BMJ Open

Email-consultation by patients in general practice: data of Dutch electronic health records

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-019233
Article Type:	Research
Date Submitted by the Author:	18-Aug-2017
Complete List of Authors:	Huygens, Martine; Maastricht University CAPHRI School for Public Health and Primary Care, Health Services Research; Center for Care Technology Research Swikels, Ilse; Nederlands Instituut voor Onderzoek van de Gezondheidszorg Verheij, Robert A; NIVEL, Netherlands Institute for Health Services Research, Friele, Roland; NIVEL, ; Tilburg University, Tranzo van Schayck, Onno; Maastricht University CAPHRI School for Public Health and Primary Care, Department of Family Medicine; Center for Care Technology Research de Witte, Luc; University of Sheffield , Centre for Assistive Technology and Connected Healthcare (CATCH)
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Health services research, Communication
Keywords:	PRIMARY CARE, Patient, email-consultation

Email-consultation by patients in general practice: data of Dutch electronic health records

Martine WJ Huygens[a,e], Ilse CS Swinkels[b,e], Robert A Verheij[b], Roland D Friele[b,c,e], Onno CP van Schayck[d,e], Luc P de Witte[f]

[a] School for Public Health and Primary Care (CAPHRI), Maastricht University, Department of Health Services Research, P.O. Box 616, 6200 MD, Maastricht, the Netherlands. m.huygens@maastrichtuniversity.nl

[b] NIVEL, Netherlands Institute for Health Services Research, Utrecht, the Netherlands, P.O. Box 1568, 3500 BN Utrecht, the Netherlands. i.swinkels@nivel.nl, r.friele@nivel.nl, r.verheij@nivel.nl

[c] Tilburg School of Social and Behavioral Sciences, Tilburg University, Tranzo, the Netherlands, P.O. Box 90153, 5000 LE Tilburg, the Netherlands.

[d] School for Public Health and Primary Care (CAPHRI), Maastricht University, Department of Family Medicine, P.O. Box 616, 6200 MD, Maastricht, the Netherlands. o.vanschayck@maastrichtuniversity.nl

[e] Center for Care Technology Research, Maastricht, The Netherlands.

[f] Centre for Assistive Technology and Connected Healthcare (CATCH), University of Sheffield, 217 Portobello, Sheffield S1 4DP, United Kingdom. l.p.dewitte@sheffield.ac.uk

Corresponding author: Martine Huygens
Email: m.huygens@maastrichtuniversity.nl
Postal address: P.O. Box 616, 6200 MD, Maastricht, The Netherlands.
Tel: +31 43 38 81 700

Abstract

Objectives

It is unclear why the use of email-consultation is not more widespread in Dutch general practice, particularly because, since 2006, its costs can be reimbursed. To encourage further implementation, it is needed to understand the current use of email-consultations. This study aims to understand the use of email-consultation by different patient groups, compared to other GP consultations.

Setting

For this retrospective observational study we used Dutch routine electronic health record data obtained from NIVEL Primary Care Database for the years 2010 and 2014.

Participants

200 general practices were included in 2010 (734 122 registered patients), 434 in 2014 (1 630 386 registered patients).

Primary outcome measures

The number and percentage of email-consultations, and patient characteristics (age, gender, neighbourhood socioeconomic status and diagnoses) of email-consultation users were investigated and compared to those who had a telephone or face-to-face consultation. General practice characteristics were also taken into account.

Results

32.0% of the Dutch general practices had at least one email-consultation in 2010, rising to 52.8% in 2014. In 2014, only 0.7% of the GP consultations were by email (the others comprised home visits, telephone, and face-to-face consultations). Its use highly varied among GP's. Most email-consultations were done for psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%) problems. These diagnosis categories appeared less frequently in telephone and face-to-face consultations. Patients who had an email-consultation were older than patients who had a telephone or face-to-face consultation. In contrast, patients with diabetes who had an email-consultation were younger.

Conclusion

Even though email-consultation was done in half the general practices in the Netherlands in 2014, the actual use of it is extremely low. Patients who had an email-consultation differ from those that had a telephone or face-to-face consultation. In addition, the use of email-consultation by patients is dependent on its provision by GPs.

