
# ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

**FAKULTA BIOMEDICÍNSKÉHO INŽENÝRSTVÍ**

**Katedra biomedicínské techniky**


# eHealth at GP's
**benefits and limits**

# eHealth u praktických lékařů
**přínosy a omezení**

Diplomová práce

Study program: Biomedical and Clinical Engineering
Field of Study: Systematic Integration of Processes in Health Service

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ČVUT
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# ZADÁNÍ DIPLOMOVÉ PRÁCE

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## II. ÚDAJE K DIPLOMOVÉ PRÁCI

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Pokyny pro vypracování:

Cílem diplomové práce je zhodnotit fungování jednotlivých komunikačních nástrojů eHealth využívaných praktickými lékaři v ČR a ve vybraných zemích EU. Zmapovat aktuálně využívané nástroje komunikace eHealth u praktických lékařů v ČR a ve vybraných zemích EU a diskutovat jejich slabé a silné stránky. Dále zhodnotit dopady těchto nástrojů na kvalitu a dostupnost zdravotnické péče v ČR a navrhnout možné alternativy systémových změn ve zkoumané oblasti.

Seznam doporučené literatury:

[1] WHO, Světová zdravotnická organizace, 09/03/2017, http://www.who.int/topics/health_workforce/en/
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# ABSTRACT

**eHealth at GP's: benefits and limits**

The digitalization of healthcare is logical consequence of technology infiltration into all fields of human activity. eHealth development offers new solutions for remote physician-patient interaction. The aim of this thesis is to explore which communication eHealth tools general practitioners (GP) currently use for patient consultations and to analyse their benefits and limits. Systematic literature review was performed to collect the evidence on eHealth communication tools impact on GP's workload, system security, health risks and user's perception of the consulting technology. Secure portals and chatbots provide the highest potential to decrease the workload and provide the most secure consultation environment. Health risks are higher when the communication channel is not integrated to the patient's electronic helath record. Patients' perception of communication media in the primary care is overall more positive than GPs'.



## Keywords

eHealth; telehealth; primary care; general practitioners; physician-patient communication

# ABSTRAKT

**eHealth u praktických lékařů: přínosy a omezení**

Digitalizace zdravotnictví je logickým důsledkem infiltrace technologií do všech oblastí lidské činnosti. Vývoj eHealth nabízí nová řešení pro vzdálenou interakci lékaře a pacienta. Cílem této práce je prozkoumat, jaké komunikační nástroje eHealth praktičtí lékaři (PL) v současné době používají pro konzultace s pacienty, a analyzovat jejich přínosy a omezení. Byl proveden systematický literární přehled k získání důkazů o eHealth komunikačních nástojích a jejich dopadu na pracovní vytížení PL, zabezpečení systému, zdravotní rizika a z pohledu vnímání konzultační technologie uživatelem. Zabezpečené portály a chatboty poskytují nejvyšší potenciál ke snížení pracovní zátěže a poskytují nejzabezpečenější konzultační prostředí. Zdravotní rizika jsou vyšší, pokud komunikační kanál není integrován do elektronického zdravotního záznamu pacienta. Vnímání komunikačních technologií pacienty v primární péči je celkově pozitivnější než praktickými lékaři.

## Klíčová slova

eHealth; telehealth; primární péče; praktičtí lékaři; komunikace pacient-lékař

# Content

# List of Abbreviations

| Abbreviation | Meaning |
|---|---|
| AI | Artificial Intelligence |
| App | Application |
| APR | Automated Patient Record |
| CPR | Computerized Patient Record |
| CSU | The Czech Statistical Office *(Český statistický úřad)* |
| CZ | Czech Republic |
| DESI | Digital Economy and Society Index |
| EHR | Electronic Health Record |
| EMR | Electronic Medical Record |
| EU | European Union |
| GDPR | General Data Protection Regulations |
| GP | General Practitioner |
| HCP | Health Care Professional |
| ICT | Information and Communication Technologies |
| MZCR | Ministry of Health of The Czech Republic *(Ministerstvo zdravotnictví České republiky)* |
| NeHC | The National eHealth Centre |
| NHS | National Health Service |
| PHR | Personal Health Record |
| SRSS | Structural Reform Support Service |
| UK | United Kingdom |
| ÚZIS | Institute of Health Information and Statistics of the Czech Republic *(Ústav zdravotnických informací a statistiky ČR)* |
| WHO | The World Health Organisation |

# 1 Introduction

Communication between healthcare professional and patient is a key component of provided healthcare [1]. Traditionally, face-to-face communication has been used for physician-patient interaction. However, technological development over the past decades have opened new communication tools often occurring outside of the clinical settings, as for example online video, social media and smart phone applications [2–6]. Distant physician-patient consultations supported by Information and Communication Technologies (ICT) is a distinct part of eHealth development which has become to be viewed as a worldwide trend including Czech Republic [5, 7, 8].

Remote consultancy is one of the objectives in The Czech National eHealth Strategy, in order to help increase citizens' insight in their own health [8]. eHealth communication is also often considered as a way to improve chronic diseases management [9], increase healthcare access in rural areas [10] and to assist in emergency situations, particularly in the context of epidemic events [11, 12]. Increasing usage of ICT in healthcare has raised questions about its impact on physicians' workload and data security [4, 13]. Also concerns have been expressed that remote consultations may have been clinically risky and less acceptable to patients [6]. However, nowadays we are seeing proactive approach towards online consultations usage due to the ongoing coronavirus outbreak – healthcare professionals are globally encouraged to provide remote services [14], which could be seen as an opportunity to get ample evidence of the eHealth value.

Therefore, the aim of this diploma thesis is to evaluate the performance of eHealth communication tools used by general practitioners in the Czech Republic and in selected EU countries. Firstly, to map eHealth communication tools currently used by general practitioners in the Czech Republic and in selected EU countries and discuss their benefits and limits. Secondly, the aim is to evaluate the impact of these tools on quality and availability of healthcare in the Czech Republic and to suggest possible alternatives to system changes in the research topic.

The presented work is structured into three parts. In the first one author provides theoretical background of studied area. In the second part author presents the overview of eHealth tools GPs currently use for communication with their patients. Besides the Czech Republic author focuses on EU countries where eHealth communication is the most developed. The third part of the thesis is practical, evaluating benefits and limits of the eHealth tools from aspects including GP's workload impact, system security, health risks and patients' perception. Key findings of this practical part are crucial for the whole work as they help to complete author's evaluation of how

discussed communication tools affect the quality and availability of provided healthcare and are also used to justify proposals of possible system changes.

This diploma thesis contributes to an understanding of the increasingly developing field of healthcare digitalisation. It provides up-to-date overview of used communication tools in primary care in the Czech Republic and selected EU countries. Author presents an analysis of benefits and limits and thus brings an answer to the question of their effectiveness and impact on the quality and availability of provided care with the focus being given on general medicine. General medicine is closest to patients in terms of local, temporal, economic and cultural accessibility [15] and therefore integrated healthcare supported by eHealth requires foremost full involvement of general practitioners (GPs) in the primary care. Key findings and suggestions of this thesis are aimed for professionals involved in implementing eHealth services and representatives engaged in legal, ethical and governance frameworks preparation.

# 2 Theoretical Background

Following chapter is dedicated to definitions of important terms necessary for basic orientation in the investigated topic. Firstly, the role of GPs in the health care system is explained. Secondly, the term eHealth is defined, followed by description of ICT tools available to use in physician-patient communication. Finally, definitions of related eHealth tools are provided to help the reader in understanding of the thesis content.

## 2.1 Primary Care

Primary care systems provide first-contact, accessible, continuous, comprehensive and coordinated care with given focus on people´s needs as close as possible to their everyday environment [16]. The primary care workforce may differ from country to country, but general practitioners (or "family doctors") are the most common primary care providers in Europe [17].

Therefore, general practitioners and family physicians should be the initial contact for disease prevention as well as for acute and chronic health issues. They are providing continuous care that focuses on the personal long-term health based on a commitment between health care professional and the individual. Comprehensive patient-centred approach of primary care is centred on the whole human taking into consideration overall physical, mental and social circumstances. Coordination presents the role by which primary care coordinates other specialists that the patient may need.[16]

The focus on primary care is particularly important in the context of chronic health conditions and population ageing [17]. With its emphasis on prevention and management of long-term conditions, primary care has proven to be an efficient way to address the main causes of poor health [16]. At the macro level, it promotes the population health and wellbeing, while at the micro level it contributes to well-coordinated and cost-effective health care system [17].

## 2.2 eHealth

During the 1990s the Internet started to have a revolutionary impact on the society. Since then the technology development and digitalisation of services has been continuously growing. Computers, laptops, tablets and smartphones became routinely used by the public. These technologies have shown remarkable value for health as they became more advanced and more incorporated into all sectors modern society [18]. Digital environment offers new opportunities for delivering health care in the areas of prevention, health promotion, curative interventions and self-management, to name a few, that may contribute to deliver health system goals. Therefore European

policies have consistently emphasised the importance of digital solutions such as electronic health (eHealth).[19]

There is no unique definition of eHealth which would be generally accepted although its widely used term [7, 20]. According to Eysenbach [20], eHealth is *"an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology."*

The World Health Organization [7] (WHO) defines eHealth as an umbrella term that involves a broad group of activities using electronic means to deliver health-related information, resources and services. It means the use of information and communication technologies for health. With regard to the definition above, eHealth term covers not only clinically used technologies but also application of various online platforms, social media and other ICT.

The use of ICT for the purpose of providing health services across distance refers to subfield of eHealth called telehealth. It encompasses remote diagnosis and monitoring, includes a wide range of non-clinical functions such as prevention, health promotion and cure.[7] Activities involving use of wireless mobile device's utilities such as mobile phone or tablet are further referring to mobile health (mHealth). mHealth is including the use of messaging, wireless broadband, global positioning system, Bluetooth and other mobile functionalities.[21]

## 2.3 Physician-patient communication

Technologies used for providing telehealth and mHealth are routinely used to communicate by the public in everyday life [22], as well as can be used in the physician-patient interaction [4]. Remote consultations are a way for patients to contact their physician as an alternative to face-to-face communication [4].

There are various technical options existing for ICT supported telehealth communication. These possibilities distinguish one-to-one or group contact and synchronous or asynchronous communication. As for example emails provide delayed feedback whereas instant messaging and online video calls provide immediate response. Other sources of communication variability include its quantity, frequency and level of direct human contact [23]. Definitions of communication media are provided below.

### 2.3.1 Electronic mail

Electronic mail is a commonly used way of communication globally. It has become a matter of daily life for many people, both at work and personal lives. [24] Patient-provider electronic mail is defined by Kane et al. as computer-based communication between practitioners and patients within a contractual relationship in which the healthcare provider has taken on an explicit measure of responsibility for the client's care [25]. It is an asynchronous way of communication that allows initiating consultation at any time [23]. In the absence of standardisation for email consultations, emailing infrastructure has been utilized differently across environments and this has included the use of unsecured and secured email [26].

Unsecured email refers to generally used email (e.g. personal email accounts), that is not encrypted. Encryption transforms written text into an indecipherable format which is transferred across the Internet. Encryption protects the confidentiality of the sensitive data, however both patient and health care professional (HCP) must have the appropriate software for encryption and decoding.[26]

Some healthcare delivery systems and commercial providers have adopted secure platforms where messages are sent through web-based patient portals [24, 27]. In contrary to personal emails, web-based portals allow patients and physicians to email each other in a data-secure environment. Such portals provide free-text windows where users can write their message [28] or structured triage questionnaires with add-on text windows [27]. Secure portals ensure the data sent from an Internet browser are encrypted before being uploaded to the website. The message is then sent to the recipient as an email. This makes it difficult for the data to be undesirable deciphered. [26] Furthermore, in some systems the web-based patient portals are integrated to the electronic health records [28, 29] and provide other features, as for example confirmation that a patient has received a message or payment facilities [26].

### 2.3.2 Online Video

Online video is a method which allows individuals or groups in different locations to connect in synchronous real-time two-way video and audio exchange. Software applications that facilitate video communication using web-cameras, computers, or mobile devices are often freely available. Online video call can be realized by utilizing Microsoft’s Skype or Teams, Zoom, Cisco WebEx and Google Hangouts [30–32]. Starting in 2005, mobile phones started to be used for clinical videoconferencing using video-call enabled instant messengers (Facebook Messenger, WhatsApp) [30, 33]. Further, some patient portals offer video-calling technology within the secure web-based platform [29].

