MEDICINE 4.0

Digitalization in Healthcare

Klinik 4.0 · Telemedicine · eHealth · Digital Administration

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Agenda

Why is Digitalization Inevitable?

78.6

Life expectancy
(men, Germany)

83.4

Life expectancy
(women, Germany)

~12%

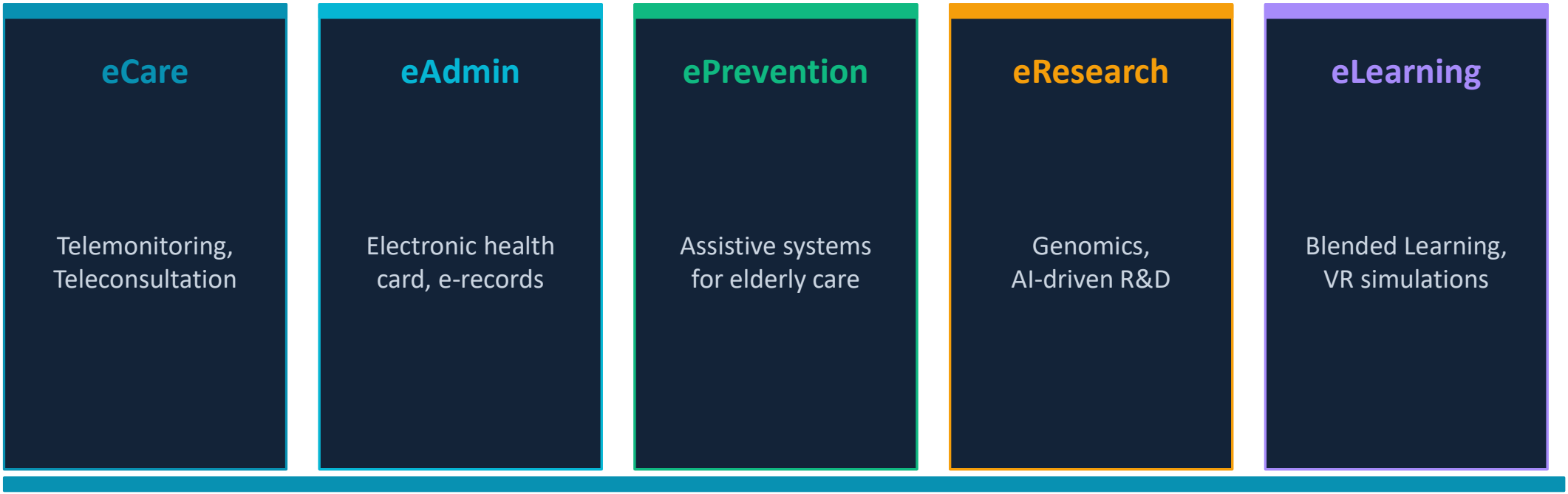
Potential cost savings
through digitalization

Key Drivers of Change

- Declining birth rates → aging population
- Rising life expectancy → more elderly patients
- Staff shortages in hospitals and care facilities
- Healthcare costs growing ~4.5% per year
- Increasing patient expectations & digital literacy

eHealth – Digital Healthcare

The umbrella term for cost-efficient, secure use of ICT to improve health and health-related areas



Foundation: Telematikinfrastruktur (TI) — the secure data highway connecting all healthcare actors

