Università degli Studi di Trieste

Corso di Laurea Magistrale in
INGEGNERIA CLINICA

CENNI DI TELEMEDICINA

Corso di Informatica Medica

Docente Sara Renata Francesca MARCEGLIA

Dipartimento di Ingegneria e Architettura

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Telemedicine origins

- 1960s → NASA experiments on humans in the space
  - Need of remote monitoring of astronauts health
  - Need of remote diagnosis and consultation

- 1974 → NASA study to define the minimum requirements for remote diagnosis

- 1977 → Canada uses the satellite network for tele-education

- Since then → many programs exploring the possibility to provide care at a distance were financed
  - Many medical specialties are interested in remote communication
  - Many environments are in need of remote communication

- Internet era and mobile era → prompted the development of systems and services

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Definitions (1/2)

- **"Telemedicine consists in the**
- **integration, monitoring and management of patients, as well as**
- **education of patients and healthcare professionals**
- **using systems and technologies allowing**
- **a prompt communication with experts and**
- **an effective access to patient's information,**
- **independent from where the patient is or the information are stored"**
- *(EC commission, 1990)*

Definitions (2/2)

USING A FORMAL NOTATION

Exchange of: audio, video, data, annotations $\cap$ Real time $\cap$ Medicine, Healthcare

Telemedicine and Telehealth

TELEMEDICINE

- Defined as the use of medical information exchanged from one site to another (American Telemedicine Association, ATA)
- Healthcare services involving patients
- The practice of medicine using ICTs

TELEHEALTH

- The use of ICTs to provide access to health assessment, diagnosis, intervention, consultation, supervision, and information across distance
- Broader than TeleMedicine → Includes non-clinical services, education, and training provided at a distance

The modalities of telehealth

Syncronous telemedicine

Real-Time

Provider and patient communicate via live video-conferencing. Used often in telepsychiatry, telehomecare, telecardiology and remote consults (teleconsults) with specialists, primary care physicians, counselors, social workers and other health care professionals.

Asyncronous telemedicine

Store & Forward

Digital images, video, audio, clinical data are captured and stored on a patient's computer or mobile device and then transmitted securely to a provider for later study or analysis. Used often in teledermatology and telepathology.

Telemonitoring

Remote Monitoring

Patient uses a system that feeds data from sensors and monitoring equipment to an external monitoring center so that health care professionals can monitor a patient remotely. Used to monitor chronic conditions such as heart disease, diabetes and asthma.

Technology

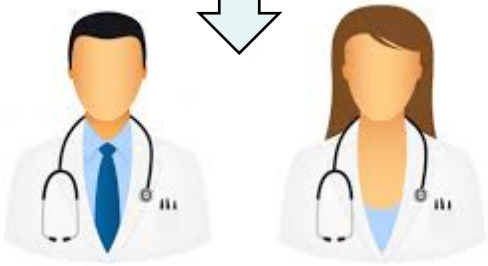
UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Application scenario