Strengths and limitations

- In this study we used routine electronic health record data obtained from a large nationwide database, comprising general practice data that is representative for the Dutch population (including 734 122 registered patients in 2010 and 1 630 386 in 2014).
- The focus of this study is on the use of email-consultation in primary care, which is one of the first eHealth services provided in primary care, and its costs can already be reimbursed since 2006 in the Netherlands.
- In this study we investigated registered GP consultations. The observation that several general practices registered no email-consultations does not indicate whether these general practices actually offered a service to perform email-consultations; it could be that they offered it, but did not use or register email-consultations.
- In this study, data of 2010 and 2014 were used; more recent data might show higher email-consultation rates.

1. Introduction

In the past decade, interest has grown in digital services for communication in primary care between patients and health care professionals [1-3]. In several European countries, between 19 (United Kingdom) to 51 (Denmark) percent of patients sent or received an email from their doctor, nurse or health care organisation [1]. Email-consultation is an asynchronous way of communication by which patients can consult their health care professional at any time of the day, and health care professionals can respond when it is suitable for them. Email-consultations are consistent with the trend in primary care towards care processes being performed more efficiently, by shifting tasks from the general practitioner to the primary care nurse [4, 5]. However, in many countries, the use of email-consultation is not yet structurally embedded in daily care routines and is often not yet encouraged by national policies [6].

Numerous studies have been conducted to investigate the concerns and benefits regarding email-consultation. Identified concerns include an increase in the workload of physicians [7-9], privacy and safety issues [9, 10], and the exacerbation of existing inequalities in access to health care [7, 9]. In contrast, other studies found that email-consultation is time-saving [11, 12], and that it can offer increased opportunities for marginalised groups to access health care [13]. In addition, it is expected that, by the introduction of email-consultation, general practice consultations can be reduced, particularly telephone consultations; however, studies have shown inconsistent effects regarding this suggested reduction [14]. In general, evidence is still inconclusive regarding the impact of email-consultations [15].

Studies are scarce of the behaviour of patients using email-consultations, compared to office consultations [1]. The few studies that have investigated the characteristics of frequent email-consultation users have shown mixed results; some found that email-consultation was used more by the younger [1, 16, 17] and higher educated groups [1], while others found that age [3] and employment status [16] did not seem to influence its use. In addition, little is known about the health issues about which patients communicate using email. It seems that patients use email to pose questions about biomedical concerns, medication, test results and to inform or update healthcare professionals about non-urgent health issues ('for your information' messages) [3, 18]. For further implementation, insight is needed to clearly understand the feasibility and acceptability of email-consultation by different patient populations and to compare these with other GP consultations [6].

In contrast to many other countries, since 2006 the costs of email-consultation in primary care can be reimbursed by the health insurance in the Netherlands; nevertheless, the actual use of email-consultation seems low [2]. In addition, the effectiveness of email-consultation and the benefits it can bring are unclear. Understanding for which patients, and for what reasons, email is currently used might be important to maximise the benefits it can bring [9].

This study aims to acquire insights into the current status of email-consultation usage in the Netherlands, by using data from electronic health records of Dutch primary care practices. In particular, the focus is on the perspective of the patient. First, the email-consultation rates in the Netherlands in 2010 and 2014 will be investigated. Second, it will be investigated which patients (age, gender, and socioeconomic status) had an email-consultation and for what health problems; these characteristics will be compared to those that had telephone or face-to-face consultations in 2014. Third, for the patient group who had (relatively) the most email-consultations, characteristics will be investigated together with the impact of email-consultation (in terms of its percentage of use

in comparison with telephone and face-to-face consultations) within this patient group. Because the use of email-consultation by patients might be dependent on its provision by the general practice, the general practice characteristics will also be taken into account.

2. Methods

2.1. Design, participants and care setting

We used routine electronic health record data from general practices, collected by NIVEL Primary Care Database [19] in 2010 and 2014. Representative data of 200 general practices in 2010, and 434 general practices in 2014 were used, representing on average 734 122 and 1 630 386 inhabitants, respectively (4.4% and 9.7% of the Dutch population). We used only data from practices that met certain criteria regarding data quality.