Key Challenges

Digital Supply Network

Apps on prescription, video consultations

Interoperability

No unified standards, isolated legacy systems

Paper & System Gaps

Manual forms, broken workflows between sectors

Staff Shortage

1,900 hospitals under cost & personnel pressure

Telemedicine

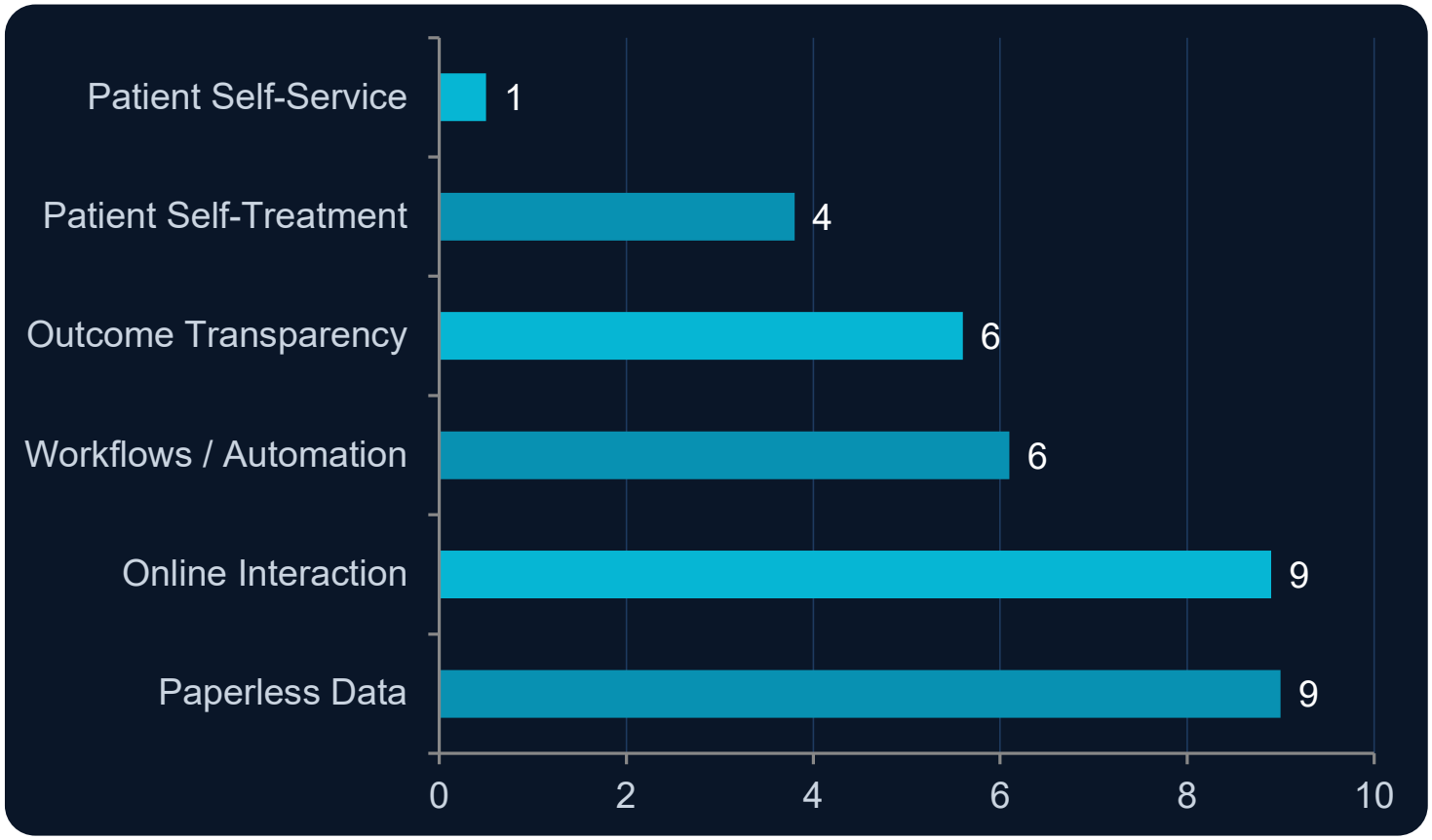
Routine visits becoming remote consultations