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

DATA

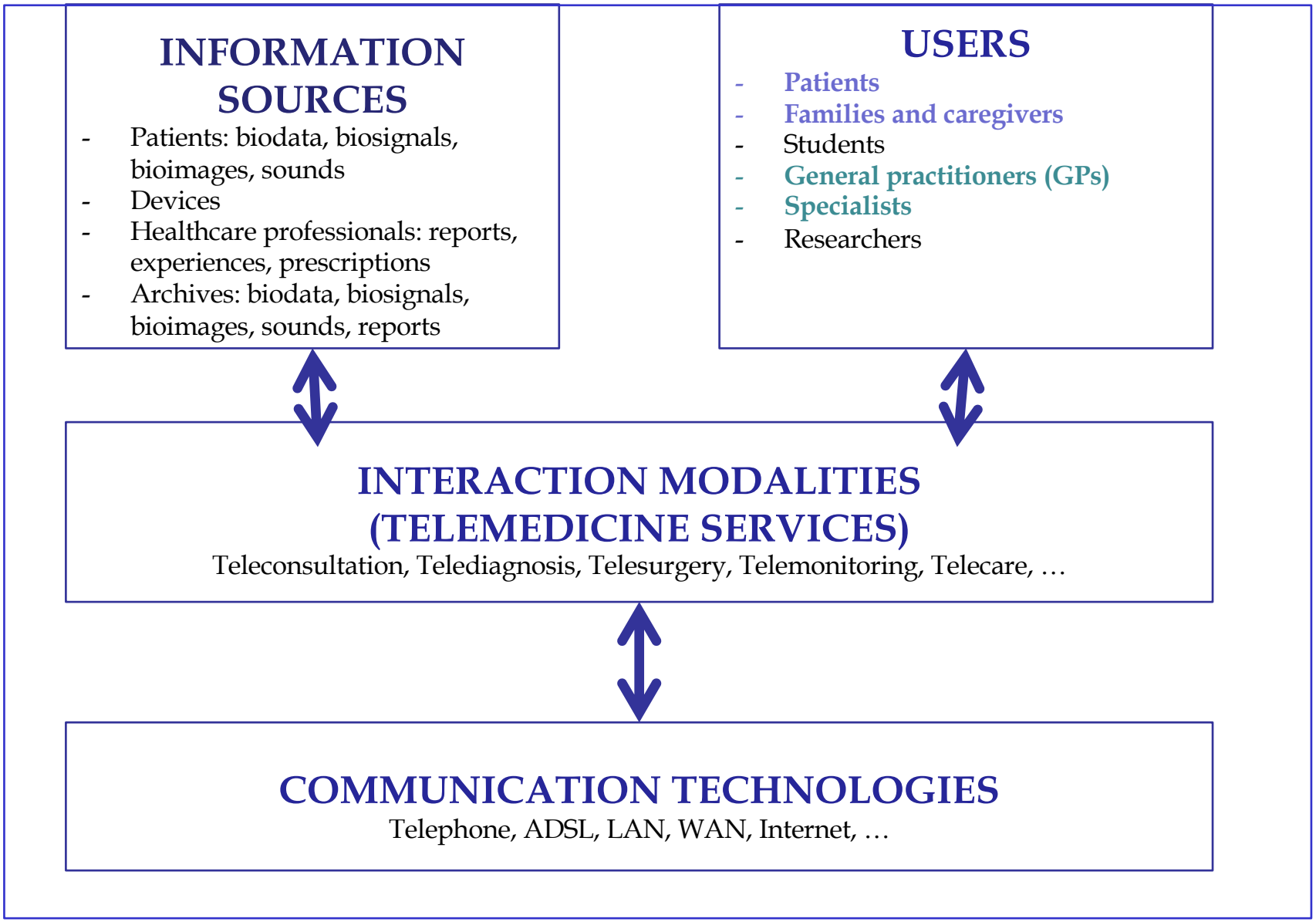
TELEMEDICINE SERVICES



TELECOMMUNICATON

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

A general model for telemedicine



Telemedicine systems: resources

- Medical devices for users
- Connection network
- Users →
  - Patients
  - Healthcare professional team
  - Consultants
- System managers →
  - Service providers
  - Communication providers
- Administration manager
- Legal consultants

Telemedicine systems: constraints

EDUCATIONAL CONSTRAINTS

- All users need specific training to use the system
- Resources have to be allocated for education and training

CERTIFICATION

- Healthcare services need to be accredited
- Quality measurements have to be defined also for telemedicine services

PRIVACY AND SAFETY

- Security related to data transmission and data storage have to be guaranteed
- Strong and shared access policies have to be defined to protect privacy

COSTS

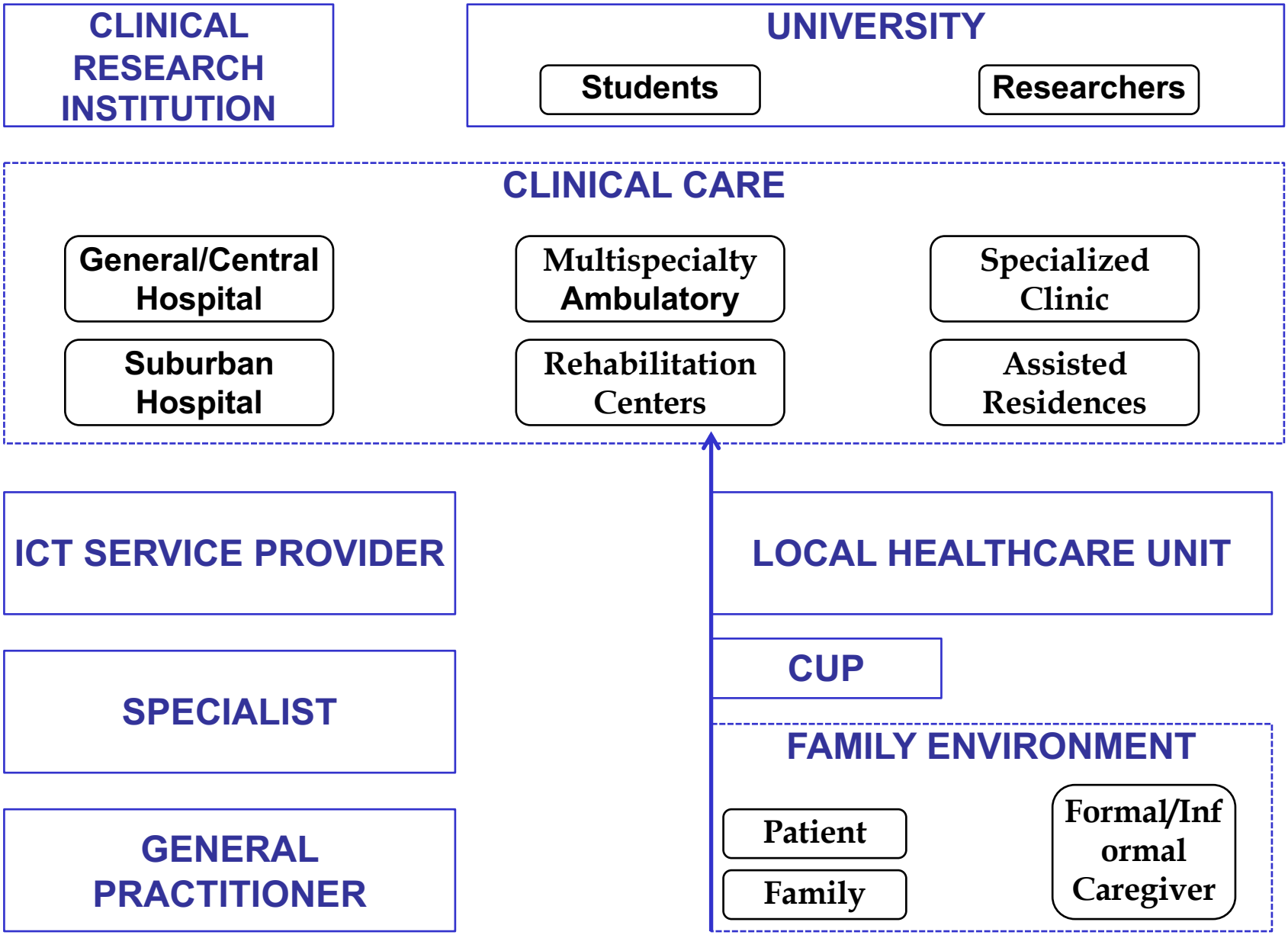
- Technical equipment
- Medical personnel

Telemedicine systems: system management procedures

- System test procedures (quality of the devices and the infrastructure; system functioning)
- Activation procedures (user definition, documentation, contracts and terms of use)
- Service provision procedure (detailed description of the service, data acquisition, specialist intervention, …)
- Access policies procedures
- Identification procedure
- Healthcare team shifts
- Storage and backup procedures
- Maintenance (ordinary) procedures
- Emergency procedures
- Operators training procedure
- Users training procedure
- Procedure for starting new services
- Assistance procedure