All Dutch residents are registered in one general practice. Health insurance is mandatory, in which GP consultations are fully covered. The general practitioner is the gatekeeper for hospital- and specialist care. Since 2006, an email-consultation can be reimbursed: 1) when it is done by a patient who is registered at the general practice, 2) in the case of an existing treatment relationship, 3) when it is not the first consultation for a health condition, and 4) when it is a substitute for a regular consultation [20].

Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of study containing no directly identifiable data (Dutch Civil Law, Article 7:458). This study has been approved according to the governance code of NIVEL Primary Care Database, under number NZR-00315.062.

2.2. Measurements

2.2.1. Characteristics of general practices

The following general practice characteristics were included: average number of registered patients per general practice and level of urbanisation (from 1 being highly urban, to 5 being not urban).

2.2.2. General practice consultation

To compare the utilisation rate of email-consultation with other GP consultations, the following were included: email-consultations, short face-to-face consultations (20 minutes or less), long face-to-face consultations (more than 20 minutes), short home visits (less than 20 minutes), long home visits (more than 20 minutes) and telephone consultations (consultation types according to reimbursement codes determined by the Dutch Healthcare Authority [21]).

To investigate and compare the patient characteristics of those who had an email-consultation with those who underwent another type of GP consultation, only email-consultations, telephone consultations and face-to-face consultations (short + long) were included. For every consultation, the date and diagnosis were included. Consultations and corresponding diagnoses were coded according

to the International Classification of Primary Care (ICPC-1) [22]. Only consultations with a single ICPC were included in the analyses.

2.2.3. Patient characteristics

Age and gender were included as patient characteristics. In addition, neighbourhood status scores were provided by the Netherlands Institute for Social Research at postal code level (PC4). This score reflects the socioeconomic status score of a neighbourhood, compared to other neighbourhoods in the Netherlands [23] and is a common indicator of neighbourhood socioeconomic status (NSES) in the Netherlands [24]. The socioeconomic status scores were assessed in 2010 and 2014 and comprised four indicators: the average household income per particular postal code, the proportion of residents with low family income, the proportion of low-educated residents and the proportion of unemployed residents per postal code. A higher score means a higher status for the area of residence. Scores ranged from -6.75 to 3.06.

2.3. Statistical analyses

Three data sets were used for this study. First, to investigate the consultation rates in 2010 and 2014, all general practices in these years (from our dataset) were included and the following consultation types were analysed: email-consultation, face-to-face consultation, long face-to-face consultation, home visits, long home visits and telephone consultation. Descriptive analyses were conducted to calculate the consultation rate per 1000 registered patients (counted from the average number of registered patients per year) in 2010 and 2014, and to count the general practices that registered email-consultations in these years.

Second, to investigate which patient groups had email-consultations, and for what health problems, and to compare this with patients that had another GP consultation, only data from general practices in 2014 were used. The following consultation types were analysed: email-consultation, face-to-face consultation (short and long) and telephone consultation. Patients and consultations with incomplete datasets were excluded (31.6% of the observations of which 28.6% due to incomplete consultations or consultations with two ICPCs). Because the use of email-consultation by patients is dependent on its provision by the general practice, the dataset was split into three groups based on the number of email-consultations that general practices had in 2014; 1) general practices that did not register any email-consultation, 2) general practices that registered a few email-consultations (n<100) and 3) general practices that registered many email-consultations (n≥100). Descriptive analyses were used to investigate general practice characteristics (the average number of registered patients per general practice and level of urbanisation) and patient characteristics (age, gender and NSES). The diagnosis categories for which email-consultations, telephone consultations and face-to-face consultations (short + long) were done were calculated using descriptive analyses.

Third, data from patients with the diagnosis identified in the previous analyses as being (relatively) most frequently used for email-consultations were used for further analysis. The following consultation types were analysed: email-consultation, face-to-face consultation (short + long) and telephone consultation. This dataset was split into three, based on the number of email-consultations that general practices registered for that specific diagnosis in 2014: 1) general practices that did not register any email-consultation for that diagnosis, 2) general practices that registered a few email-consultations for that diagnosis (n<25) and 3) general practices that registered many

email-consultations for that diagnosis (n≥25). Descriptive analyses were used to investigate general practice characteristics (the average number of registered patients per general practice and level of urbanisation) and patient characteristics (age, gender and NSES).