Patient Centricity

Patients self-inform; need digital tools

Savings Potential: €42 Billion / Year

McKinsey Study (2022) — 26 digital health technologies across 6 categories



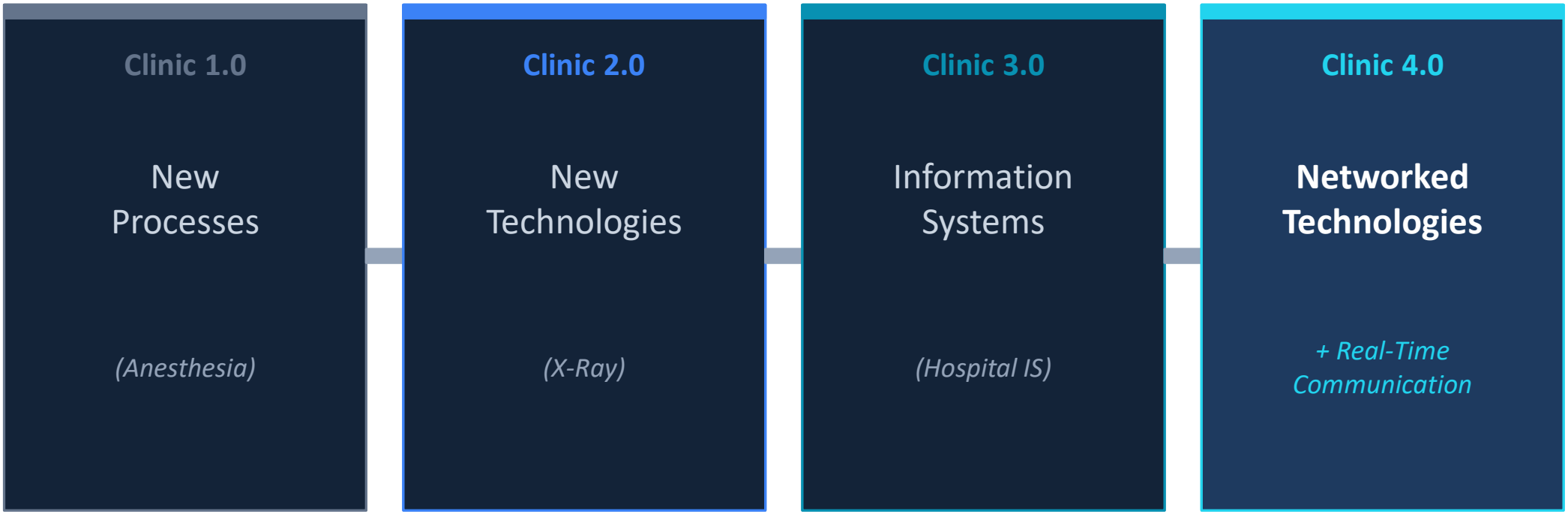
€16 bn

saved by
Clinic 4.0 alone

12%

of total health
system costs

Clinic 4.0 – Evolution of the Hospital



Goal: The right information, to the right person, at the right time

EMRAM Model (HIMSS, 2015 global standard) measures hospital digitalization on 8 levels (0–7)

Doctor 4.0

Specialist Networks

Clinics collaborate across specializations. Expertise is shared via video conference — no need to transfer patients unnecessarily.

Real-Time Access

MRI, CT scans, patient history, medications — all accessible instantly from anywhere via connected systems.

From GP to Team Player

The general practitioner becomes a team leader who assembles the best expert network for each patient.

Teleconferencing

Joint diagnoses with remote specialists. Joint treatment plans without patient transport.

Nursing & Administration 4.0

Mobile Documentation

Real-time patient data on tablets — no paper notes lost during rounds

RFID Tracking

Locate patients, staff, and equipment anywhere in the hospital instantly

Electronic Order Entry

Automated medication orders, lab requests; links pharmacy, wards & external care

Voice-Bot Documentation

AI voice assistants document ward rounds automatically into the HIS

Mobile Identity Access

Digital key management for controlled-access areas (e.g. drug cabinets)

Hospitality Entertainment

Bedside tablet for streaming, services, appointment booking & ward info

Patient 4.0 – More Control, More Responsibility

New Capabilities

- Electronic Patient Record (ePA) — all data in one place, patient controls access
- Wearables & Home Monitoring — chronic patients avoid unnecessary hospital stays
- Telemedicine consultations from home
- Active participation in treatment planning
- Book follow-up appointments digitally via bedside terminal

The boundary between inpatient and outpatient care is disappearing

Patient becomes master of their own health journey

Smart hospital:
https://youtu.be/UjQm0maxkSg?si=au4RcR4O5vV3QcWO

Research & Education 4.0

VR & AR Surgery Training

Students practice operations in simulation — zero risk to patients. Experienced surgeons train rare scenarios.