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Actors involved



Actors involved: users

- The users request the service→
  - Patients
  - Families
  - Formal/Informal caregivers
  - Institutions
  - Healthcare professionals
- The user is responsible to transmit and/or receive medical data/signals/images
- The user is responsible of satisfying the technical/behavioural constraints that are indicated by the service provider in order to ensure data quality and reliability
- To do so, the users need **specific training**

Actors involved: service providers

- Legally responsible for the provision of the service
- It is usually the healthcare service provider (institution, hospital, …)
- Should receive payments/reimbursements
- The service provider can use a third party for the technological infrastructures and services
- It is responsible for the correct integration of the telemedicine in →
  - The technological infrastructure of the institution
  - The clinical and administrative workflows and processes
  - The available budget and financial plan

Actors involved: technological providers

- The role of the technological provider is crucial because it ensures the communication infrastructure

- The responsibility of the technological provider depends on its contract with the service provider:
  - Connection timing
  - Maximum time without connection
  - Data quality requirements
  - Data storage requirements
  - Emergency intervention time frame
  - Security and privacy requirements

Telemedicine systems: classifications

By medical specialty	By healthcare path phase	By healthcare service
• Telecardiology • Telepathology • Teleradiology • Teleoncology • Telesurgery • …	• Teleprevention • Telediagnosis • Telerehabilitation • …	• Telereport • Teleconsultation • Telemonitoring • …

Telemedicine classification by service

Tele-reporting

- → the reports are created and visualized remotely

Tele-consultation

- → a second opinion is asked remotely

Tele-explanation

- → from a specialized to a non-specialized physician

Tele-psychology

- → to provide comfort to the patient/family

Tele-monitoring

- → remote monitoring of patient's clinical condition

Tele-prescription

- → remote prescribing (drug, therapies, rehabilitation, activities, exercises,..)

Tele-control

- → possibility to remotely change what is monitored

Tele-booking

- → remote booking of visits, exams, …

Tele-administration

- → remote control of administrative procedures

Tele-education

- → training, support, and even examination in a remote fashion

Examples

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Televisits

Examples

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Telerehabilitation

t-kura

Home Servizi Esperti Come Funziona Chi siamo Contatti

Questo sito utilizza cookie tecnici, analytics e di terze parti, proseguendo nella navigazione accetti l'utilizzo dei cookie. Ok Privacy e cookie policy

Example

eazyScripts gets $2M to help telemedicine providers e-prescribe

By Jeff Lagasse

The company's e-prescribing solution was built to address the specific needs of telemedicine providers, aiming for a user experience that's fast and efficient. EazyScripts said its clients are saving time, increasing patient volume and improving patient and provider satisfaction.

Its user interface, striving for modernity, enables providers to begin using it without any training, and it's adaptable to a provider's preferences, running on desktops, laptops, tablets, and smartphones.

Providers can send an electronic prescription in a matter of seconds, the idea being that they can put a greater focus on patients' health outcomes. EazyScripts also offers secure electronic prior authorization and medication adherence options

Example Service to support telemedicine

Telemedicine efficacy

- At present, the **efficacy of telemedicine intervention is still under debate**
- One of the main problems is the lack of appropriate and systematized **research methodologies**:
  - Economic analysis of telemedicine has not yet met accepted standards
  - Lack of exploration of the socio-economic impact of telemedicine
  - Lack of evidence on factors promoting uptake of telemedicine is lacking
  - Qualitative methods face an undeveloped use
- Evaluation is still dependent on the **implementation place**:
  - No cross-border collaboration
  - No common language to establish benefits and drawbacks

Elements to evaluate the efficacy of the service/system (PICO)

Population/participants

- Clear identification of the target users
- Definition of the key stakeholders: patients, families, caregivers, healthcare professionals

Interventions

- ICT tool used
- Phase
- Health vs Social

Comparisons

- With standard care
- With other systems

Outcomes

- Health related outcomes (morbidity, mortality, quality of life, patient' satisfaction)
- Process outcomes (quality of care, professional practice, adherence to recommended practice, professional satisfaction)
- Costs or resource use.

Is telemedicine effective? YES

Types of interventions that were found to be therapeutically effective include:

- online psychological intervention, telepsychiatry, and cognitive behavioural therapy
- programmes for chronic heart failure with remote monitoring
- home telemonitoring of respiratory conditions
- web and computer-based smoking cessation programmes
- telehealth approaches to secondary prevention of coronary heart disease
- Virtual reality exposure therapy (VRET) for anxiety disorders
- robot-aided therapy of the proximal upper limb
- home telehealth for diabetes, heart disease and chronic obstructive pulmonary disease
- internet based physical activity interventions

Is telemedicine effective? PROMISING

- Areas in which telemedicine showed therapeutic promise, but still requires further research include:
  - Virtual reality in stroke rehabilitation
  - Symptoms and behaviour associated with and knowledge about specific mental disorders and related conditions
  - Diabetes
  - Weight loss interventions and possibly weight loss maintenance
  - alcohol abus
- Telemedicine seems also promising in terms of:
  - Health service utilisation (e.g., asynchronous telehealth developments could result in shorter waiting times, fewer unnecessary referrals)
  - High levels of patient and provider satisfaction with equivalent (or better) diagnostic accuracy.
  - Positive patient experiences and empowerment especially for patients with chronic conditions and in rural areas

Is telemedicine effective? NOT ENOUGH EVIDENCE

- The improvements introduced by telemedicine services and systems is only partial (e.g., in diabetes it improves glycemic control but not other aspects of management)

- There is a lack of Randomized Controlled Trials (RCTs)

- There remain certain topics that require further research, → technical, ethical, legal, clinical, economical and organisational implications and challenges