To identify significant differences of general practice characteristics between the three groups of practices, two-way Anova with Bonferroni correction (average number of registered patients, mean age and NSES of the general practice patient population and level of urbanisation per general practice) were conducted. Differences in patient characteristics within the three groups of general practices (patients who had an email, telephone- or face-to-face consultation) were not tested for statistical significance because of the large sample size. In large samples, small differences can be detected as significant, even though they are not practically relevant. Therefore, only relevant differences are reported. The statistical package STATA (version 14.0) was used to conduct the analyses.

3. Results

3.1. Study population

Dataset 1

In 2010, data from 200 general practices were used, including 2 708 191 general practice consultations (577 487 patients). The mean age of the study population was 41.7 (sd=23.1, missing data n=4 207), 45.5% male, and the mean NSES was -0.10 (sd=1.19, missing data n= 93 193). In 2014, data from 434 general practices were collected including 6 473 921 general practice consultations (1 307 822 patients). The mean age of the study population was 43.1 (sd=23.4, missing data n=9 298), 45.7% male (missing data n=98), and the mean NSES was 0.08 (sd=1.10, missing data n=28 209). The characteristics of these general practices can be found in Table 1.

Table 1. Characteristics of general practices in 2010 and 2014.

General practice characteristics	**2010** *Mean (SD) or n (%)*	**2014** *Mean (SD) or n (%)*
n general practices	200	434
n registered patients	734 122	1 630 386
n general practice consultations	2 708 191	6 473 921
n patients who had a general practice consultation	577 487	1 307 822
Average number of registered patients per general practice	3671 (sd=2501)	3757 (sd=2384)
Level of urbanisation		
Very urban	40 (20.0%)	89 (20.5%)
High	46 (23.0%)	99 (22.8%)
Moderate	38 (19.0%)	84 (19.4%)
Little	42 (21.0%)	85 (19.6%)
Not urban	32 (16.0%)	75 (17.3%)
Missing	2 (1.0%)	2 (0.5%)
n general practices that registered email-consultations	64 (32.0%)	229 (52.8%)

Dataset 2

In dataset 2, data from 2014 were used. Home visits, and patients and consultations with incomplete data were excluded. 429 general practices were included. Non-response analyses showed no

differences after exclusion (compared to the complete dataset without home visits) regarding patient characteristics (age, gender and NSES) and general practice characteristics (average number of registered patients per general practice and level of urbanisation). Characteristics of the general practices in the total data set 2, and of the general practices that registered none, a few (<100) and many (≥100) email-consultations can be found in Attachment 1.

Examination of the differences in general practice characteristics between these three groups showed differences in number of registered patients per general practice, level of urbanization and age. General practices that registered email-consultations had a higher number of registered patients per general practice, were located in more urban areas and had a younger patient population. No significant difference of NSES was found between these three groups.

3.2. Data set 1: the use of email-consultation in 2010 and 2014

The number of general practices that used email-consultation increased from 32.0% in 2010 to 52.8% in 2014. The consultation rates per consultation type for 2010 and 2014 can be found in Table 2. The utilisation of email-consultation increased from 8.4 per 1000 registered patients in 2010 to 17.6 in 2014. In comparison, 1033.9 telephone consultations per 1000 registered patients were carried out in 2010, and 1140.6 in 2014. In general practices that registered email-consultations, 0.6% (n=5 494) of the total GP consultations were by email in 2010; in 2014, this was 0.7% (n=24 556).

For 2014, the consultation rate per consultation type was calculated for general practices that did not register any email-consultations, that registered a few email-consultations (n<100) and that registered many email-consultations (n≥100). In general practices that registered many email-consultations, the utilisation of email-consultations was 95.8 per 1000 registered patients.

Table 2. Consultation rate per 1000 registered patients per year.