### 2.3.3 Mobile Messaging

Text messaging using Short Message Service (SMS) is frequently utilized interpersonal mobile communication which allows exchange of alphanumeric messages containing maximum of 160 characters between mobile phones [34]. SMS can also be sent to the patient from web-based platform (e.g. patient portal) that allows are allowing pre-scheduling of sending, automation and monitoring of reception status. [35]

A less used channel like SMS is called Multimedia Message Service (MMS). MMS may contain a combination of images, graphics, audio and video features apart from the text only. [34, 36] However, SMS and MMS usage have decreased in recent years following the availability of online messaging applications such as WhatsApp, Viber or Facebook Messenger [33, 36]. Instant messaging application allows its users an exchange of texts, voice notes, images, videos and locations over the internet (mobile data, Wi-Fi) between individuals or in a group chat. Instant messaging app can also be accessed from a web browser once an account is created via mobile phone. The main feature of instant messaging is no cost per message compared to SMS or MMS. [33]

### 2.3.4 Social media communication

Following the definition of Ressler and Glazer [37] social media are broadly described as a group of online-based tools that allow individuals to gather, collaborate and communicate in real time. HCPs can use social media to share information to educate the public, promote healthy behaviours and increase awareness of health-related services. Patients can participate in digital dialog or conversation with HCPs as well as with other patients. [7] Social media can be categorized according to Lee Ventola [38] into following groups:

- Social networking (e.g. Facebook, Google Plus, Twitter, discussion forums) and Professional networking sites (e.g. Sermo, LinkedIn),
- Sharing media (e.g. YouTube, Instagram, Flickr, Pinterest),
- Blogs and microblogs (e.g. Tumblr, Blogger, Twitter),
- Collaborative knowledge/information aggregation sites (e.g. Wikipedia),
- Virtual reality and gaming environments (e.g. Second Life). [38, 39]

The focus of the thesis is put on social media being used in primary care setup for GP-patient communication, namely: networking sites, blogs and microblogs.

Networking sites provide platforms to communicate, establish and maintain connections among user profiles sharing social relations, interests and/or activities in virtual groups (e.g. centred on specific nursing needs) supported with additional services coming from the networking site provider.[39] These platforms allow users to have conversations using posted messages and to develop integrated user-generated content [40].

Blog and microblogs are easy-to-publish websites where authors (bloggers) post their essays in sequential order. Blogging platforms are considered to be a tool for

information dissemination, social networking, and communication. Microblog is enabling the authors to publish shorter contents typically not exceeding 140 characters.[39]

### 2.3.5 Conversational agents

Other communication technologies such as that using artificial intelligence are also being actively explored [23]. Artificial Intelligence (AI) was defined by McCarthy as *"the science and engineering of making intelligent machines",* which can be understood as development of computer algorithms to perform tasks automatically with minimal human intervention [41]. Physician-patient communication can be supported by AI empowered software applications using Natural Language Processing [42]. Such applications also known as conversational agents or chatbots can analyse and understand human languages. They are programmed to learn simple vocabulary, pattern matching and conversation rules in written text. Using principles of dialog simulation they provide information via texting or speech and create an interaction between the agent and the user (patient). Therefore, the communication can be partly or fully automatized.

Recent year's development of chatbots has shown that it can be programmed to recognize a particular voice. Voice-driven bots can therefore complete tasks based on automatic speech recognition. Ongoing calls are immediately transcribed, analysed and followed in the real time. [23, 42]

## 2.4 Related eHealth terms

### 2.4.1 Electronic prescription

Kierkegaard [43] defines electronic prescription (ePrescription) as a tool that allows physicians to generate accurate, error-free and understandable digital prescriptions from the point-of-care directly to a pharmacy.

### 2.4.2 Medical records

Medical record is an analogue or electronic record containing the patient's personal data and medical history within one particular health care provider [44]. Patient's record includes information on diagnoses and treatment, medications, allergies and immunizations, as well as radiology images and laboratory results [7]. Many different terms have been used for medical records over time describing the move from a paper records to one generated electronically. [44]

First type of electronic record was an **Automated Patient Record (APR)** mainly used in the 1990s. APR represents paper-based documentation which is then scanned

and stored as a digital copy. [44] Collection of individual patient's medical information stored on a computer indicates **Computerised patient record (CPR)**. However, single medical records in CPR were not linked and each record concerned only one specific episode of healthcare provision. [44]

Collection of patient's medical records created by one healthcare provider associates **Electronic Medical Record (EMR)** that is still widely used by GPs in many countries. Collective management EMRs provides data source for **Electronic Health Record (EHR).** EHR is defined as the systematic collection of health information belonging to an individual patient. Shared EHR contains information from all providers of the patient among institutions, regions or whole country. The access to patient's EHR information is available in real time to all authorized healthcare providers. [44]

Some healthcare systems allow patients to control their records, as well adding information from home measurements (e.g. blood pressure, glucose level). The patient's health record is called a **personal health record (PHR)**. [44] A PHR that directly links to patient's EHR is referred as a patient portal. **Electronic patient portals** are therefore online platforms that allow patients to access their health records, as well as to interact with their healthcare provider: to consult in data secure environment, to request a prescription or schedule an appointment. Additionally, patient portal can work as a platform to share health-related articles and information.[29]

# 3 Current overview

Presented chapter is reflecting current conditions of primary care and the benchmarking of eHealth communication tools within Europe. First section underlines the current challenges the primary care is facing. In the second section the general level of eHealth development is reviewed, as well as the basic ICT infrastructure among GPs. Subchapters of this section offer an overview of the most current communication tools that are used for GP-patient interaction and their examples, with given focus on countries with the most developed eHealth services.

Available evidence has been reviewed in order to introduce the current state of eHealth tools and their usage, both in the European Union and also in the Czech Republic. The review is presented for each communication tool from the perspective of the current situation abroad, then in the Czech Republic.

## 3.1 Primary Care conditions

The world is undergoing demographic change of population ageing. It is the result of the declining fertility rates and increasing life expectancy. This demographic change has resulted in increasing numbers of people aged over 65. The share of population aged 65 and more in EU countries increased from less than 10% in 1960 to nearly one fifth (19 %) in 2018, and is projected to increase to nearly 30% by 2060. [17, 45] The same trend is observed also in the Czech Republic [46].

Together with growing life expectancy that continues to steadily increase, the number of people who suffer from chronic health conditions is rising too. Currently, 54% of EU citizens aged over 65 years live with one or more chronic diseases which is below the average of the Czech Republic. Approximately three of five (59 %) individuals in the same age group in the Czech Republic report having at least one chronic disease. In addition, around a quarter of Czechs report having two or more chronic conditions.[47] Chronic and multi-morbidity patients require good management of their conditions at primary care level which is providing them comprehensive person-centred care.[17]

The overall number of physicians in nearly all EU countries has increased over the past years. However, shortages of GPs are common, particularly in rural and remote areas. The European average was 0.8 practising GPs per 1 000 inhabitants in 2016. [48] In the Czech Republic the density of GPs per 1 000 population was a bit lower, 0.7 in 2018 [47], but with vast regional disparities across the country [47, 49]. According to Czech law, primary care physician should be available within 35 minutes' travel and health insurance companies are responsible for contracting enough providers to keep this

target. However, an ageing population of GPs may negatively affect the future availability of primary care.[47] The average age of Czech GPs is 55 years [49]. More than 38% of GPs are 60 year old or older [49]. Approximately half of the country's regions were listed by the The Ministry of Health of The Czech Republic (MZCR) as having vacancies for GPs mostly in the regions of Liberecký, Ústecký, Zlínský and Středočeský [47].

Above-mentioned reasons together with changing disease patterns are expected to drive greater demand for the primary care workforce. As a result, primary care staff is working under growing pressure to provide high quality, accessible and cost-effective care. National and international authorities therefore encourage providers to adopt new ways of working, including those incorporating eHealth.[8, 16, 17]

## 3.2 eHealth adoption

The European Commission has supported EU member states in developing local eHealth strategies and action plans since 2002 [50], however implementation of eHealth services is still quite diverse across Europe. The Digital Economy and Society Index (DESI) is an index evaluating Europe's digital performance. According to eHealth indicator of DESI Denmark, Sweden, Finland, Netherlands, Estonia and the United Kingdom were the leaders in providing online healthcare services in 2019 among EU member states. In contrary to Malta, Poland and Bulgaria that have the lowest scores. [51] A nation-wide EHR system, as per WHO Global eHealth Survey (2017), exists in almost half of EU member states [52]. The list of countries with national EHR system and their DESI indexes is available in the Annex A: Digital Public Services

The European Commission funded several studies on eHealth benchmarking focused on the GPs in primary care. The latest surveys were performed in 2013 and 2018. [53–55] Comparison of both analyses shows that eHealth adoption in the 27 EU[1] member states increased during followed period. Highest increase in the level of adoption since 2013 showed GPs in Estonia. Estonia is also ranked as one of top in the overall eHealth adoption. [53, 55] Except in Estonia, the highest level of eHealth use as routine part of GP's work was found in Denmark, Finland, Spain, Sweden and the United Kingdom, as opposed to countries with the lowest level of implementation (Greece, Lithuania, Luxembourg, Malta, Romania and Slovakia), where eHealth is still not widely spread. [55]

The Czech Republic belongs to the medium-performing country as per DESI eHealth Services index in 2018, ranking 16$^{th}$ out of the 28 EU Member States [56]. Generally, Czech Republic is referenced as a country of Central Eastern Europe region that is undergoing slow progression in eHealth implementation, trying to reach European

[1] 27 EU states reffers to all 28 member states as of 2018, except for the Netherlands.

average [57]. There is a nationally working system of electronic prescribing which was made obligatory for all healthcare providers by medical law in January 2018 [58] and electronic sick notes that are in use since January 2020 [59]. Additionally, there is no nationally centralised EHR repository in the Czech Republic [52]. Efforts to implement national EHR system were temporarily suspended in 2012 due to financial, legal, and political issues [60]. Currently the National Health Information Portal "NZIP" is under construction. However, its functionality as EHR/PHR system is at the moment not planned and the portal should work only as a public health related information source. Responsible for the implementation of the first stage of the portal has the Institute of Health Information and Statistics of the Czech Republic (ÚZIS).[61]

There are other continuous efforts of MZCR to progress digitalisation of the Czech health care. MZCR established the Czech National Telemedicine Centre in Palacky University Olomouc in 2012 as a coordinating and educational centre [60]. Another organisation which started to operate under MZCR administration is The National Contact Point for eHealth. This contact point working in the Vysočina Region since June 2019 has become part of the European eHealth infrastructure (eHDSI – eHealth Digital Service Infrastructure), focusing on cross-border exchange of patient data.[61] Lately, in view of the lack of sufficient administrative capacity Czech government submitted a request the Structural Reform Support Service (SRSS) of the European Commission to assist in the implementation of The National eHealth Centre (NeHC). SRSS supported that project and NeHC commenced operation within MZCR structure in January 2019 in order to "*implement effective and sustainable eHealth solutions*" in the Czech Republic. [62] Finally, MZCR prepares the law proposal on the healthcare digitalisation which was supposed to be submitted to the government till the end of March 2020. This was however postponed due the COVID-19 pandemic.[63]

From the perspective of eHealth adoption among GPs, Czech Republic is getting close to European average[2][55]. The use of eHealth within Czech general practice remains associated with obligatory and administrative tasks (such as registers reporting, submitting reimbursement documents, communication with authorities) instead of provision of patient care via consultations [60].

### 3.2.1 ICT infrastructure

A key role for successful eHealth deployment plays the underlying ICT infrastructure [7]. The correlation between well-developed ICT infrastructure and level of eHealth outcomes was confirmed by Tavares (2018). Her study *„eHealth, ICT and its relationship with self-reported health outcomes in the EU countries"* compares countries based on ICT Development index created by the International

[2] Based on comparison of composite indicators: adoption of telehealth, EHR/PHR and health information exchange. The composite index of 2018 for Czech Republic is 2.063; while EU average is 2.131).

Telecommunication Union and the composite eHealth index for primary care. The study concludes that Denmark, Finland, Luxembourg, Netherlands, Sweden and United Kingdom are countries with well-developed ICT infrastructure as well as the eHealth systems.[64]

As resulting from the study of European Commission almost all (99.74%) GPs in EU were already using computer or laptop in their practice in 2013 [53]. The deployment of other electronic devices is slower. In 2013, 49% of European GPs had smartphones in the office and only 10% had tablets [53]. The availability of the internet connection in the GP's office increased to 97% (2013) [53] from 66% in 2007 [54]. 54% of European GPs had a website for their practice in 2013 [53].