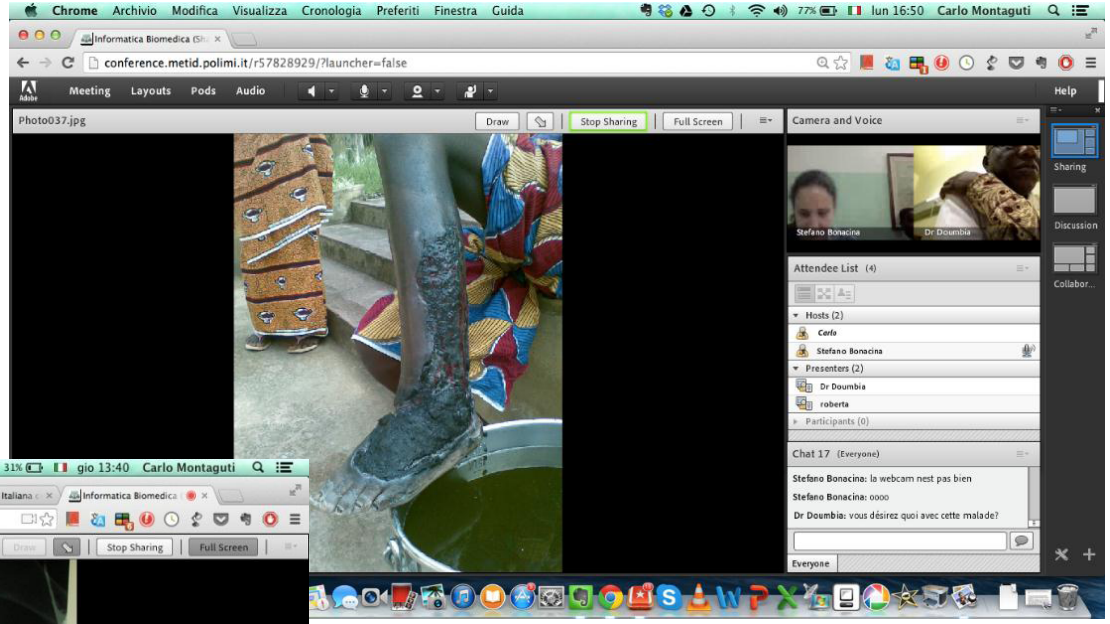
- Telemedicine is a dynamic field, and new studies and new systematic reviews are rapidly being published also on new areas of intervention (e.g., smart homes, spiritual care)

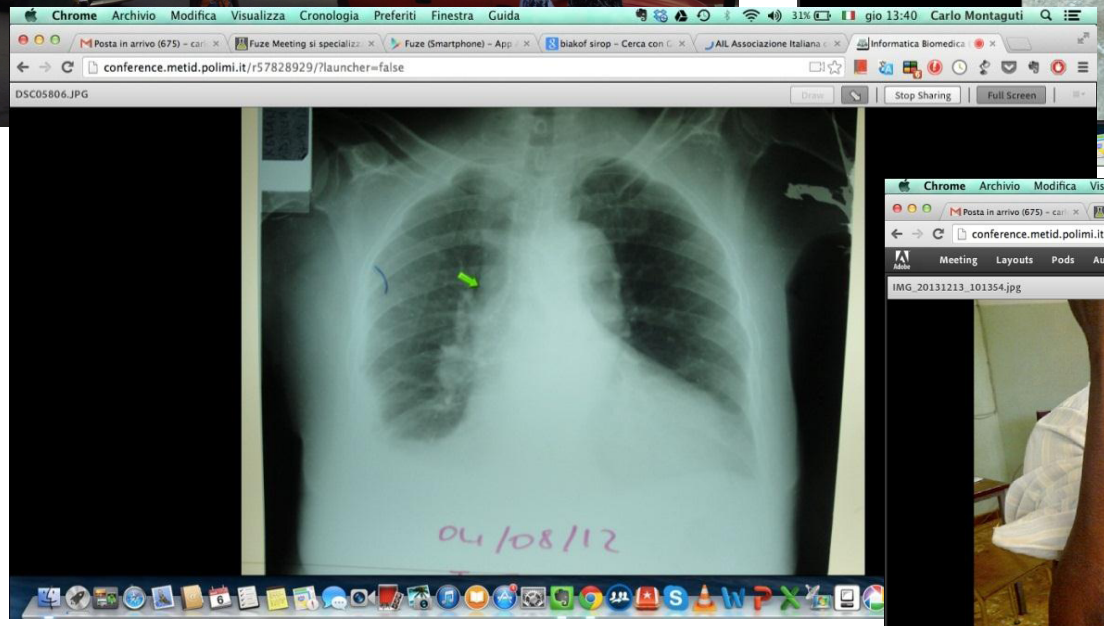
Other aspects of efficacy

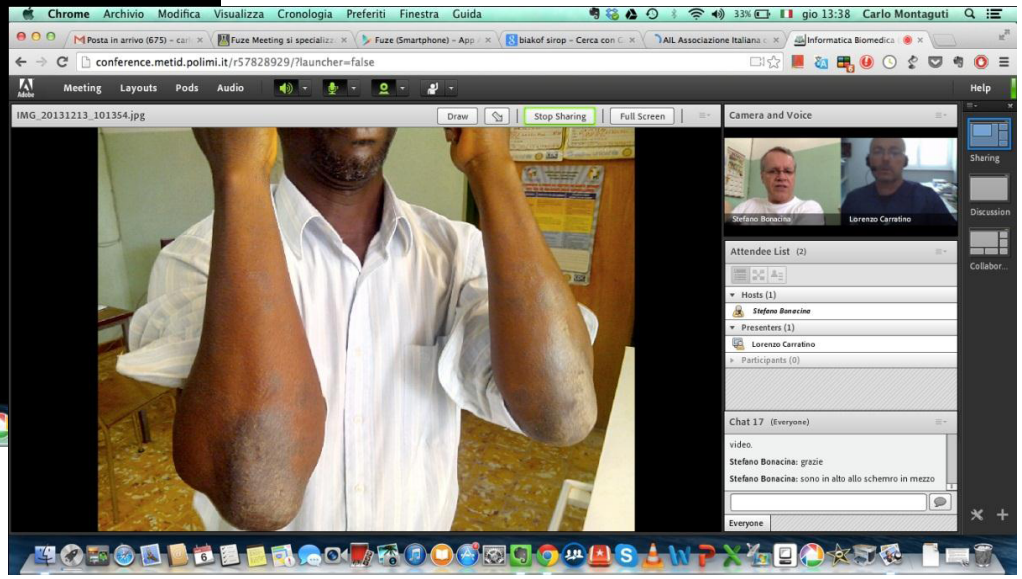
- The knowledge and understanding on the costs of telemedicine is still lacking:
  - Cost-effectiveness is usually related to the decrease in the use of hospitals, improved patient compliance and satisfaction
  - However, social and organizational costs have to be quantified
- Telemedicine may further alter the patient/healthcare professional relationship → education and empowerment
- The telemedicine service/system can be not suitable for everybody→
  - More user-centered design
  - Consider gender and age issues
- Present lack of guidelines