Year	General practices	n	Email	Face-to-face	Face-to-face long	Home visit	Home visit long	Tele-phone
2010	All general practices	200	8.4	2325.0	374.6	147.4	73.3	1033.9
2014	All general practices	434	17.6	2299.6	532.6	128.9	89.2	1140.6
2014	*GP that did not register email-consultations*	205	-	2241.3	510.8	145.0	94.5	1058.6
2014	*GP that registered <100 email-consultations*	163	8.1	2404.2	563.2	120.4	89.2	1176.3
2014	*GP that registered ≥100 email-consultations*	66	95.8	2222.2	524.9	99.7	72.5	1307.3

3.3. Data set 2: characteristics of email, telephone and face-to-face consultation users

Table 3 shows the characteristics of patients who had at least one email, telephone, or face-to-face consultation, distributed in terms of general practices that performed none, a few, or many email-consultations. In general practices that had a few email-consultations, 0.6% of the patients who had at least one GP consultation had an email-consultation. This was 4.8% in general practices that had many email-consultations.

In general practices that registered email-consultations, relevant differences were found in age between patients who had an email versus a telephone or face-to-face consultation; patients that had an email-consultation seemed to be older.

Table 3. Characteristics of patients who had an email, telephone, or face-to-face consultation in general practices that registered none, a few (n<100) and many (n≥100) email-consultations.

	General practices that did not register any email-consultation (n=211)		**General practices that registered a few (n<100) email-consultations (n=175)**			**General practices that registered many (n≥100) email-consultations (n=43)**		
Patient characteristics	**Telephone** n patients= 255 153	**Face-to-face (short + long)** n patients= 466 672	**Email** n patients= 3 214	**Telephone** n patients= 275 352	**Face-to-face (short + long)** n patients= 441 424	**Email** n patients= 7 225	**Telephone** n patients= 81 221	**Face-to-face (short + long)** n patients= 133 427
	Mean (SD) or n (%)	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*
Age	47.3 (sd=23.7)	43.6 (sd=23.4)	46.4 (sd=20.8)	45.7 (sd=23.5)	42.0 (sd=23.4)	46.4 (sd=19.9)	45.2 (sd=23.3)	42.1 (sd=22.9)
Gender (% male)	103 117 (40.4%)	212 399 (45.5%)	1 355 (42.2%)	110 337 (40.1%)	198 051 (44.9%)	3 055 (42.3%)	32 288 (39.8%)	59 850 (44.9%)
NSES	0.02 (sd=1.02)	0.02 (sd=1.02)	0.22 (sd=1.07)	0.06 (sd=1.18)	0.05 (sd=1.19)	0.36 (sd=.97)	0.35 (sd=.97)	0.38 (sd=.97)

3.4. Data set 2: diagnosis categories of email-consultations vs telephone and face-to-face consultations

The diagnosis categories for which patients had an email, telephone or face-to-face consultation in 2014 can be found in Table 4 (listed from the most to the least frequently used diagnosis category). Most email-consultations were associated with the following diagnosis categories: psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%). In comparison with other GP consultations, these diagnosis categories were less frequently associated with telephone consultations (psychological: 9.1%; endocrine, metabolic, nutritional: 7.3%; and circulatory: 8.2%) and face-to-face consultations (psychological: 5.8%; endocrine, metabolic, nutritional: 4.4%; and circulatory: 9.1%).

Considering specific diagnoses, most email-consultations were done for hypertension (5.3%, n=873 consultations), diabetes (5.0%, n=835 consultations) and depression (2.5%, n=409 consultations). This involved 1.8% (diabetes), 1.6% (depression), and 1.0% (hypertension) of the total number of GP consultations for diabetes, depression and hypertension, respectively, in general practices that registered email-consultations.

Table 4. Diagnosis categories associated with email, telephone, or face-to-face consultations in general practices that registered at least one email-consultation in 2014 (n general practices=218), listed from the most to the least frequently used diagnosis category.