The analysis of Czech statistical office indicates that the core ICT infrastructure is widely adopted also by GPs in Czech Republic. In 2018, 98% of GPs used a computer during patient's visit and 97% of them had Internet connection in their office [65]. Only 1.3% of Czech GPs used tablets in 2018 [60] and more than a third (41%) of GPs in the Czech Republic had their own websites [65]. Such website offers patients online booking for examinations (22% of GPs), prescription requests (38%) or free text-windows to pose an enquiry (14%) [65].

### 3.2.2 Electronic mail

EU Commission survey [55] indicates that only 19% of European GPs use email routinely to interact with patients about health-related issues, 19% GPs use it occasionally, while 62% don't use it or are even not aware about this functionality [55]. However, information exchange between GPs and patients has increased [55, 66]. The type of electronic mail communication is also changing from the continuously declining use of regular emails to increasing availability of more secure channels [67].

Secure messaging through patient portals is mostly used in regions with well-developed EHR/PHR systems. A typical example of a country with national well-established patient portal (called "*Sundhed.dk*") is Denmark, which is reported as a country with the highest number of emails sent/received in physician-patient interaction [24, 68, 69]. During the period 2009-2019, the proportion of people using the email to contact their GP increased from 12% of the population in 2009 to 36% in 2019. This finding is consistent with local health policy, because it has been set compulsory for all Danish healthcare providers to offer email consultations since 2009 [24, 69]. Furthermore, this service is reimbursed in Denmark since 2006. [22, 24]

Similarly to Denmark, patients are provided the opportunity to consult through national patient portal also in Norway ("*Helsenorge.no*") [70] and in Portugal ("*SNS Portal*") [71]. However, the high rates of email consultations in Denmark are not typical of European implementation. The level of electronic mail use by countries reported in the Newhouse et al. [24] (2015) greatly varied among European countries. The study

found that except in Denmark, the patients from Estonia, Italy, and Sweden are more likely to use email to contact their GP than those in France, Belgium, Spain, Slovakia, Slovenia, and United Kingdom.

Out of the 14 countries included in the Newhouse's study, United Kingdom together with France and Slovakia showed the lowest prevalence of email consultations among general practices. [24] UK-based survey from 2015 by Brant et al. [72] estimates that email or secure messaging via website were used frequently by 8% and sometimes by 13% of UK GPs. British national health insurance system is divided in separate National Health Service (NHS) entities for England, Northern Ireland, Scotland and Wales, which are politically accountable to their respective governments. Therefore the NHS-patient portals offering infrastructure for secure messaging are employed on regional levels [27].

However, there are other consulting media increasingly being offered among United Kingdom practices. There are structured consultations in use, accessible via GP practice website and mediated by commercial system providers (e.g. "*eConsult*", "*askmyGP*", "*Egton.net*" and others) [73, 74]. Patients firstly complete a structured online questionnaire triage about their symptoms and leave an electronic message for the GP, if necessary. The completed questionnaire is then emailed to the GP's EMR system or NHS-mailbox. This provides the GP a medical history to enhance the subsequent contact of the patient (message, face-to-face, online video). [27, 73, 75] NHS has supported the roll-out of these software systems providing £45 million for a national programme [76]. Furthermore, NHS claims to all patients to have the right to online consultations by April 2020 [77]. *eConsult* system is already used among 2757 GP offices (covering 23.5 million NHS patients) [75], and a total of 1.2 million patient requests were received via *askmyGP* platform during the year 2019 [78], in contrary to 307 million patient consultations at NHS GPs every year [77].

There is not enough evidence available indicating wide use of secure-consulting portals or email among other countries in the European region. Even though it seems that email consultations are offered at 68% of general practices in the Netherlands, its actual use is extremely low [79]. Similarly like in the Netherlands, there is no nation-widely applied system in the Czech Republic providing secure platform for physician-patient interaction [8] and therefore the possibilities offering secure communication are limited to regional or commercial solutions. As for example recently implemented "*CLICKDOC*" [80] or EHR/PHR system "*Zdravel*" [81]. However, the evidence on how many users is among GPs is not available. Klocek et al. [60] reported that web-portals use in physician-patient interaction 3.3% of Czech GPs for sharing tests results and 13.1% for setting up an appointment. Further,

73% of GPs used an email in 2018 to schedule patients' visits [60]. The actual uptake of email for health consultations is not reported. Consultations via email are either not

provided by Czech GPs, or they are done by using regular email box [8]. There are no legislative requirements for GPs to provide electronic consultations in the Czech Republic and physicians provide that services voluntarily. Nonetheless, Czech GPs were recently encouraged by professional associations to provide telephone or electronic consultations instead of face-to-face with regard to ongoing coronavirus pandemic [82] and simultaneously these services started to be reimbursed as a clinical provision of care from health insurance coverage [83].

Queries discussed via electronic mail are mostly related to non-urgent issues. Patients usually send an electronic mail to their GP to pose enquiries asking about test results, requesting a prescription renewal or to provide a GP regular update about their chronic health issues [4, 24, 79, 84, 85]. Considering specific diagnoses, the highest number of consultations is done for hypertension, hypercholesterolemia and diabetes mellitus [4, 67, 79, 86]. Demographic characteristics of electronic consultations users were reported among the younger [24, 73, 85, 87], especially those living in located in more urban areas [79] and most educated groups [24, 87], while others haven't found any education correlation [79]. The evidence on users of online consulting is indeed particularly among women [73, 84, 85, 88, 89], with difference in the age-group 70-79 years, where men are more frequently consulting their GP than women [85].

### 3.2.3 Online video

Online video has been used in healthcare for half a century, previously introduced as a method to communicate between healthcare professionals [90]. However, the evidence on video consultations for clinical purposes has begun to accumulate after the millennium [91–93]. The sub dimensional score reflecting provision of digital services between GPs and patients in 2018 (comprising video-mediated consultations and monitoring) was found the highest among all countries covered in the EU Commission study in Denmark and Estonia [55]. This finding correlates with presence of national patient portals that offer also video-consulting [94, 95]. Video calls can be performed also through patient portals from commercial suppliers employed in general practice [73, 75].

In the Netherlands last year, none of the interviewed GPs was providing video consulting to their patients and only 3% of them had plans to do it within one year [96]. Similarly in the United Kingdom back in 2015 none of the surveyed GPs offered patients to conduct video consultation and only 4% of practices had plan to do so sometime in the future [72]. In that time video-consultations were deployed only within frame of local pilot projects [97]. However in 2014 the UK government made a commitment to spend £3.6 million on the introduction of Skype video consultations in 230 general practices by the 2020 [98]. Nowadays more than 0.7% of appointments in general practices in England are made through online video [99]. Many different suppliers providing video consulting solutions are listed by National

Dynamic Purchasing System of NHS, from which a GP or practice can select the best video system provider [74]. Some of them are focusing on mobile-phone solutions, as for example ”*Push Doctor*”, which allows a patient to connect with one of ”*Push Doctor*” GPs, however the consulting GP has real-time access to the patient’s EHR notes made by registering GP [74, 100].

Similar services are provided by GPs also in Norway and Sweden. Patients using these video consultations remain registered with their original practices, but can use these digital services to fulfil their immediate needs.[101, 102] In Sweden, video providers are reimbursed by the regional municipalities on a per-consultation basis. Provided services are the same as during traditional face-to-face visit, including prescribing medicine or diagnostic tests at partner organisations. The use of video-consultations in Sweden has grown rapidly with an average monthly growth of around 20% since December 2017 with 30 000 digital consultations in primary care.[103]

The use of online video at GPs has been currently growing because of COVID-19 outbreak. Healthcare delivery systems are accelerating the deployment and implementation of video consultation. The number of GP practices using video in the United Kingdom recently went from 3600 to 5700, which covers over 80% of practices over the country [104].

In Germany eHealth Act set up a deadline (July 2017) for the introduction of video consultations to be provided by GPs authorized by statutory health insurance. Individual practices receive fee up to €800 annually for each physician offering video consultations from the statutory insurance funds. Practices can charge a technology surcharge of €4.21 for each consultation for up to 50 sessions in a year quarter. Video consultations were set up to be appropriate only for certain types of conditions and services are remunerated only when a patient has one of these specific symptoms. This includes visually monitoring operation wounds, skin problems and musculoskeletal disorders or restrictions to the movement. However, this regulation is abolished for the next quartile to allow the care of all patients that are for example in the quarantine due the COVID-19. Furthermore, some providers of video consultations offer their service for free at the moment [105].

Preventive and security measures were set up at both national and private levels. Danish national health authority opened the possibility of video consultancy through mobile app *“Min læge”* [94], the Estonian Health Insurance Fund decided to fund remote consultations [106]and globally operating WhatsApp provider encouraged Health Care Professionals to use their encrypted video calls to connect with patients [107]. Video was recommended as a way to consult during outbreak especially for people with anxiety, for whom a video consultation may be more reassuring than a phone call [32].

The use of video consultations in Czech general practice is not comprehensively reported in literature. There is no nation-widely applied system for video consultations

[8] and therefore similarly like possibilities for email-type consultation, platforms offering video calls are limited to regional or commercial suppliers. GPs can use recently implemented secure platforms "*CLICKDOC*" [80] or "*VideoDoktor.cz*" [108]. However, the evidence on how many GPs is using that systems is not available. Even there are no legislative requirements for providing that services in the Czech Republic, there are individual GPs offering online videos. Furthermore, these services started to be reimbursed from health insurance due to ongoing outbreak. [83]

However, video-visits in primary care are generally used for follow-up care at patients with common chronic illnesses like hypertension, diabetes and obesity, in mental health, or to review lab results [97, 103, 109, 110]. The group of patients interested in video consultation instead of face-to-face visit is particularly among younger working people [97, 110], especially women [103, 110, 111].

### 3.2.4 Mobile Messaging

Mobile phones become widely accessible form of mediated communication and text messaging became one of the most common used forms of mobile technology [112]. The General Medical Council in the United Kingdom acknowledges that text messaging *"can be convenient and support effective communication between doctors and patients"*[113]. However, the mobile messaging in GP-patient interaction is mostly used as one-way informative tool from providers to patients.

Practical uses of mobile messaging in European general practice include appointment reminders [114], support of patient's self-management [115], follow-up of patient's health [116], test results sharing [117] or prescription delivery [118]. Two-way texting interaction was implemented in order to collect patient data [119]. Two years old studies reported that nearly 40% of GP practices used text messaging to communicate with patients in the United Kingdom [120] and around 66% in the Ireland [121]. Recently globally operating business owners introduced instant messaging solutions for health care professionals to help them stay connected with their patients during the coronavirus outbreak [107]. Nonetheless, the actual mobile messaging usage in general practice among European countries is not reported in literature.

The usage of mobile texting by Czech GPs was analysed by Klocek et al. [60]. The study reported that 42% of Czech GPs uses SMS to communicate with patients and that 18% of them is using SMS to share results of patient's laboratory test [60].

Regardless age or sex of the patients, mobile reminders in primary care are mostly used for patients with chronical diseases like asthma or diabetes [114, 120], or for progressing patients' personal healthy lifestyle changes including diet, exercise goals and smoking cessations. Instant messaging virtual peer-to-peer supporting groups are often used within HIV/AIDS patients group [120, 122–124].

### 3.2.5 Social Media

As resulting from WHO survey in 2015 among 35 European countries (including Czech Republic), only six countries (14%) reported having a national policy to govern the use of social media in health professions. Although social media is a relatively new channel of communication, almost all EU member countries (91%) reported that individuals are using social media to learn about their health. [7]

Networking sites in primary care are used as a platform to share health-promotive information at providers' profiles or within patient groups. Examples can be found on Facebook, as well as on other networking servers like globally operating *"PatientsLikeMe*" or "*CureTogether*" [39, 125]. Discussion forums and collaborative platforms are used for provision of education and guidelines to support patients in disease self-management [125]. This initiative is supported by professional organisations, as for example by NHS England which is providing physicians the guide, how to implement supported self-management [126].

However, social media in terms of physician-patient consultation appear as a single individually run projects more than large application. As for example, a micro-blog was used by GPs in the Netherlands for primary care delivery between 2009 and 2013. Their Twitter account @tweetspreekuur was used as a consultation platform via direct messaging and public tweeting, with possibility for patients to continue the consultation through a secure online platform.[39] More recent evidence doesn't indicate large use of social media in current general practice [40].