Where telemedicine can be effective

UNIVERSITÀ
DEGLI STUDI DI TRIESTE





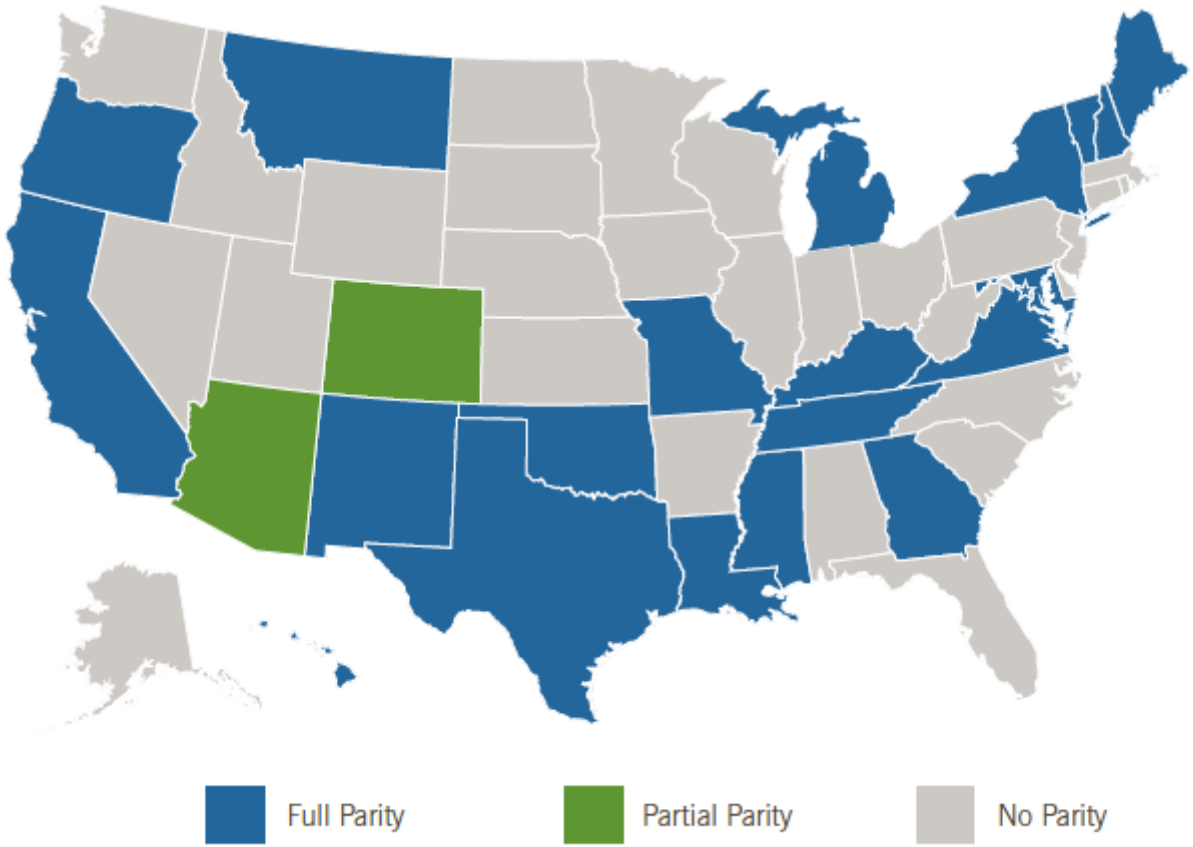


Rural areas with poor transportation infrastructures can benefit from teleconsultation and telediagnostic

Who pays for telemedicine services?

Twenty states and the District of Columbia have enacted parity laws requiring insurers to cover telehealth services.

Chart 4: Private Payer Coverage and Reimbursement for Telehealth Services



- Do public and private payers cover telehealth services and adequately reimburse hospitals?
- Payment is a complex and evolving issue and a possible barrier to adopting such services.
- Providers that also have their own health plans may find it easier to deploy telehealth because they control their coverage guidelines and can benefit from the cost savings.

Adoption history

Teladoc's membership hits 17.5M in Q4 2016

"So we look at the remote monitoring space quite a bit. I would say our first step into that is not exactly remote monitoring, but we did a partnership with CareCentrix around the home care space, where a home care nurse can bring one of our physicians into the home virtually to help assess a patient," he said. "Remote monitoring gets to the next level of clinical integration. And so we are starting to talk to some hospital systems primarily about what they are doing and how we could be helpful to them. But it's not I wouldn't call it immediate on our product roadmap. It's a little further out relative to the next, let's say, 9 months to 12 months."

"During the year, we completed our company's 2 millionth telehealth visit, representing savings through our clients in the U.S. healthcare system of over $900 million," Gorevic said on the call. "As context, it took us about 12 years to reach our first million visits, while only 14 months for our second million. This clearly signals the inflection point in overall telehealth adoption."

Adoption history

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

mobihealthnews

PROVIDER PAYER PHARMA CONSUMER INVESTOR Search

Why the utilization conversation in telemedicine is bigger than dollars and cents

By **Jonah Comstock** | March 09, 2017

SHARE Share 0

A study **published in Health Affairs** and conducted by the RAND Corporation made a big splash this week with a bold claim: That telemedicine doesn't actually reduce healthcare costs because the increased convenience leads to increased utilization, which ultimately costs more than in-person care would have.