AI & Machine Learning

Big Data analytics identify new patterns in disease. Algorithms support doctors in complex decisions (e.g., tumor treatment options).

Cross-Hospital Data Sharing

Networked hospitals combine datasets for faster breakthroughs. Currently fragmented — can't be easily shared.

Video Collaboration

Students virtually attend live surgeries from anywhere. Expert consultations across institutions.

Telemedicine

Medical consultation across distance using ICT — supplements, never replaces, direct care

Teleconsultation (Telekonsil)

Multiple doctors collaborate on complex cases (e.g. oncology) via video — with AI support for optimal treatment decisions

Telemonitoring

Continuous remote monitoring of vital signs. Wearables & home devices detect changes in chronic patients before emergencies occur

Teletherapy & Telecounseling

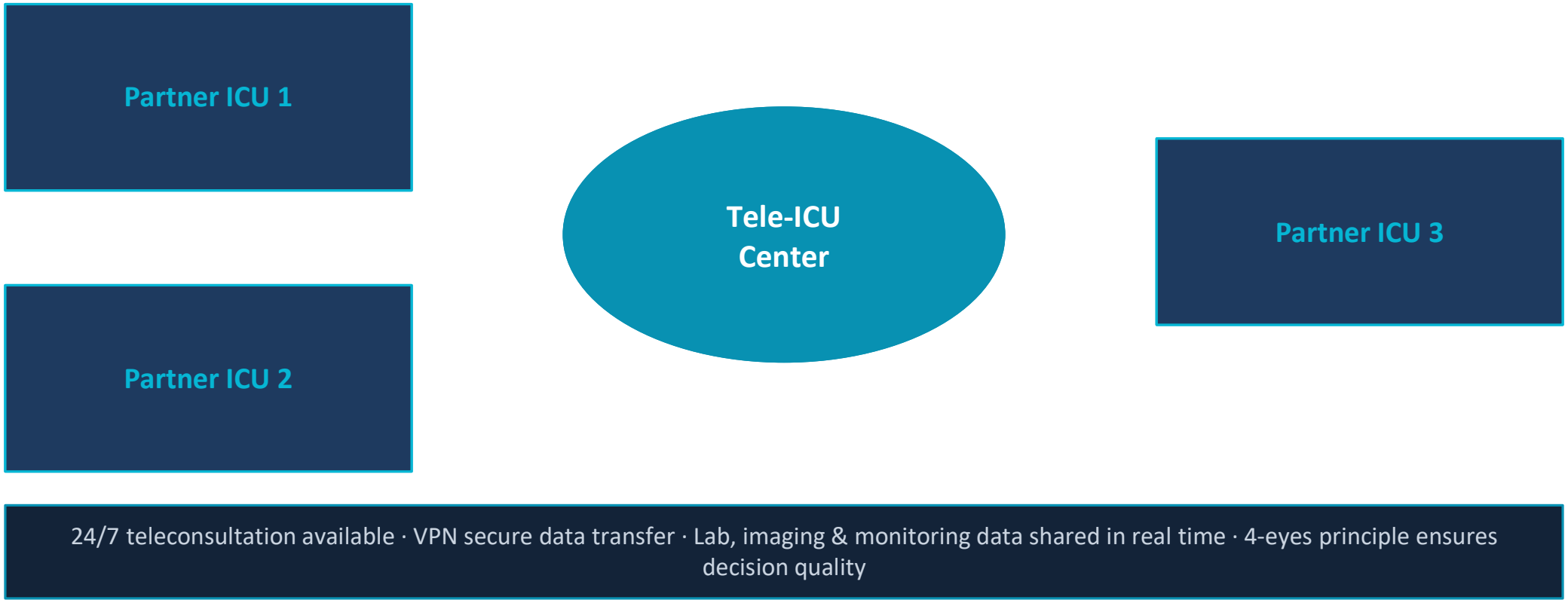
Online psychiatric consultations. Routine follow-ups for physical conditions without unnecessary travel