As per Czech Republic, Klocek et al. [60] reported that 14% of GP's practices has their own public profile on social media and 3% are planning to get it. Recently, some practices have been sharing real-time information regarding the COVID-19 through social media [127]. However, the information on how much Czech GPs use social media to communicate with their patients is not reported. [60]

Patient groups in networking social media mostly gathers individuals with chronical health problems, as for example asthma or diabetes [39, 40]. The age of social media users for health purposes is positively associated with the age between 11 and 44 years, with more users among women [3, 128]. It was reported, that patients who support social media as a way to communicate with their GP were disproportionately from lower-income environments [120]

### 3.2.6 Conversational agents

Smart-phone based chatbots, such as Apple Inc's *"Siri"* are now widely used in the society [129] and they are increasingly being used among whole healthcare sector [41, 42, 130]. A search on *ClinicalTrials.gov* returns five trials ongoing on health-related chatbots in European countries [131]. The interest for primary care is given in conversational agents as a symptom checkers to supplement, enhance, or even

replace personal consultation with a GP [130]. These tools let patients check their pathologies and provide machine-tailored answers on potential treatments and outcomes. Some offer follow-up with a GP via online chat or video [132].

In 2017, United Kingdom's NHS has given the status of General Practitioner to conversational agent *„GP at Hand"* which is working as a symptom checker [133]. The Babylon Health, a digital health company that launched *„GP at Hand"*, has successfully requested a support from NHS England to cover extra costs of £18m to cope with increased number of registered patients [134]. In 2019 Babylon performed 2.2 million of AI consultations and had almost 4 million users [132]. Furthermore, in August 2019 NHS England announced a £250 million investment in AI applications for health and care through the creation of the NHS AI Lab [135].

Among other European countries, the companies launching symptom checkers operate in Spain (Mediktor) and in Germany (Ada Health). In 2019, Ada Health claims to make more than 15 million symptom assessments and has 8 million users globally. Mediktor reports more than 3 million assessments.[136, 137] Overall, chatbots implementation increased recently by affords of many globally operating companies rolling out chatbots to help people during the COVID-19 outbreak. Icelandic Sidekick Health has built tracking application for the national health system to help triage patients and take some pressure off health services [138]. However, the efforts of AI implementation are not always nationally supported. Among European leaders, there governments in the United Kingdom, France and Germany support the AI development the most.[139]

There are no locally operating chatbots available among Czech primary care. However, the use of AI is pointed out in National AI strategy of the Czech Republic as a tool to be used for fulfilment of the National eHealth Strategy of the Czech Republic 2016-2020 objectives. More specifically, the short-term (to be fulfilled until 2021) objective is to prepare strategy implementing AI applications align with approaches of European countries with similar levels of health services. The mid-term objectives are stated as a creation of specialized workplaces for evaluating AI healthcare applications and implementation of a programme for collecting and protecting high-quality healthcare data for use in AI applications. [140]

Patients willing to consult AI chatbot are regardless indication mostly aged between 20 and 34 years (70%), when 20% are between 35 and 64 years old, around 70% of women [141]. However, voice-enabled bots are studied to be beneficial especially for the elderly and cognitively impaired patients, since they often feel uncomfortable or cannot be using computers or tablets [142]

## 3.3 Summary of current overview

This chapter provides summary of current overview, identifying the eHealth communication tools currently used by general practitioners in the Czech Republic and in selected EU countries.

Telephone consulting is the only world-widely used alternative to the face-to-face consultation that became the first point of contact to practices among whole healthcare spectrum. However, the author did not include telephone consultations within this diploma thesis, because phone calls are globally well-established and have been already broadly studied since decades ago [143–146]. Author focuses on the most current and innovative communication media such as electronic mail, online video, text messaging, social media and AI conversational agents. The highest rates of their implementation among European countries are generally seen in Denmark, Sweden, Finland, Netherlands, Estonia and the United Kingdom.

The most used remote alternative for physician-patient interaction in primary care is electronic mail. Electronic mail consulting via secured platform is conducted mostly in countries with well-established patients' portals, such as Denmark, Norway and the United Kingdom, to name a few. In contrary to other countries, secure communication portals in United Kingdom have implemented structured forms. GPs in European countries where there is no national system or policy, including Czech Republic, use commercial websites hosting secure email or the conventional email platforms.

Second platform, that can be used for GP-patient interaction is an online video. Rates of videoconferencing between GP and a patient were found the highest in Denmark and Estonia [55]. However, United Kingdom government strongly pushes forward video implementation among GPs' practices by the end of this year [98]. In the Czech Republic, GPs less likely use video to communicate with their patients, however there are recently new commercial suppliers at the market offering secure platforms for video calls [80, 108].

Mobile messaging in GP-patient interaction is generally used as one-way informative tool from providers to patients, mostly to share appointment reminders [114]. Social media are on the other hand used mostly as a networking communication platform within groups of patients. Neither mobile messaging, nor social media are widely used for private physician-patient clinical consultations.

Currently the most innovative communication media are AI conversational agents working in the primary care as symptom checkers. The AI-bots usage is significant in the United Kingdom, where is the implementation of chatbots widely supported by local national healthcare system. Chatbots are available also in other European countries however their operation is held by private international suppliers.

The acceptance and use of technologies are inextricably linked with various patient groups. Younger generations especially women exhibit greater interest in remote health-related consultations. Secondly, higher number of people with chronical health issues uses electronic communication to contact their GP relative to those reporting good health.

# 4 Practical part

The practical part of the thesis is aimed to provide an investigation of benefits and limits regarding eHealth communication tools. Firstly, the motivation and of research is presented. Secondly, the overall methodological approach used for the data collection and subsequent data analysis is described. Finally, evaluation of benefits and limits is performed from following perspectives: (1) its impact on GP's workload, (2) system security, (3) health risks and (4) GPs' and patients' perception of each medium. To address the aim of this thesis systematic literature review was performed.

## 4.1 Aim

There is an increasing demand noticeable in the primary care, especially among GPs as they provide the first level of care. Despite the fact, that international and local authorities are claiming the benefits of eHealth and encouraging providers to adopt new ways of working [8, 16], most general practices have been slow to adopt alternatives to the face-to-face consultation, citing concerns about their potential impacts, particularly on the workload and data security [27, 72, 147, 148]. Furthermore, there is yet insufficient evidence indicating that remote patient-provider communication results in safe outcomes comparable or better than face-to-face consultation and if users are comfortable with remote consultations [67, 149, 150].

Therefore, the aim of this thesis is to evaluate benefits and limits of the eHealth tools GPs currently use for communication with their patients. The focus is given on communication media that have been presented in the Chapter 3 of this thesis. In order to explore benefits and limits of each currently used eHealth communication medium following research questions were formulated:

(1) How does the communication tool impact the GP's workload?
(2) How is ensured the privacy protection of consulted information?
(3) How is avoided the clinical risk of remote consultation that would impact patients' health?
(4) How GPs and patients perceive care delivered through given communication platform?

Through these research questions, this study aims to provide understanding of the benefits and limits of eHealth communication tools and their impact on the quality and availability of provided care in general practice.

## 4.2 Methodology

This section provides an overview of the overall methodological approach used for the data collection and subsequent data analysis related to studied area. The author followed the systematic review process recommended by Brereton et al. [151].

Firstly, the research questions were specified into a set of more detailed questions:

(1) Regarding the impact on the GP's workload, three specifying research questions were set.
   a. Is it possible to integrate consulted data from communication medium into EMR/EHR system automatically?
   b. Does the remote intervention impact the number of general practice contacts?
   c. Did GPs perceived time-saving when they implemented such a method of consultation?

(2) Questions following the data security risks led to two separate sub-questions.
   a. Does the communication medium allow user authentication to provide precise identification of a patient and GP before each consultation?
   b. Does the system provide IT user support in order to address potential cybernetic risks?

(3) Sub-questions assessing the potential risk for patients'health are following:
   a. Does the communication tool have any measure to avoid potential misunderstanding and miscommunication that could negatively impact patients' health?
   b. Is it possible to get back to the received information?
   c. Does the communication tool provide information source on patients' health history?

(4) User's perception of delivered care is explored through given sub-questions.
   a. Do patients perceive any benefits regarding the communication media in contrary to face-to-face consultations?
   b. Do GPs perceive more benefits or negatives steaming from incorporation the communication tool into general practice?

Secondly, the research questions were validated by consultation with Prof. Jarmo Reponen, M.D., PhD, an acting professor of healthcare information systems at University of Oulu (Finland) during March 2019.

Furthermore, to ensure uniformity of research questions several definitions important for the screening process were clarified:

> **General practice contact** was defined to include every kind of contact – attendance at surgery, home visits, telephone calls, emails, online video or any other communication media [66].

**Authentication** was defined as the process of recognizing a user's identity. It is the mechanism of associating an incoming request with a set of identifying credentials. Identification phase provides a user identity to the security system. This identity is provided in the form of a user ID.[152, 153]

The process of review conduction was initiated using databases of Web of Science, Science Direct, SpringerLink and the University Library of Oulu between April and June 2019.

An initial electronic literature search was performed to identify the current gold standards for electronic communication between GP and a patient. This combined search of "electronic communication", "physician-patient" and "primary care" in Web of Science. Database retrieved 77 citations. From these 77 citations, 2 instruments were identified, "email", "secure messaging". Further search of these key words in Science Direct, SpringerLink and the electronic database of University Library of Oulu have been extensively tested and led to find other eHealth communication media.

Secondary search terms were based on additional keywords from articles found primarily, related to "email, webmail; secure messaging; video, remote consultation; SMS, instant messaging; GP consultation, remote consultation, eConsultations, telehealth, mHealth, telemedicine; smartphone; mobile application; social media, whatsapp; conversational agent, chatbot". Synonyms for the main terms were identified. Search strings were constructed using AND and OR to include synonyms. To ensure comprehensiveness of performed systematic review, the tool "cited-by" tools within Web of Science was used to identify all relevant articles. Furthermore, secondary search was performed also by using additional web-search on Google Scholar and through searching specific oriented websites of national health authorities and providers of online consultation platforms, in order to ensure the retrieval of a comprehensive list of all eHealth communication tools available to GPs.

The selection of primary studies was performed by reading the title and the abstracts and irrelevant papers were extracted. The critical appraisal was performed and only studies focused on European countries general practice were used. Inclusion criteria included English-language, full-text availability and communication exchange between GP-patient, with focus on articles published after 2015 (not exclusively). Full copies of remaining studies that were focusing on GPs selectively were downloaded and checked.

To asses found studies, an Excel table was used as an assessment tool. That is how 21 studies were found regarding electronic mail, 16 for online video, 15 for social media, 10 for text messaging and 10 for AI-bots. However, after assessing the appropriateness of individual studies only 14 remained for electronic mail, 7 for online video, social media and text messaging, while 6 for chatbots. Finally, the data were extracted, and review report was written.

## 4.3 eHealth communication tools evaluation

In presented chapter author provides written report conducted by systematical literature review process described in the methology chapter.

### 4.3.1 Electronic mail

This sub-section summarizes findings on benefits and limits that are affecting the use of email consultations in primary care.

**Workload** impact resulting from providing email consultations in general practice is not consistently reported in literature. Surely, the volume of messages always plays an important role [88]. Number of non-essential emails can generate more work and additional consultations for a GP [154]. However, the administration of non-clinical enquiries can be shifted to primary care nurse [88, 116, 155]. In order not to distract a GP with administrative-like messages, some practices had two different mail-boxes, one for medical information and one for the office management (appointments, schedules) [116].

Emails can particularly reduce number and length of telephone consultations [70, 79, 85, 88, 116]. However, reduced number of telephone consultations correspond to the increased number of email consultations and therefore the overall number of GP-patient interactions remains the same [85]. In contrary to telephone communication, email provides self-documentation [27, 156] and allows GP to create templates for frequently asked questions [116]. GP can also use some reliable internet links in order to support the enquiry answer and doesn't need to type every single reply [27].

Closer evaluation of electronic mail impact on GP's workload requires distinguish the type of electronic mail. Professional secure portals offering EHR links save the consultation content automatically in the patient's record [73, 84, 88, 150, 157, 158], furthermore consultations through some secure-platforms can be conducted in form of structured questionnaires [27, 84, 155, 157]. Structured formats gathers information about a query which is sent as a report to the GP [73, 84, 159].

As opposed to consulting in unstructured free-text, the structured report facilitates the consultation assessment [27, 70, 88]. The length of evaluation per consultation in structured form takes about three minutes, which makes it approximately 3-times quicker than regular face-to-face appointment [88]. In some cases subsequent face-to-face visits after online consultation were completely avoided [27, 70, 88]. However, Carter et al. [157] didn't perceive any impact on the GP's workload, while Banks et al. [158] and Farr et al. [150] reported that most structured consultations resulted in GPs needing to follow up with a telephone or face-to-face appointment and therefore increased the amounts in work. In contrary, overall decrease in workload was

reported also in relation with unstructured free-text email consultations [70, 116], as well as that it had no impact [86, 111, 154].