The study looked at claims data from a cohort of 300,000 employees with access to Teladoc through their employer. Researchers compared a cohort of telemedicine users to a cohort of non-telemedicine users and found that in the telemedicine users, visits to primary care doctors barely decreased, meaning that the Teladoc visits were mostly additive (visits that otherwise would not have occurred), rather than substitutive (visits that otherwise would have occurred in person). They found that 88 percent of visits were additive, and only 12 percent replaced in-person visits. The result: telemedicine cost the payer $45 per patient more than a plan without telemedicine would have.

Today

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

New development: 'Healing at a distance'—telemedicine and COVID-19

Higor Leite, Ian R. Hodgkinson & Thorsten Gruber

To cite this article: Higor Leite, Ian R. Hodgkinson & Thorsten Gruber (2020): New development: 'Healing at a distance'—telemedicine and COVID-19, Public Money & Management, DOI: 10.1080/09540962.2020.1748855

To link to this article: https://doi.org/10.1080/09540962.2020.1748855

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES

CSH Cold Spring Harbor Laboratory BMJ Yale

HOME | AB

Search

Comment on this paper

From Isolation to Coordination: How Can Telemedicine Help Combat the COVID-19 Outbreak?

Yunkai Zhai, Yichuan Wang, Minhao Zhang, Jody Hoffer Gittell, Shuai Jiang, Baozhan Chen, Fangfang Cui, Xianying He, Jie Zhao, Xiaojun Wang

doi: https://doi.org/10.1101/2020.02.20.20025957

This article is a preprint and has not been peer-reviewed [what does this mean?]. It reports new medical research that has yet to be evaluated and so should *not* be used to guide clinical practice.

SHARE April 03, 2020 SPECIAL EDITORIAL

COVID-19 is catalyzing the adoption of teleneurology

Brad C. Klein, Neil A. Busis

First published April 1, 2020, DOI: https://doi.org/10.1212/WNL.0000000000009494

FULL PDF | CITATION | PERMISSIONS | MAKE COMMENT | SEE COMMENTS | Check for updates | Downloads

BMJ 2020;368:m998 doi: 10.1136/bmj.m998 (Published 12 March 2020)

The NEW ENGLAND JOURNAL of MEDICINE

Virtually Perfect? Telemedicine for Covid-19

Judd E. Hollander, M.D., and Brendan G. Carr, M.D.

EDITORIALS

Check for updates

Video consultations for covid-19

An opportunity in a crisis?

Trisha Greenhalgh *professor*[1], Joe Wherton *researcher*[1], Sara Shaw *associate professor*[1], Clare Morrison *quality improvement lead*[2]

COVID-19 for Fast Track Publication

Telemedicine in the Time of Coronavirus

Brook Calton, MD, MHS, Nauzley Abedini, MD, MSc, and Michael Fratkin, MD
Division of Palliative Medicine (B.C., N.A.), Department of Medicine, University of California, San Francisco (UCSF), San Francisco, California; and ResolutionCare (M.F.), Eureka, California, USA

SPECTIVES IN HOSPITAL MEDICINE

: Telemedicine for COVID-19 Pandemic Response

MD, MBA*, Yonatan Platt, MD, John R Dressen, MHA,
ws, MD, FACP, SFHM, Jerome C Siy, MD, MHA, SFHM

, Bloomington, Minnesota.

What has been implemented

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

- Enabling medical staff to **deliver services via telemedicine** (whatever platform)
- **Health services remote access** for citizens to reduce the risk of exposure to COVID-19.
- **Online consultation** in designated areas to avoid patient visits to general practitioners (NHS, 2020).
- Full **e-prescribing** (via email) – Lombardy
- **Triage** implementation via telemedicine before people enter healthcare facilities, to limit unnecessary healthcare visits (CDC, 2019).
- Approaches to **identify and track** infected sub-populations and areas, as well as provide self-assessment capabilities, are telemedicine apps

Services

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

TABLE. **Telemedicine Applications for COVID-19 Pandemic Response**

Application	Example(s)
Patient Triage	Online screening tool with/without video; remote monitoring of triage rooms with self-administered NP[a] swabs
Direct Care	Telemedicine equipment[b] used by attending services as adjunct to standard bedside rounding; also used by specialists[c] to see COVID-19 suspected or confirmed cases at rural sites without usual access
Exposure Reduction	Telemedicine equipment[b] placed in patient room and at nurses stations to limit entry/exit of isolation rooms; also used by specialists[c] with multiple patients at tertiary or quaternary care sites to limit exposure
Provider Shortages	Ill or self-monitoring providers can round on and care for admitted patients from home