E-Triage

Online or phone tool that helps patients assess if a hospital visit is truly necessary — reduces ER overcrowding

Tele-Intensive Care & Hub-and-Spoke Model

- Video conferencing unit required at every partner ICU
- Dedicated tele-intensivists + specialists on call
- Can also operate as peer-to-peer cooperation between equal ICUs



24/7 teleconsultation available · VPN secure data transfer · Lab, imaging & monitoring data shared in real time · 4-eyes principle ensures decision quality

Effects of Telemedicine

↓ Mortality & Hospital Stay

More frequent consultations, earlier analysis, higher treatment compliance, faster emergency response

Sepsis Survival

~11% of ~2M ICU patients/year in Germany develop sepsis. Tele-visits dramatically improve protocol adherence

Tele-Stroke Care

In rural areas: stroke expert linked in immediately after admission. Correct treatment without delay

Tele-Emergency

Remote paramedic guidance via telenotarzt. Reduces unnecessary emergency doctor callouts

Early Warning Algorithms

AI-based systems detect organ failure early. Ambulatory patients continue normal life while monitored

Smartphone Apps

Post-treatment symptom tracking, audio-video follow-up consultations, self-management for chronic conditions

Telemedicine:
https://youtu.be/B9oC8vUjqk8?si=4P466pZWu3gTzj0v

Risks & Challenges

Cybersecurity & Ransomware

A single virus can shut down an entire digitalized hospital. No operations possible — patient lives at risk. IT security is the fundamental prerequisite for Clinic 4.0.

Data Privacy

Patient data is extremely sensitive. Full transparency required: patients must know who accesses their data and why. GDPR compliance is non-negotiable.

Liability & AI Decisions

If AI makes a wrong diagnosis or a cyberattack causes harm — who is liable? Legal frameworks must be defined before deploying advanced AI in clinical settings.

Once these hurdles are cleared → Clinic 4.0 offers more benefits than risks

Digital Administration (E-Government)

Simplification of internal & external workflows in public institutions via ICT

G2G
Government to Government

G2C
Government to Citizen

G2B
Government to Business

G2E
Government to Employees

✅ Advantages

- 24/7 service availability
- No in-person visits needed
- Frees staff for complex tasks
- Home office enabled for civil servants
- Faster, cheaper, more efficient processes

⚠️ Challenges

- Data privacy & IT security risks
- Digital accessibility barriers for elderly/disabled
- Federalism slows unified implementation
- Legacy IT systems (Lock-in effects)
- Political will and coordination required

Estonia – The Gold Standard of Digital Government

99%

of government services
fully digital

1×

Data submitted
only once (Once-Only)

X-Road

Secure data-sharing
platform between agencies

How Estonia Did It

- National ID card = driver's license + loyalty card + digital signature (PIN-protected)
- Citizens can see exactly who accessed their data, when and why
- Birth data auto-transferred from hospitals → child benefits paid automatically
- Legal digital signature — no more paper documents
- Only exceptions: marriage, divorce, property purchase

DE Germany

- OZG law (2017): all services digital by 2022
- Still relies on FAX for health reporting
- Birth certificate mailed to 3 agencies
- Federalism = 16 different approaches

Summary & Outlook

- Digitalization will save €42 bn/year in Germany — it's not optional, it's necessary
- Clinic 4.0 transforms every department: doctors, nurses, patients, research & admin
- Telemedicine improves survival rates, reduces hospital stays, enables remote care
- Cybersecurity, privacy, and liability must be solved — they are prerequisites, not afterthoughts
- Digital administration (Estonia model) shows what a fully connected healthcare + governance system looks like
- Germany has the legal framework in place — now execution and collaboration must follow

Medicine 4.0: The future of healthcare is networked, data-driven, and patient-centered.