**Privacy protection** is offered by secure messaging through patient portals. Possibility to consult GP through nationally-operating patient portals is determined with access the national service. Access to the national patient portals requires multi-factor authentication, often including several separate pieces of evidence. Available ways of authentication use mobile authentication, online banking or governmental identifiers, electronic certificates and user ID with passwords.[152, 153, 160]

Furthermore, national patient portals provide comprehensive users' support, such as help desks to address technical and navigation issues, or telephone and email contacts for addressing users queries [152, 153]. Usually there are also materials available for people to educate themselves on safe online behaviour and security matters [160]. Similar level of data security is applied to private suppliers' portals, because they have to be compliant with local policies and regulations as same as national portals [153, 161]. Regarding the consulted data accessibility, the common approach is to allow citizens visibility of their data, as well as to health professionals they treat them [153, 160]. Further, users can report any suspicious behaviour seen regarding their patient's or professional profile [160].

In like manner for secure portals and conventional emails citizens control their own log [26, 152]. However conventional emails don't provide users authentication and therefore patient is not fully identifiable. Furthermore, personal emails aren't necessarily encrypted and aren't integrated to EHR systems. Users of conventional emails can perceive lack of guidance and users' support. [26, 154]

**Health related risks** in case of structured consultations, as well as in conventional email [73, 150, 154, 158]. Primary care staff mentions typing-like consultancy can lack the contextual information compared to face-to-face communication or even phone calls, which can make correct interpretation of the messages more difficult [70, 158]. However, lack of information at the secure portals can be substituted by linking the portal to the patient's record, where GP can check all the health data on the concrete patient [88, 157]. Concerns however differ for consulting via free-text or queries with structured questionnaires. Quality of electronic consulting using free-text (as regular email) can be dependent on the patient's ability to express themselves [70]. Structured queries can provide more detailed history than a free-text tool, because they can be thematically framed. Structuring also helps in consistent history taking, where questions aren't missed or forgotten.[74]

Receiver of conventional emails cannot always confirm the patient has received their email response that might contain important information [154, 157]. On the other hand, when consulting medium incorporated to clinical system, the responds has to be given within a stated timeframe [88]. Structured online forms can even respond in real time

[84, 88] and users are notified in case of contact out of opening hours that their request will not be processed until the next working day.

Email consultations or secure messaging are mostly used for non-urgent follow-up of issues previously discussed during in-visits, as for example for adjusting a treatment, prescribe referrals or provide results of laboratory tests [70, 162]. To avoid healthy risks, Norwegian PHR portal set up exact requirements for patients when remote consultation cannot not be used, including newly emerged clinical problems and sick leaves requests [70].

**Patients' perceive** email as the most popular way of contact to services [27, 72, 88, 116]Regular emails with free-text windows provide easy and quick platforms for patients. They allow them to express for any problem, as well as any relevant thoughts or concerns of patient. This is not possible with tick-box questionnaires via structured consulting. Further, it can take longer to complete, which can deter some patients from using the tool [74]

Patients are especially comfortable with receiving laboratory tests results by electronic mail, but they are less willing to use this way of contact for more serious conditions such as receiving a brain computed tomography scan results. In general, patients are satisfied with secure messaging portals. Some patients even review their medical information recorded on a patient portal and send the clinic messages to correct errors. Further, just as emails, secure messages can be convenient because patients can reread the message with instructions that they have received from their GP [84, 116].

On the other hand, patients' satisfaction with electronic mail can be lowered by not receiving answer in time [27, 70, 84, 88]. Patients' adoption of secure messaging via official healthcare portals is not consistently reported. Some studies claim that the level of use of secure portals is lower than using personal e-mail accounts to contact their GP. Especially because of the lack of information (patients don't know about the portal, don't know how to use it), lack of motivation, and negative attitude towards secure portals [73, 84]. Eccles et al. [73] observed both positive and negative perceptions of the same issues, suggesting that experiences of using the online platform were complex and relative to the patient and their characteristics, as well as the conditions in which the patient made the request.

## 4.4 Online video

Following chapter summarises evidence on benefits and limits regarding video consultations in primary care.

**Workload** change after video implementation can reduce overall number of contacts face-to-face [110]. While evaluating workload resulting from providing video consultations, it is important to answer whether it replaces face to-face visits

or it adds another activity to the workload. Video consultations were proceeding like face-to-face appointments [120, 163].Then patients who needed to consult simpler issues like medication reviews and blood test results could request just shorter visit and there were no unnecessary time slots. Workload resulting from potential additional face to- face visits was decreased by educating patients and reception staff on which conditions are appropriate to discuss via Skype. [43] Some patient portals allow patients to perform video consultation. Thereafter, the documentation of performed video visit is reported in patient's EHR as checked [61].

**System security** has to be ensured, a procedure to identify the patient takes place before the video consultation in many systems. Methods of identifying users and equipment include use of telephone numbers, equipment IP addresses, and user email addresses. As for example in local UK video Attend Anywhere webpage-based service, patients were emailed a secure web link with the date and time of their consultation. Following the link and log in with the name and telephone number, the link opens to a virtual waiting room showing the name of their GP [110]. When video consultations are planned in advance, its considered safer regarding the system security [43]. For safety reasons, Cavendish Health Centre recommends GPs to use a pseudonym username, because Skype has an open access address book, and always to ensure that the patient's contact details are up to date on their record [43].

Regarding the Skype software security, an independent security assessment was performed in 2005 (Skype Security Evaluation, Tom Berson, 2005) [74], that concluded that Skype can verify user identity and content confidentiality between systems. The aspects of the Skype architecture and communication protocols, which use 'standards based' cryptography for authentication and confidentiality, appear to be implemented in a robust manner, as well as used algorithms. The Skype security model prevents anyone from interfering or capturing any part of a Skype communication. It also makes it very difficult for anybody to eavesdrop on content by installing an internet computer in the theoretical path of Skype traffic. However, complete anonymity or secrecy cannot be guaranteed. [43][74] Video consultations should not be recorded, unless the service user provides explicit consent to live recordings - if provided this should be noted in the care record [74].

### Health risk

Video consultations appeared to be less 'information rich' for GP than face-to-face consultations [110], but were considered suitable for simple problems not requiring physical examination. Technical problems were common and, though, infrastructure issues would need to be addressed before the technology and approach can be mainstreamed in primary care.

Online private GPs usually lack access to patients' EHR, with the potential for important information to be missed. Commercial providers have partnerships with healthcare organisations that allow patients to have diagnostic tests carried out prior to their video consultation if necessary.Research shows that video consultations are highly dependent on good technical connection. If technical connection is high-quality, GPs and patients tend to communicate in much the same way as in a face-to-face consultation. The risks regarding appropriate timing of video consultation relies on the doctor and patient being available at the same time, hence may not be exempt from long waiting times or delays [74].

On the contrary to face-to-face consultations, video can rise question about the ability of the GP to perform an adequate physical examination [20], however this is dependent on the GPs ability to pick up on visual cues and carry out a visual examination when visual examination is important (e.g. assessment of inhaler technique, people who are housebound, have a mental health problem or palliative care need[110]. The risk of liability stemming from a miscommunication or misunderstanding can be reduced by using two screens (or a split screen), when a GP can view Skype and the electronic patient record simultaneously. (43) Problems with the technology can disrupt the consultation. Patients and the practice require the right equipment with the appropriate IT infrastructure, to ensure the quality of the image to be very good in general and high enough quality for safe video consultations [74]. In case of lack internet connection, there should also be a backup option such as a telephone as the video quality is highly dependent on the internet connection. [43]

Video consulting to patients' homes is unlikely to be appropriate for severely ill patients, when a full physical examination or procedure cannot be deferred, or when comorbidities (eg, confusion) affect the patient's ability to use technology (unless relatives are on hand to help).

In comparison to telephone-only consultations for decision making on acute health conditions, video proved benefits of better treatment decision making [21], resulting from facilitate understanding through non-verbal communication compared to other remote consulting methods [74]. Anyway, Central London Clinical Commissioning Group has been recommending to GPs not to use Skype for emergency calls and when it was inevitable that some patients need to be seen face-to-face for a physical examination, an additional appointment was scheduled [43].

**Patients' perception**

As resulting from NHS survey among three thousands of respondents, the preferred method of access by video chat was for 36% of people compared to other way or remote consulting [164]. Patients really liked video consultations, especially [110]tients may need to download a software or an app to undertake a video consultation [74], sometimes even in-person support may be needed to tackle both technical issues (such

as assessing technical readiness and installing web cameras and monitors) and operational ones (such as identifying and redesigning key workflows.

Patients are overall satisfied with video visits as an alternative to in-person visits. Loose of face-to-face contact is not considered to be a limiting factor. However, in United Kingdom patients revealed a much higher preference for secure messaging, telephone or face to face consultations compared to video (askmyGP data first quarter 2019). A preference for telephone is also reflected in the recent evaluation of Babylon's GP at Hand Service [74]. Video visits are providing the patients a convenient way of consultation to their GP related to decreased travel costs and time save (cut of waiting time and no transportation needed), and some appreciating the comfort of being in their own environment [20][43]. Some patients appreciate the possibility to contact their GP via Skype from abroad, especially for medication reviews and queries about their test results [43]. Limiting factors for patients are concerning privacy issues, especially for those patients who connected to video visits in their workplace [20] [43]. People didn't see the advantage of video if they did not require the visual examination or even felt uncomfortable with it e.g. discussing sexual health problems [110].

### 4.4.1 Text messaging

Following chapter provides review of evidence on benefits and limits regarding texting used in the patient-physician interaction.

#### Effect on workload

GPs usually appreciate instant messaging mostly regarding good time-saving management in contrast to consultations over calls [34][36]. The use of text messaging as opposed to phone calls is more efficient and may facilitate GPs with more time to address patients' needs [34]. Also study by Head et al. [63] concluded that SMS tailoring and personalization is associated with greater intervention efficacy, and therefore can reduce workload [63]. On the contrary workload can be increased, when patient opens a forum for ongoing discussion and therefore new questions to answer occurs for a GP [34].

While using instant messaging apps like WhatsApp, an integration with EMR was identified as a problem. Electronic and hardcopy records of communication can be made by e mailing chats from WhatsApp, including images and other attached files, ideally to a secure server. Thus, this process is not made automatically and it requires additional workflow. [25] Modern messaging apps for HCP that are intended for clinical practice are linked to the GP's software. Software can then send messages automatically, as for example for appointments reminding a day before patient's planned visit. This can significantly reduce GP's workload and can help to the GP's office run on time with prescheduled visit and appointments [49][50].

### System security

System security is extremely dependent on the concretely used communication channel. Identified risks related to using regular SMS texting include confidentiality and consent issues, as well as problems with incorrect phone numbers. Patients should agree on texting policy and accept the informed consent. The patients have to understand the benefits and limitations of text messaging (for example importance of advising their general practice when mobile numbers are changed). [34] Specific challenges can be faced while sending texts to young adults in the age 16-17 years old (changing mobiles, shared phones). The content of a text message should be carefully considered, bearing in mind that the identification of the patient is never 100%, or that others may read the text. [59] Without using unique patient identifiers maintaining the confidentiality is problematic. De-identifying the concrete patient information makes knowing who is being discussed in a chat group difficult. Using minimal identifiers (e.g. patient initials) all the time allows possible identification. [25] Confidentiality risks occur also related to data privately stored on smartphones, and exchanged among closed messaging groups (e.g. on WhatsApp). If the pictures are forwarded to the wrong recipients; or if the photos are used for non-intended purpose to which the patient had consented. Measures to address confidentiality of patient data stored and exchanged via phones require smartphone security (e.g., data encryption and remote data wiping in case the stolen phone). [27] Clearly, text messaging alone is inappropriate for urgent or important messages [59].

### Health risk

Safety concerns have been raised regarding texting in general practice specifically because of risk of a miscommunication or misunderstanding.

is mostly related with messages for multiple patients in a chat messaging groups, where it can be difficult to identify to which patient the message referred [34]. Lack of punctuation in messages and used abbreviations can create ambiguous information that can be misunderstood [62]. Text of SMS may be too brief for a patient to understand sent information. Therefore, for example test results sent via SMS can mislead patients regarding ‘normal results’ or the opposite. This concern can be demonstrated on sending results from routine blood tests, when some patients can easily misunderstand the value between HDL and LDL cholesterol levels. [34]

### Patients’ perception

As resulting from NHS survey among three thousands of respondents, the preferred method of access by messenger app is 19%, when text message/SMS is preferred by 16% of patients [164]. Most patients are happy to receive texts from their GP, especially appreciated is the advantage of receiving fast test results that’s followed by

providing effective patient reminders. As SMS message is sent directly to a patient's mobile phone, they are deemed as convenient and as easy to use as a smartphone communication apps, however Jenssen et al. [65] concluded that patients from low socioeconomic and minority ethnic groups are more likely to support the use of text messaging as a way of communication with their GP. The main limiting factor for patients is being unable to respond to web-generated text messages and worries regarding SMS confidentiality. [34]

## 4.5 Social Media

Following chapter investigates the benefits and risks resulting from social media application in the patient-physician communication.