[a]NP: nasopharyngeal

[b]Mounted screen with camera, tablet/laptop with integrated camera, or similar

[c]eg, Infectious Disease, Cardiology, Critical Care, Pulmonology

Emergency telemedicine system in China

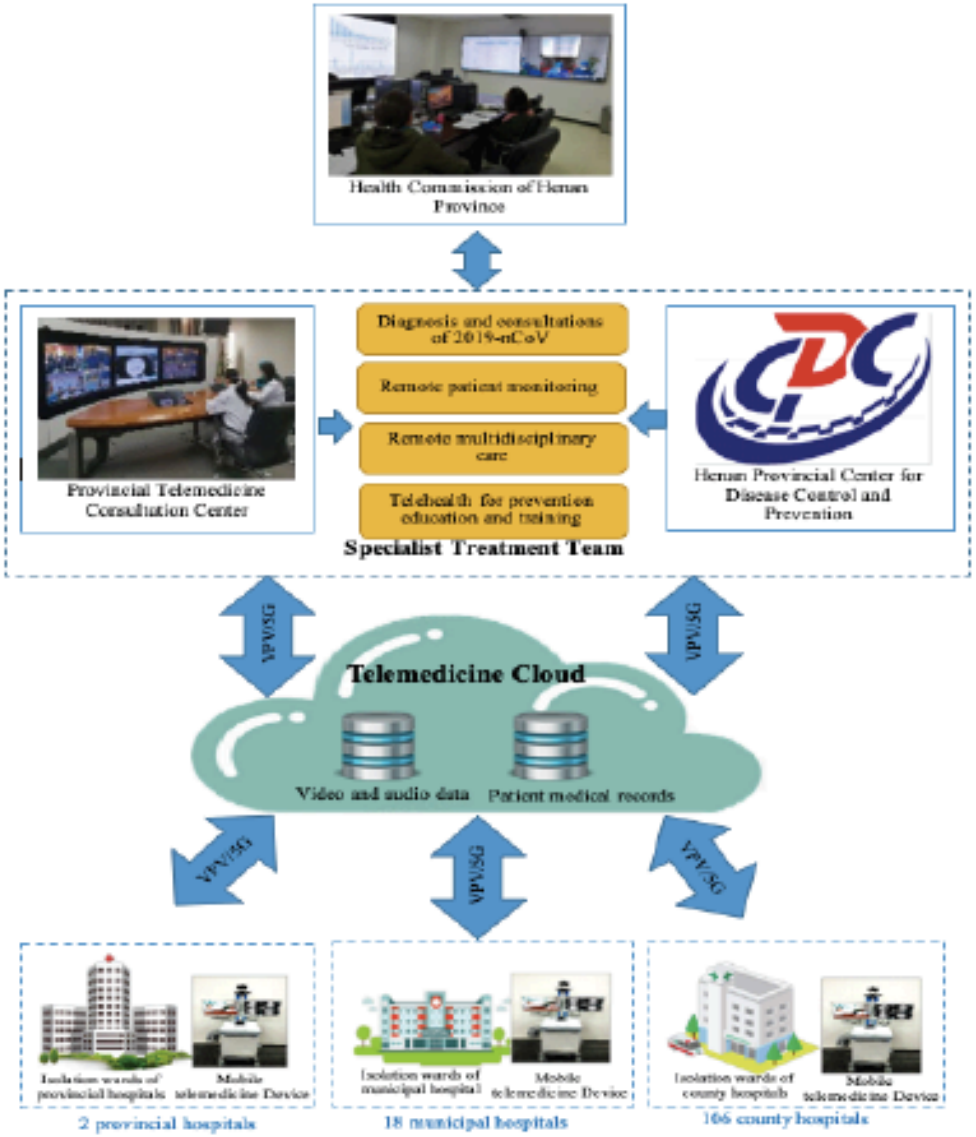


Figure 1. Architecture of the Emergency Telemedicine Consultation System

Zhai et al, 2020

How this system helped in China

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

- **Care:** Severe cases and patients with mild and moderate respiratory infections received telemedicine consultations through the ETCS.
- **Diagnostic support to avoid healthcare workers infectios:** In the isolation wards, the mobile telemedicine device effectively collects, transforms, and evaluates patient health data such as blood pressure, oxygen level, and respiratory rate, and reports them to the care team, to avoid direct physical contact.
- **Involvement of different specialists at low risk,** including nurse care managers and social workers to help patients with pneumonia obtain post-treatment care to avoid coronavirus re-infection.
- **Education:** the specialist treatment team provides primary care guidance on coronavirus (e.g., clinical criteria for COVID-19 diagnosis, patient transfers, and cleaning process) to all physicians and nurses at 126 connected hospitals via video conference.

Contact Tracing systems

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Singapore TraceTogether
https://youtu.be/buj8ZTRtJes

BLUE TRACE
https://github.com/OpenTrace-Community

- community-driven approach where participating devices exchange proximity information whenever an app detects another device with the TraceTogether app installed.
- Based on Bluetooth Relative Signal Strength Indicator (RSSI) readings between devices across time to approximate the proximity and duration of an encounter between two users
- This proximity and duration information is stored on one's phone for 21 days on a rolling basis — anything beyond that would be deleted. No location data is collected.
- If a person unfortunately falls ill with COVID-19, the Ministry of Health (MOH) would work with them to map out their activity for past 14 days, for contact tracing.
- Only 12% of the population installed it
- **Privacy concerns**

