1	6	15	6	3	0.042	0.912	0.048	0.913	0.063	0.914
1	6	15	6	4	0.003	0.914	0.022	0.914	0.012	0.917
1	6	15	9	2	0.449	0.816	0.444	0.823	0.429	0.819
1	6	15	9	3	0.089	0.907	0.094	0.909	0.104	0.909
1	6	15	9	4	0.011	0.914	0.039	0.914	0.022	0.917
1	9	15	3	2	0.325	0.852	0.313	0.859	0.320	0.852
1	9	15	3	3	0.047	0.906	0.056	0.907	0.067	0.908
1	9	15	3	4	0.005	0.909	0.027	0.909	0.013	0.912
1	9	15	6	2	0.449	0.812	0.444	0.819	0.429	0.815
1	9	15	6	3	0.089	0.902	0.094	0.903	0.104	0.903
1	9	15	6	4	0.011	0.909	0.039	0.908	0.022	0.912
1	9	15	9	2	0.551	0.769	0.563	0.775	0.534	0.772
1	9	15	9	3	0.147	0.893	0.162	0.896	0.157	0.895
1	9	15	9	4	0.025	0.908	0.057	0.908	0.037	0.911
1	9	15	9	5	0.004	0.909	0.043	0.909	0.008	0.912

Outcomes (2)

- Calculation with expectations can be used as a lower bound



T	P	C	U
1	10	10	10

Outcomes (3)

- Two hospitals are involved in this research
  - Rivas, Gorinchem
  - Groene Hart Ziekenhuis, Gouda
- Presented modeling approach and simulation are used for analysis in these two case studies

Conclusions

- Analytically: When travel time is shorter than preparation time, the DtP-policy is equal or superior to the PtD-policy for every patient
- Variation is important to take into account in deciding on the number of rooms
  - Numerical computations of given equations to determine the number of required rooms

Discussion

- Important things to think about when implementing DtP-policy
  - More rooms are required
  - Additional offices for administration work done by doctors
  - Expensive equipment
  - Doctor idle time
  - IT infrastructure

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ORchestra Bibliography

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