### 4.5.1 Effect on workload

One of the most noted barriers why HCPs don't use social media while contacting their patients is the lack of time. For GPs it can be hard to incorporate the online tool into routine practice. In the same time other GPs can appreciate the social media advantage, by saving consultations time when instead of providing general information to patients by themselves, they use suitable social media. Using social media for patient education may in fact be a time-saving and a potential demand reducing option for patient care [1][8]. Impact on workload vary on the social media channel used, as well the purpose of its use. As for example online discussion forum for patients with asthma were found as a useful tool, but HCPs noted it takes time to log in and to instruct the patients. Also, the GPs found that the system has more functions than necessary and therefore this social medium increased their workload [52]. Social media are not linked with EMRs of patients, even this theoretical integration have been studied in the literature [60].

### 4.5.2 System security

No discussion of social media regarding the healthcare is complete without at least a mention privacy issues of these networks. The security among various social media vary a lot. Primary care staff should always assume that all information exchanged over social media are public and posted in a public medium. Even when a message is private (e.g. a direct message on Twitter or Facebook) this does not mean that the sent information is secure and protected. [7] Patient privacy on social media in contrast to face-to-face is dealing with the permanency of digital information. Closed, secure systems with data encryption can maximize the safety but attention should always be paid to the security, access, and permissions involved in any social media used in the health care delivery. Especially while using unsecure third-party open sites (e.g. Facebook, Twitter) postings, public or private message, may ultimately belong to the third party and security breaches have been known to occur. There have always been

concerns related to the risks of breaching patient confidentiality and data protection requirements related to social media. There are also related ethical requirements (including patient consent) for using social media for health care delivery. Most reputable healthcare organizations have well-established and clear policies governing such clinician ethics and discipline issues as they use online environments including social media. [27] For example, a policy statement by the American College of Physicians has recommended HCPs not to contact patients through social networking sites [8]. This recommendation seems reasonable, considering social media posts can be created anonymously and therefore the HCP can never be sure about patient's identity [7].

### 4.5.3 Health risk of Social Media

Kovic et al. [66] performed a survey of medical bloggers and found that successful medically related blog writers are often university educated authors who are trustworthy to their information sources and are motivated to influence readers by sharing their practical knowledge or skills in a creative way [66].

Risk of a miscommunication or misunderstanding related to social media use in primary care is quite high. Authors of medical information posts found on social media sites are often unknown or are identified by limited information. Social media are also creating medium for shared collective medical knowledge. This interactive environment of social media magnifies health issues, since any user can upload content to a site. Social media users may also be vulnerable to conflicts of interest that they may be incapable of interpreting provided information. In any case of GP-Patient social media interaction, a HCP should avoid providing specific medical advice to nonpatients and always should use appropriate disclosures and disclaimers regarding the accuracy, timeliness, and privacy of electronic communications. [7]

### 4.5.4 Patients' perception

Generally, the use of social media for healthcare purposes has increasing acceptance among patients [34]. Patients also seem to be more interested into social media use than their physicians, perhaps because they face fewer barriers to entry than media [1]. Compared to other electronic communication channels, patients are less interested in receiving information via social media than through e mail [48]. Some user may have a negative perception of using social media as it may be seen as inappropriate and unprofessional [8]. A survey of patients conducted in 2013 at a family practice clinic found that 56% of patients wanted their GP to use social media for reminders, for scheduling appointments, for diagnostic test results, as well for prescription notifications and answering general enquiries. Patients who did not use social media said they would start if they knew they could connect with their HCP. [7]

## 4.6 Conversational Agents

Following chapter summarises evidence on benefits and limits regarding the conversational agents use in primary care.

### 4.6.1 Effect on workload

Considering GPs' workload, chatbots in the primary care setting as well voice driven intelligent bots can save valuable time and complete tasks like appointment scheduling, administering reminders for medication, treatment compliance, providing medication use or misuse instructions or answering medication frequently asked questions [31]. As resulting from eCHAT evaluation by Goodyear-Smith [30], generally, staff found the way of screening to be simple, quick, and easy to use. They valued the way it facilitated patient engagement and the integration with the EMR. Overall, the time needed to identify problematic lifestyle behavior and mental health issues is reduced, because eCHAT tool is self administered by the patient before the visit. [30]

The symptom checker functionality of apps could be useful for Member States to complement primary care surveillance and understand more about of COVID-19 in the population. These data are collated together with data from more widespread testing of those with symptoms as part the COVID-19 surveillance systems. This would complement existing surveillance systems and, in particular, overcome the challenges for surveillance of COVID-19 in many countries which recommend that patients with respiratory symptoms should not visit their general practitioner.

### 4.6.2 System security

Healthbots must follow the same rules as any other medical software and pass privacy and security controls. Healtbots must be GDPR (Health Insurance Portability and Accountability Act) compliant to ensure the patient's personal information is received and stored in a way that is not available for hackers. [76] Privacy and security issues are mostly related to voice driven chatbots, because anything that's said loud can be heard by someone else [23][31]. In contrast to other communication medium, AI chatbots can easily identify the patient, especially voice driven chatbots that have voice recognition ability that identifies the patient by using biometrics [57].

### 4.6.3 Health risk

As resulting from Razzaki [54], artificial intelligence powered symptom checkers, as for example The Babylon Triage and Diagnostic System, have the potential to provide diagnostic and triage advice with a level of accuracy and safety approaching that of human doctors (54), For example, while Babylon's own assessment is that their symptom checker outperforms the average human doctor on a subset of the Royal College of General Practitioners exam, a study in the Lancet concluded that the

evidence of this impact is not convincing. However tools may vary in their outcomes. Further, patients might not accept self-care/pharmacy dispositions when delivered by a computer, and may fill out the form differently a second time or phone for an appointment. Then the risk that over-cautious implementation of red flags could increase unnecessary direction to urgent care. [74] Therefore, the risk of liability stemming from miscommunication or misunderstanding is low. [54] The level of risk is decreased also because the online triage systém where the patient enters the symptoms is directed to the right person or service in real-time (synchronous) [74].

### 4.6.4 Patients' perception

As resulting from NHS survey among three thousands of respondents, the consultation with a virtual GP (a computer stimulation or robot) would prefer only 7% of people patients [164]. Patient perceptions of visiting their GP only after chatbot consultation is widely positive. A study conducted by global company Price-Waterhouse-Cooper (PwC) in 2017 found out that only 39% of UK patients were comfortable with the idea of consulting with a computer employed by artificial intelligence. [75] This may be because of the perceived lack of quality or accountability that is characterized by computerized chatbots as opposed to traditional face to face interactions with human physicians [31]. Willingness of patients for AI consultations was higher in Netherlands (55%), Belgium (51%), Norway (50%) and Sweden. Lack of impersonality and inability to 'look beyond the data' were classified as disadvantages. [75] Some patients may feel that chatbots are safer to interact than human professionals and are willing to disclose more medical information and report honestly all medical symptoms to chatbots. [27].

# 5 Results

This chapter provides summary of key findings resulting from benefits and limits analysis above. The results are presented in two parts. First part presents the results from the point of view of summarised evidence. The second presents the results from the performed qualitative analysis.

## 5.1 Characteristics of the included studies

Author, year, country, type of study, design and sample were extracted to describe the characteristics of the studies. Included studies are listed in each table dealing with the (see Appendices 2-4). The studies included in presented analysis were published between 2008 and 2020. The number of published studies increased steadily, being highest in 2018. Of the 2060 potentially relevant publications identified, 41 were included in the final review. Of the total number of included studies majority of studies were published in 2017, except studies regasding social sites (2011) and chatbots (2018). The studies were mostly conducted in the United Kingdom followed.

A variety of study designs were used, although the majority employed qualitative methods including descriptive designs such as surveys and interviews.

## 5.2 Findings

This chapter presents key findings from performed systematic review. The findings are presented for each communication medium individually.

### 5.2.1 Electronic mail

Evaluation of electronic mail impact on benefits and limits requires distinguish the type of electronic mail: conventional free-text typed or structured questionaries' available through secure portals. The findings regarding the conventional email are presented inTable 5.1 and for secure portal messaging in the Table 5.2.

**Table 5.1:** Benefits and limits of conventional free-text email

| | Benefits | Limits |
|---|---|---|
| **Workload** | Volume dependent | Volume dependent |
| | | **No EHR integration** |
| | | No-time-saving |
| **Security** | – | **No authentication** |
| | | No IT support |
| **Health Risk** | Possibility to re-read | **No safety measure, risk of critical informatik loss** |
| | | Lack of context information |
| **Users' perception** | Familiar way of communication | Lower if not receiving reply in time |

[27, 116, 154]

Supporting evidence available in the Annex B and in attached excel table.

**Table 5.2:** Benefits and limits of secured messaging through patient portal.

| | Benefits | Limits |
|---|---|---|
| **Workload** | ↓ contacts | Depending on volume |
| | **EMR integration** | |
| | **Structured forms** | |
| **Security** | Authentication | |
| **Health Risk** | EMR integration | Context information provided |
| **Patient's perception** | Possibility to reread | Less user-friendly |
| | Health data accessibility | |
| | Reply with given period | |

[73, 84, 88].

### 5.2.2 Online Video

The findings regarding the online video are presented in the Table 5.3.

**Table 5.3:** Benefits and limits of online video consulting.

| | Benefits | Limits |
|---|---|---|
| **Workload** | ↓ contacts | Requires punctual appointments organisation<br>Usually not EMR integrated |
| **Security** | Patient's logging ID<br>EMR can be seen simultaneously | Patient's contact details have to be up to date |
| **Health Risk** | Better decision making in comparision to telephone | Highly dependent on internet connection (low quality video)<br>Not for acute issues |
| **Patient's perception** | Convenient, time-saving consultancy | Privacy during the call |

[27, 93, 110, 111, 163]

### 5.2.3 Mobile Messaging

The findings regarding the mobile messaging are presented in the Table 5.4.

**Table 5.4:** Benefits and limits of mobile messaging.

| | Benefits | Limits |
|---|---|---|
| **Workload** | ↓ contacts<br>automatic reminders<br>↑ efficiency | Necessity of typing if not EMR integrated |
| **Security** | | Patient's contact details have to be up to date |
| **Health Risk** | | Wrong receiver in Chat group<br>Too short to explain well |
| **Patient's perception** | Fast results, effective remiders | Unability to respon web-sent messages<br>Confidential issues |

[116, 118, 119, 124, 165]

### 5.2.4 Social Media

The findings regarding the mobile messaging are presented in the Table 5.5.

**Table 5.4:** Benefits and limits of social media.

| | Benefits | Limits |
|---|---|---|
| **Workload** | educational purposes | not EMR integrated |
| **Security** | | Data not protected |
| **Health Risk** | | Wrong receiver in Chat group<br>Too short to explain well |
| **Patient's perception** | Fast results, effective remiders | Unability to respon web-sent messages<br>Confidential issues |

[39, 167, 170]

### 5.2.5 AI chatbots, voice-driven technology

The findings regarding the mobile messaging are presented in the Table 5.6

**Table 5.6.** Benefits and limits of AI-chatbots in the primary care.

| | Benefits | Limits |
|---|---|---|
| **Workload** | Automatic complatation of taskEMR integrated | Generating new HCP-patient contacts in unclear situations |
| **Security** | Well protected<br>Voice biometric recognition | Voice-driven tasks can be heard |
| **Health Risk** | Level of accuracy and safety of humans (red-flag notifications) | Level of health issues recognition is limited to preinstalled input of knowledge |
| **Patient's perception** | More honest patients | Potential age and language barriers |

[119, 130, 168, 172]

### 5.2.6 Summary of findings

Following Table 5.7 presents summary of all findings from performed systematic review.