Pan-European initiatives

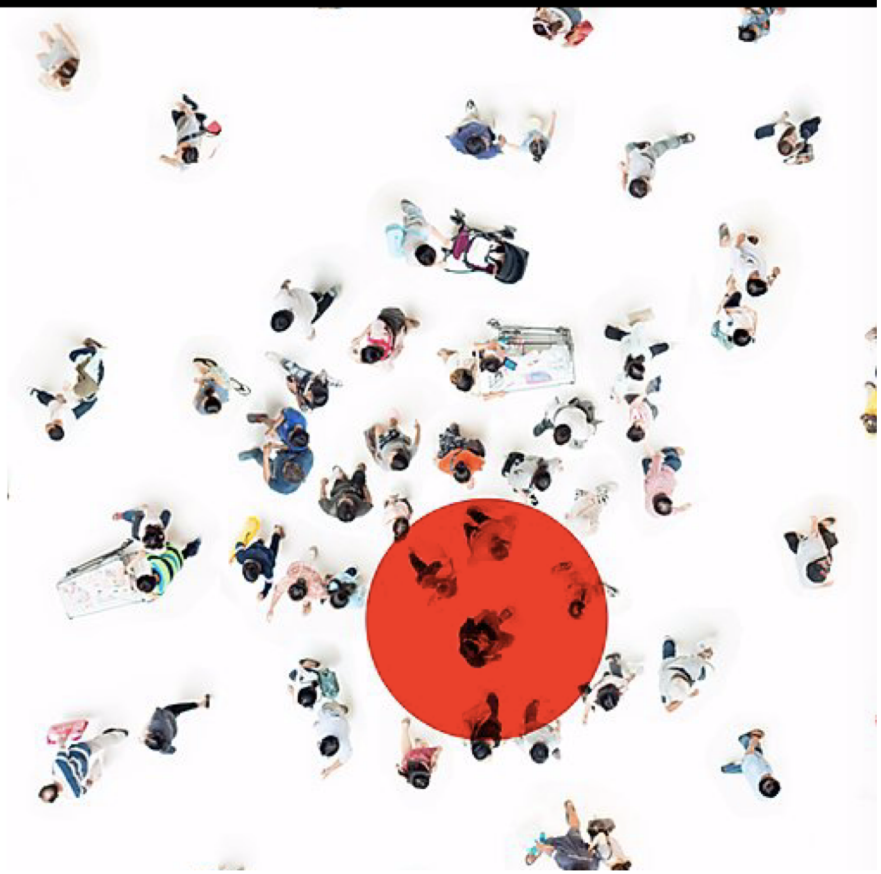
UNIVERSITÀ
DEGLI STUDI DI TRIESTE

OVERVIEW

PEPP-PT

Privacy-Preserving Proximity Tracing

Pan-European Privacy-Preserving Proximity Tracing (PEPP-PT) makes it possible to interrupt new chains of SARS-CoV-2 transmission rapidly and effectively by informing potentially exposed people. **We are** a large and inclusive European team. **We provide** standards, technology, and services to countries and developers. **We embrace** a fully privacy-preserving approach. **We build on** well-tested, fully implemented proximity measurement and scalable backend service. **We enable** tracing of infection chains across national borders.



PEPP-PT

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

The PEPP-PT mechanisms will have these core features:

1. Well-tested and established procedures for proximity measurement on popular mobile operating systems and devices.
2. Enforcement of data protection, anonymization, GDPR compliance, and security.
3. International interoperability to support tracing local infection chains even if a chain spans multiple PEPP-PT participating countries.
4. Scalable backend architecture and technology that can be deployed with local IT infrastructure.
5. Certification service to test and ensure local implementations use the PEPP-PT mechanisms in a secure and interoperable manner.
6. Our reference implementation is available under the Mozilla License Agreement.

Contact-tracing system - alert

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Decentralized Privacy-Preserving Proximity Tracing

Version: 12th April 2020.
Contact the first author for the latest version.

EPFL: Prof. Carmela Troncoso, Prof. Mathias Payer, Prof. Jean-Pierre Hubaux, Prof. Marcel Salathé, Prof. James Larus, Prof. Edouard Bugnion, Dr. Wouter Lueks, Theresa Stadler, Dr. Apostolos Pyrgelis, Dr. Daniele Antonioli, Ludovic Barman, Sylvain Chatel

ETHZ: Prof. Kenneth Paterson, Prof. Srdjan Čapkun, Prof. David Basin, Dr. Jan Beutel, Dennis Jackson

KU Leuven: Prof. Bart Preneel, Prof. Nigel Smart, Dr. Dave Singelee, Dr. Aysajan Abidin

TU Delft: Prof. Seda Guerses

University College London: Dr. Michael Veale

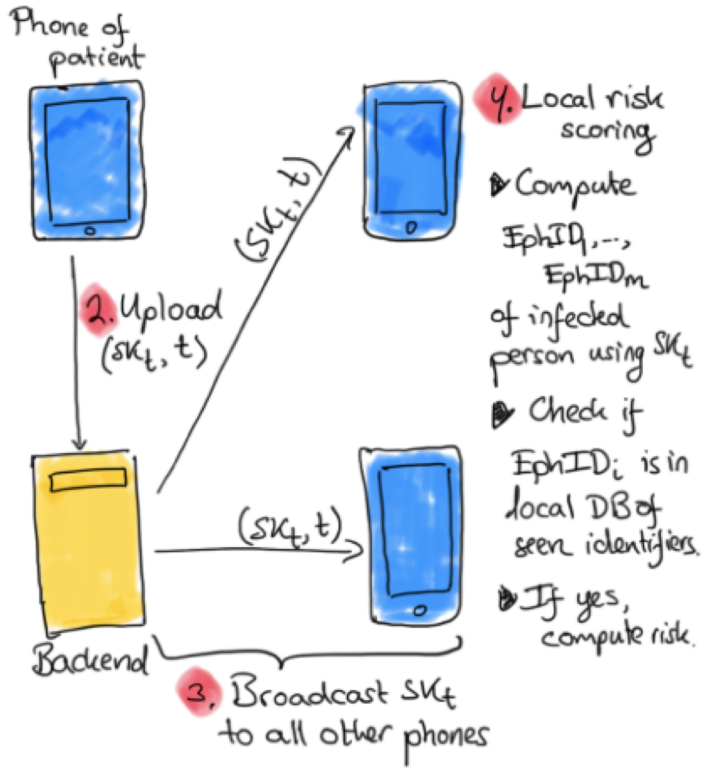


Figure PT: proximity tracing process.

The system provides the following security and privacy protections:

- **Ensures data minimization**. The central server only observes anonymous identifiers of infected people without any proximity information; health authorities learn no information (beyond when a user manually reaches out to them after being notified); and epidemiologists obtain minimal information regarding close contacts.
- **Prevents abuse of data**. As the different entities in the system receive the minimum amount of information tailored to their requirements, none of them can abuse the data for other purposes, nor can they be coerced or subpoenaed to make other data available.
- **Prevents tracking of non-infected users.** No entity, including the backend, can track *non-infected users* based on broadcasted ephemeral identifiers.
- **Graceful dismantling.** The system will organically dismantle itself after the end of the epidemic. Infected patients will stop uploading their data to the central server, and people will stop using the app. Data on the server is removed after 14 days.

https://github.com/DP-3T/documents/blob/master/DP3T%20White%20Paper.pdf

Regulatory considerations

- The COVID-19 crisis stimulated policy makers, regulators and payers to encourage expanded use of remote health care. Policy restrictions were loosened or lifted.
- Many telehealth services are now reimbursed with few associated administrative burdens.
- In the USA, some federal rules have been waived to make it easier for physicians to provide care remotely, i.e. to adopt telemedicine

This change is not merely installing or using new technology but introducing and sustaining major changes to a complex system.