**Table 5.7.** Benefits and limits of social media.

| | Ordinarye mail | secure portal | video | Messaging | Social Media | Chatbots |
|---|---|---|---|---|---|---|
| **Workload** | questionable | ↓ | ↓ | ↓ | questionable | ↓ |
| EMR integration | no | **yes** | no | depends | no | **yes** |
| **Security** | no | **yes** | **yes** | no | no | **yes** |
| Patient identification | no | **yes** | **yes** | no | no | **yes** |
| **Health Risk** | questionable | low | questionable | questionable | questionable | low |

# 6 Discussion

Previous chapters summarized the available evidence on currently implemented eHealth solutions for GP-patient communication. Despite some gaps in the available evidence, the findings indicate that communication platforms broadly differ in their benefits and limits, and therefore in the overall impact on the provided healthcare. Thus, following chapter is discussing key findings regarding the communication media, limitations of provided review and the possible implications of key findings in the Czech healthcare system.

## 6.1 Discussion of key findings

Discussion of benefits and limits in the structure of particular communication media for GP-patient interaction can serve as a comparison of various consultation platforms and can be valuable source for unresolved issues of future development of health services. The discussion of benefits and limits is performed from four studied impacts: on the GPs' workload, system security, healthy risks and users' perception.

Inconsistent findings were yielded regarding the communication media effect on workload. As mentioned above, AI chatbots and voice-driven technology have clearly the potential to reduce GP's workload, as well as structured consulting, video calls and SMS reminders. On the other hand, GP can spend a great deal of time by managing free-text emails and social media, especially if considering subsequent follow-up as an additional task. However, there is unique finding reckoning that free-text communication could replace 2% of visits [87]. Similarly Dash et al. [116] perceived decrease in the workload while using free-text email. This could be due the fact that followed GPs offered two different mail-boxes, one for clinical and second for administrative issues manageable by nurse. Because lots of patient's requests are administrative related [73, 111]. What seems critical for workload evaluation is, if patient after remote consultation continued to contact GP by face-to-face, which might affect the aim of reducing the workload [156], and the remote service adds another activity to the workload or replaces existing GP's tasks. Furthermore, it is necessary to ensure that GPs' understand the IT technical shortcomings [93, 156]. That is why Chudner et al. [166] suggest to engage stakeholders into innovation implementation and ensure the system user-friendliness.

As resulting from presented findings, workload impact and system security strongly depends on the IT infrastructure used. However, little has been reported on technical characteristics in reviewed studies regarding GP-patient interaction. These concepts are often beyond the technical expertise of clinical researchers that focus

mostly on acceptability, benefits, and challenges of remote consulting from patients' and clinicians' views, rather than technical evaluation. Williams et al. [169] supports finding of this thesis, that lowest secure communication platform is among social sites, as opposed to secure portals, where authentication process is often as safe as for online banking [153, 160] and chatbots with biometric security measures [42, 171, 172]. Asystem allowing retrieval of patient's identity reduces the medico-legal risks of remote consultancy [153], because lack of proper patients identification increases consequent potential for error in clinical decision making [173].

Every practice should be compliant with the general data protection regulations (GDPR) that came into force on May 2018 [19], however finding of this thesis suggests that in case when there is no secure medium, GPs use unprotected email system to communicate with patients [60, 87]. Despite this fact and GDPR recommendations, the percentage of GPs who is discussing confidentiality issues in relation to unprotected remote communication with their patients is not reported in studies included in presented review. However, recent recommendation of NHS England suggests, that in emergency situations, the data protection is only secondary matter and GPs can use tools such as Skype, WhatsApp and Facetime, if its considered as a short-term measure caused by emergency situation [174].

The author finds a correlation between impact on workload and the potential health risks. Communication platform which is not integrated with the EHR increases the physician's registering load and involves extra work, as well as is risky regarding the patients' safety. Castrén [87] found that more than 70% of physician-patient email contacts were not documented in the EHR. However, comprehensive EHR containing all health-related patients' information was found to be important to ensure patients' safety [175]. Therefore, communication media linked to patients' EHR are perceived as more safe.

Health risk is also affected by the nature of communication tool itself. Even though there is little evidence published by JAMA Internal Medicine in May 2016, saying that remote consultancy provide the same level of opportunity as a physical visit [176], author of this thesis finds differences between patient's safety ensured during face-to-face visit and its remote alternatives. For various previously presented reasons, standalone unstructured texting does not meet the requirements to provide consultation avoiding unwarranted variation in quality [26, 150, 158]. The risk occurs especially, if social media or mobile messaging would be used for clinical decision making. Finding of this thesis leads to strong consideration that social media can be a powerful tool for public health information dissemination, but at the same time it can contain loads of misinformation [128]. Similarly SMS can be too short to cause misunderstanding or can easily be sent to wrong telephone number [116, 120].

Author of this thesis found that GPs differ in their technology perception and uptake rates in contrary to patients. The higher acceptance of technology was found by patients. This finding is consistent with other studies, as for example with Chudner et al. [166]. Despite the available evidence claiming potential benefits resulting from technology implementation, there is a general reluctance among GPs to implement alternatives to face-to-face consultations [72, 150, 158]. Overall, GPs preferred the asynchronous ways of communication for its decreasing impact on the workload and flexibility [84, 88, 116, 156]. The potential to decrease workload was cited especially in the context of structured consulting [84, 88, 155]. This finding is in accordance with Dyer-Smith and Badial [177], finding 87% of structured consultations didn't need any follow up, if GP was properly trained on consultation model. Disadvantages for using remote consultations included concerns regarding the patient's security, potential workload increase [150, 156, 158], lack of data protection [4, 73, 178] and guidance [154].

The main findings regarding the patient's perceptions are, overall, highly positive, which is in accordance with previous studies [179]. Similarly like GPs, patient's preferences also revealed higher for electronic mail compared to video [110, 111]. Reasons underlying this satisfaction include enhanced convenience, reduced cost and waiting time [70, 88, 89]. However, there were also clear grounds for dissatisfaction, particularly with care delivered by the personal email when patients don't receive follow-up in time [13, 28, 73]. Almost three out of four responders stated that availability of online access would influence their move to another practice [179], nonetheless, responders were reluctant to award a high monetary value to it. Furthermore, patients' satisfaction is highly dependent on the patient and their characteristics, as well as the health conditions in which the patient made the request[73, 79].

## 6.2 Impacts on quality and availability of healthcare

According to the results of this thesis, health care professionals are nowadays encouraged in using various communication media that broadly differ in their benefits and limits, and therefore in the overall impact on the quality and availability of provided healthcare. In order to increase quality of provided health care the technology should bring positive outcomes for patients as well as for general practice staff.

eHealth technology holds promising potential to enhance primary care. Benefits discussed in this thesis range from administrative tasks support to clinical decision-making supplementation. However, the technology is not sophisticated enough to be considered a viable alternative to seeing a person. Interpersonal face-to-face interaction using vision, voice, empathy, smell, active listening, touch and other senses will always be the most unique and relevant occasions to meet, discuss and get recommendations

from a GP. Clearly, any eHealth tool won't be able to replace human physicians. However, technology should be used to ease the physician-patient interaction and help GPs to provide higher quality, personalized and empathetic care.

The use of AI chatbots illustrates higher benefits in increased productivity and efficiency of provided care, far beyond other communication media. With speeding up the diagnostics, it can improve the day-to-day life of GPs, letting them spend more time looking after patients and support patients in self-managing their health. At the same time, many questions have been raised about the possible negative impact AI could have. Ethical considerations of AI mainly include responsibility for AI solutions [132] and increased inequality in the care access for elderly and people in developing countries [180]. Furthermore, set of actions have to be taken prior AI implementation into daily healthcare, such as setting up standards, regulations and guidance [132]. Therefore, chatbots introduce more international and long-term goal than a possible alternative for systematic change in the Czech general practice.

Finding reachable solutions that could positively impacts on quality and availability of Czech primary care, the focus should be given on structured messaging through secured patient portals. Studies documented a high rate of patient satisfaction with the portals [152, 179], which enables patients to take a more active role in their own health [160, 181]. Portal use also improves physician-patient communication with not having negative impact on provider's workload [88, 157], while providing sufficient level of patient's safety [84, 88, 157] and data protection [152, 153, 160]. Furthermore, patient portals offer reliable health-related information that can possible help patients to self-manage their health. Complementarily, portals allow patients administrative benefits of online appointments booking and prescription requesting. Therefore, patient portals seem to offer great potential for higher quality of provided care.

## 6.3 Implications for Czech Republic

So far, the Czech Republic is failing in the international comparison in the field of health digitalization and therefore the implications of this review assessment for Czech healthcare system are complex.

### 6.3.1 Need for a leadership role

The efforts of building national EHR repository with patient access are however discussed at least since 2012 [60]. The big picture seems to be that a nationally employed communication platforms like those in Denmark and Estonia require centralized governmental institution that has the authority to establish an all-encompassing ICT infrastructure and to effectively operate it. This on one hand requires a national government standing behind the system providing administrative and managerial capacity, and on the other hand requires healthcare professionals and all

citizens willing to accept governmental agency as necessary authority letting yielding enormous cache of sensitive personal information. Clear and courageous leadership at national level is a key to drive through the changes that eHealth implementation brings.

As described in the Chapter 3.2 of this thesis, MZCR established number of eHealth focusing institutions that should somehow contribute to reaching the same goal of increased quality and availability of Czech healthcare. However the organisational structure between established organisations is not clear and there is no available evidence about their effective collaboration. Therefore, roles and responsibilities should be made clear, and collaboration should be a central piece in this process.

### 6.3.2 Public discussion needed

Implementing such a complex system is a long process taking lots of efforts. Development of Czech national portal EHR/PHR is described in the The National eHealth Strategy of the Czech Republic [8]. As stated in the Strategy, there are three strategic objectives: *"1) Ensuring easy and equal access to information about healthcare providers, ensuring availability of services with simple tools of electronic communication, 2) Providing accurate information on state of health and treatment plans, 3) Development of information support to care for their own health and improving health literacy".* Furthermore, one of sub-objectives is *"distance electronic consultation of health. Its output will be a protected channel of communication between a patient and his/her physician. This service will enable to solve the needs of a patient for which his/her physical presence in the office is not required"*.

Taking this Strategy extract as an example, the document gives a reader an impression, that the strategy is too general too be easily followed in order to meet its objectives. The document specifies the direction of Czech eHealth development however there are no closer information about the tactics of achieving it. Furthermore, the strategy includes international examples of successful national portals in Denmark and Norway. But the description of presented foreign solutions is not specific enough, which makes us think about the Strategy as about a document without a clear idea and vision of how the system should work and which exact functionalities it should contain. Not having a clear idea of desired solution could be one of the reasons, why implementation of the Czech national "NZIP" portal is undergoing progressive delay.

Successful transition towards healthcare digitalization requires all healthcare professionals to be comfortable with managing the digital tools. This is not always the case today and it will require initiatives that enhance the skills of healthcare personnel. At the same time, eHealth solutions should strive to achieve high levels of usability, so that GPs and all HCPs do not perceive them to be a burden. Furthermore, healthcare should be patient-centred, integrated, sustainable and equitable. In order to achieve

these expectations it is necessary to understand how healthcare can develop into well-managed segment that takes full advantage of eHealth solutions. Accordingly, engaging the dialogue with the primary eHealth solutions users, both citizens and HCPs, is critical step to this implementation process. This approach includes being open to existing actors as well as to new entrants that can contribute in innovation and further development of healthcare system. Clearly, a discussion among professionals and public representatives must happen in order to define exact system needs.

### 6.3.3 Calling for an inspiration

Furthermore, Czech Republic should not passively follow the newest innovation trends, but rather use the benefits of taking a slower approach to eHealth implementation. In such circumstances, the focus may be on harvesting insights and learning from other countries, in order to avoid unwanted and most probably expensive thresholds beyond which there is no return. The outputs from national, well-moderated discussion should be verified and benchmarked with the other countries, ideally using common platforms within the EU organs and working teams focused on eHealth.

The aim is to prove the same trends and most relevant ways how to address them, how to avoid getting into wrong direction and perhaps even find the common ground and use the already existing ideas as a lever in domestic argumentation later on. The system requirements (e.g. technical functionalities, phases of implementation, resources – both financial and human, legislation adjustments, regulatory policies and professional organisations cooperation) will be gradually shaped once public discussion (end users, GPs) and international benchmark deliver solid and robust strategy direction.

As soon as straightforward requirements are given, the MZCR should manage the complete political process in the Czech Parliament and government in case there will be the need to create or adjust laws. In alignment with managing the legal environment the MZCR should start working on a tender definition. The author expects that state human resources involve enough experienced healthcare professionals; however, it might happen that the governmental organisation lacks the employees with tender management and business operations experience. For these purposes, if political circumstances allow, there is always a possibility to involve a private third party company with the aim to help organize and manage the tender in which not only domestic, but also international companies submit their offers and proposals. Inspired by commercial business sector, outsourced expertise driven by market competitiveness can push the digital solutions and innovations even more forward.

### 6.3.4 Use what we have

Based on the described actions that has to be taken I assume that we are talking about long-term project that will last years, rather than few months. After preparing a ground

for service provider of the patient portal, or chatbots in the far future, months of implementation will follow, not talking about its testing phase and step by step roll out, followed by educating, guiding and supporting staff to work towards common goals that will contribute to continued development of the patient portal.

In order to create a general practice where digital solutions are incorporated into a natural part of work requires different ways of working as well as care flows. However, it is not necessary to wait with eHealth tools introduction into the practice until full operation of future national portal. As resulting from the Chapter 3 and practical part of this thesis, there are already consultation platforms available, among which online video can ensure decent level of security, especially for low-risk patients [110, 182]. Furthermore, some GPs already started to use video because of ongoing pandemic. Therefore, we can start spreading the use of video calls mediated by medical software. We are already aware of the communication method benefits and we are able to manage given constraints and limitations.

Therefore, while the state prepares environmental ground for the long-term strategy represented by patient portals and chatbots, author recommends to increase utilization of tools being widely spread and already available, focusing on video consultations. GPs and patients would step-by-step learn how and when is appropriate to use remote consultations. It is critical to make both healthcare professional and patients aware of future online health services. This approach would help to avoid low uptake of usage of patient portal once it is introduced. Furthermore, given recommendation is in accordance with Atherton et al. [27] that suggests to increase the remote communication uptake in order to recognize its impact on the healthcare system.

### 6.3.5 Need of guidelines

In order to encourage GPs to use online video with their patients, professional organisations should publish guideline representing common approach on how to incorporate eHealth communication into daily practice. As resulting from the key findings of this thesis, not all communication media are appropriate for health-related consultation. It is estimated, that 90% of all the patients that are using email to contact their GP are sending critical information [28]. However, current evidence presented in the Chapter 3 indicates, that GPs consult their patients using conventional means of communication. GPs should be therefore educated on which media are appropriate for clinical interaction and how to use them.

Easy to read guidelines with clear instructions should be provided. Such a guideline should contain information on clinical appropriateness, patient consent, use of the tool itself and finally on documentation of the consultation evidence in the patient's EHR. This will help GPs to deliver a consistent patient experience, avoid unwarranted variation in quality and optimise digital routes to provide care with essential standards.

Lists of assured video systems that comply with set standards should be available as well, in order to avoid disturbances and limitations related to the technology. Additionally, examples from local GP practices sharing advantages and risks of digital technology could be beneficial evidence to support other GPs in implementing new ways of working.

Furthermore, also citizens will have to be educated on new ways of healthcare delivery, especially regarding the clinical appropriateness of remote consultations that will require increased autonomy of a patient. Professional organisations should therefore create also fliers for GPs to be distributed to patients in the offices.

### 6.3.6 Online services reimbursement

Traditionally, the lack of funding is noted as one of the factors why the HCPs don't offer online services [183]. Therefore, discussion with healthcare payers has to be open prior encouraging GPs to use remote ways of working. As stated in the Chapter 3, remote consultations started to be acknowledged as a clinical care provision in terms of reimbursement only recently with regard to ongoing coronavirus pandemic [82]. However, it is not clear if such arrangements will remain.

As presented in the chapter 3, reimbursement of video consultations was established in Sweden and Germany. As opposed to Swedish operation, where GPs providing video are reimbursed by municipalities per-consultation basis, in Germany GP offering a video consultancy receive annual fee and additional technology surcharge for each consultation up to 50 sessions in a year quarter. Limiting number of reimbursed video consultations seems reasonable in order to motivate GPs to provide innovative ways of working, but limiting misuse of remote consultations.

Getting to appropriate remuneration of GP's work is needed for all provided eHealth services. This requires innovative ways of reimbursing regulations that rewards beyond the mere volume of activity to the resulting impact on quality and outcomes. A balance between financial and nonfinancial incentives should be struck with the aim of motivating healthcare actors to provide the best possible care.

### 6.3.7 Change in medical education

As AI implementation will be progressing, the working routine of GPs and other HCP will most likely change over time. The technology support will allow GPs spending less time on administrative tasks and focus more on patient. To do so, a GP will have to be capable to use the technology, having skills and digital literacy. There will no longer be such a need of memorising facts, but instead there will be continuous need of learning and multidisciplinary working. From long-term point of view, this change will require incorporating digital skills into medical university curricula.

### 6.3.8 Continuous monitoring need

Last but not least, such a complex and long-term change will require continuous monitoring and evaluation of reaching objectives according to the plan. It is necessary to streamline and extend horizon of the statistical data collection regarding the healthcare services. It is obvious from the chapter 3, that a lot of data on eHealth communication tools is not available for the Czech primary care. Furthermore, once they are available they are already at least one or two years outdated. On the contrary, available statistical data on health services exploitation in the United Kingdom are one or two months old. Efficient monitoring is crucial for alterations of ongoing development, if needed. The need of efficient statistical data collection is align with the importance of taking an evidence-based approach to supporting the future commissioning of digital technology.

## 6.4 Limitations and Strengths

Author recognizes limitations in the performed review. Firstly, the literature search yielded studies that were diverse methodologically. Studies included in the review were heterogeneous in study design and sample size of both groups HCPs and patients. Some of the studies were not focussed exclusively on GP-patient communication and were dedicated to all primary care staff including nurses. Another limiting factor is that reviewed articles consist mainly of highly selected populations of patients and GPs, which may have had an impact on the results, biased findings and limited interpretations.

Secondly, there were not enough studies found regarding the use of social media and chatbots in the primary care. Findings on data and health security indicate that social media don’t need to be futher investigated, however artificial intelligence tools will definitely require loads of future research and education.

Third, the author included only English-written studies and reports. This may have restricted the findings toward newest articles from non-English speaking countries. As such findings should not be used to force only one particular communication medium to be widely implemented among general practices in the Czech Republic, but should be taken as current insight to the European eHealth development, to familiarize decision makers with available technology and approaches that can be employed in physician-patient interaction, and to identify opportunities for further employment growth in this emerging field of eHealth.

The strength of this thesis is its complexity. Wide range of reviews on alternatives to face-to-face consultations has been conducted; however, many of them are primarily concerned with particular ‘mainstream’ technology and don’t compare all communication tools available. Furthermore, only a minority of studies specifically focus on use in general practice.

# 7 Conclusion

An effective communiation between GP and a patient is a key factor healthcare quality anywhere in the world. Nowadays, also in the context of COVID-19 outbreak a phenomenon of remote consultancy has been gaining on importance. However, there are certain aspects why this alternative way of working is not widespread and implemented among general practices.

Reasons for slower implementation of eHealth communication often contain GPs' worries of icreased workload, not sufficient protection of sensitive data and decreased ability to perform save clinical decision during remote consultation. Furthermore, users of such a technology often perceive barriers to consult their health remotely. With regard to cited concers, this thesis aimed to evaluate benefits and limits of the eHealth tools GPs can use for communication with their patients.

Completely five communication tools have been described and evaluated by systematic literature review with help of an extensive analysis of 41 studies. The impact on the quality and availability of provided healthcare has been assessed for each of the mentioned tool and final summary of key findings regarding benefits and constraints has been provided.

In order to confirm the aim of the thesis, it was concluded that secure portals and chatbots are the most favourable tools to increase quality and availability of the primary care and they should be used in the near future, not only thanks to the international trends observation, but mainly in regard to the performed analysis of the tool’s benefits a limits. Having definded results of performed analysis, the author is able to answer set of research questions.

Regarding the first research question assessing the impact on the GP’s workload, the potential of decreasing have online structured consultancy through secure portal, video, text messaging and a chatbot. Second question tend to evaluate the privacy protection of consulted information. It was find the highest when secure portal, video or chatbot is used as a consultancy medium. Third research question was observing the clinical risk steaming from miscommunication or misunderstanding, which was found the highest through conventional email, mobile messaging and social media. The last research question on users’s perception can not be definitelly addressesed on which communication medium is the best perceived. However patients are generally more willing to consult remotely, than GPs. And finally, all asynchronous communication media were better perceived than video.

On top of these conclusions, the thesis compared the international status of eHealth implementation with the Czech environment and finally suggests a direction which the

Czech healthcare professionals and authorities should apply when implementing the preferred eHealth tools that proved to have the most benefits, namely secure portals and chatbots. Estimating a long process to implement them, which requires involving public discussion, international benchmark and best practises check, finance and organization clarification and gradual rollout, a temporary solution is presented: there is a good chance to start utilizing already available tool for online video which proved to be decreasing workload while keeping decent level of clinical security, as well as data security, if performed through clinical software.

Of course, the implementation of any centralised communication system should ideally be implemented within stable political environment allowing consistent and aligned eHealth strategy among major political players and institutions. Nontheless, higher set of actions will be more successful if presented to professionals and public as a tool "improving a service" rather than "implementing a technology".

Finally, it needs to be mentioned that such a complex topic offers more aspects to consider which were not described in this thesis in bigger detail. Firstly, clinical safety of evaluated tools needs to be assessed in the context of whole population among all age groups, rather than in studies being performed with actual users that are often younger, not having any health issues. Secondly, future higher uptake of chatbots requires addressing questions regarding ethic and responsibility which should be further investigated. Moreover, any major changes in healthcare system have always been a typical and sensitive topic in political discussions and therefore one of the related topics worth further assessment in the context of digitalisation and eHealth services could be its financing and related political perceptions of improving healthcare availability.

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# Annex A: Digital Public Services

**Table 0.1: Digital Public Services Dimension and the presence of National EHR systems**

| Country | DESI eHealth index | National EHR |
|---|---|---|
| Denmark | 15,9 | yes[52] |
| Sweden | 14,3 | yes[153] |
| Finland | 14,2 | yes[52] |
| Netherlands | 13,5 | no[52] |
| Estonia | 13,4 | yes[52] |
| United Kingdom | 11,6 | no[52] |
| Spain | 11,4 | yes[52] |
| Belgium | 11,3 | yes[52] |
| Croatia | 11,3 | no[52] |
| Slovenia | 10,1 | no[52] |
| Portugal | 9,9 | yes[52] |
| Lithuania | 8,6 | yes[52] |
| Latvia | 8,4 | no[52] |
| European Union | 7,4 | - |
| Hungary | 6,9 | no[52] |
| France | 6,5 | yes[153] |
| Italy | 5,7 | yes[52] |
| Greece | 5,7 | no[52] |
| Ireland | 5,5 | no[52] |
| Czechia | 5,3 | no[52] |
| Slovakia | 5,1 | no[52] |
| Romania | 4,6 | yes[52] |
| Luxembourg | 3,9 | yes[52] |
| Austria | 3,8 | yes[52] |
| Germany | 3,5 | no[52] |
| Cyprus | 3,4 | yes[52] |
| Poland | 2,5 | no[52] |
| Bulgaria | 2,5 | no[52] |
| Malta | 2,4 | no[52] |

Sources: eHealth DESI Index 2019 European Commission, Digital Scoreboard [51], WHO Global eHealth Survey 2017 [52]; [153].

# Annex B:

| Author | Year | Country | Study Design | Medium |
|---|---|---|---|---|
| Fagerlund at al. [70] | 2019 | Norway | Qualitative study (interviews) | secure messaging |
| López Seguí et al. [84] | 2020 | Spain | Retrospective Cross-Sectional Study | secure messaging |
| Dash et al. [116] | 2016 | Switzerland | Qualitative study (postal survey) | regular email |
| Cowie et al.[88] | 2018 | UK | Mixed-methods | structured secure messaging |
| Farr, Banks, Edwards et al.[150] | 2018 | UK | qualitative interviews and surwey, quantitative data | structured secure messaging |
| Banks et al. | 2017 | UK | Qualitative study (interview) | structured secure messaging |
| Carter et al. | 2018 | UK | Mixed methods | structured secure messaging |
| Edwards et al. | 2017 | UK | Observational study | secure messaging |
| Riippa et al. | 2015 | Finland | Controlled before/after study | secure messaging |
| Casey et al. | 2017 | UK | Case study | structured secure messaging |
| Johansson et al. | 2020 | Sweden | Mixed methods | structured secure messaging |

| | | | | |
|---|---|---|---|---|
| Eccles et al. | 2019 | UK | Mixed-methods | structured secure messaging |
| Atherton et al. | 2013 | UK | Qualitative study (interviews) | regular email |
| Atherton et al. | 2018 | UK | Mixexd-method case study | regular email; structured secure messaging |