	Email-consultations *n consultations=16 558*		**Telephone consultations** *n consultations=770 103*		**Face-to-face consultations (short + long)** *n consultations= 1 609 157*	
	Diagnosis category	*n (%)*	*Diagnosis category*	*n (%)*	*Diagnosis category*	*n (%)*
1	Psychological	2434 (14.7%)	Musculoskeletal	109 115 (14.2%)	Skin	259 034 (16.1%)
2	Endocrine, metabolic, nutritional	1802 (10.9%)	Digestive	75 508 (9.8%)	Musculoskeletal	245 441 (15.3%)
3	Circulatory	1777 (10.7%)	Respiratory	74 819 (9.7%)	Respiratory	172 494 (10.7%)
4	Musculoskeletal	1609 (9.7%)	General /Unspecified	70 539 (9.2%)	Circulatory	145 828 (9.1%)
5	Skin	1428 (8.6%)	Psychological	70 297 (9.1%)	Digestive	106 511 (6.6%)
6	General /Unspecified	1423 (8.6%)	Circulatory	62 924 (8.2%)	Ear	974 12 (6.1%)
7	Respiratory	1274 (7.7%)	Skin	56 879 (7.4%)	Psychological	93 820 (5.8%)
8	Digestive	1213 (7.3%)	Endocrine, metabolic, nutritional	55 952 (7.3%)	General /Unspecified	92 600 (5.8%)
9	Female Genital	649 (3.9%)	Female Genital	40 276 (5.2%)	Urological	90 444 (5.6%)
10	Pregnancy, Childbearing, Family Planning	574 (3.5%)	Neurological	24 262 (3.2%)	Endocrine, metabolic, nutritional	70 548 (4.4%)
11	Neurological	554 (3.4%)	Pregnancy, Childbearing, Family Planning	22 347 (2.9%)	Female Genital	47 670 (3.0%)
12	Social Problems	380	Eye	17 894	Eye	43 327

		(2.3%)		(2.3%)		(2.7%)
13	Urological	367 (2.2%)	Blood	13 757 (1.8%)	Neurological	42 980 (2.7%)
14	Male Genital	348 (2.1%)	Ear	12 812 (1.7%)	Pregnancy, Childbearing, Family Planning	32 618 (2.0%)
15	Eye	288 (1.7%)	Social Problems	12 124 (1.6%)	Blood	29 950 (1.9%)
16	Blood	242 (1.5%)	Male Genital	11 648 (1.5%)	Male Genital	19 839 (1.2%)
17	Ear	196 (1.2%)	Urological	3 895 (5.1%)	Social Problems	18 641 (1.2%)

3.5. Data set 3: email-consultations for diabetes

As described in the previous paragraph, email-consultation involved (relatively) the highest percentage of GP consultations for the specific diagnosis of diabetes (1.8%). Therefore, in-depth analyses were carried out for this diagnosis group.

In 2014, 37 409 patients had at least one GP consultation for diabetes (80 867 GP consultations). The mean age of the study population was 66.4 (sd=13.7), 51.5% male and the mean NSES was -0.15 (sd=1.14). Characteristics of the general practices in the total dataset 3, and of the general practices that registered none, a few (<25) and many (≥25) email-consultations for diabetes, can be found in Attachment 2. General practices that registered email-consultations for diabetes had a significantly higher average number of registered patients and were located in more urban areas. No significant difference was found in mean age and NSES.

3.5.1 Dataset 3: Characteristics of patients with diabetes who had a consult by email, telephone, or face-to-face

Characteristics of patients who had a diabetes consultation with their GP by email, telephone, or face-to-face in general practices that registered none, a few, or many email-consultations can be found in Table 5.

In general practices that registered email-consultations for diabetes, relevant differences were found in age of patients with diabetes who had an email-consultation versus a telephone and face-to-face consultation; patients that had an email-consultation seemed to be younger.

In general practices that registered many email-consultations for diabetes, 12.5% (n=233) of the patients with diabetes had at least one email-consultation, and in general practices that registered a few email-consultations for diabetes this was 1.8% (n=132). In addition, in general practices that registered many email-consultations for diabetes, 13.8% (n=560) of the GP consultations for diabetes were by email. In comparison, 29.0% (n=1 180) of the consultations were by telephone, and 57.2% (n=2 327) face-to-face. In general practices that did not register email-consultations for diabetes, 40.1% (n=23 722) were telephone and 59.9% (n=35 448) face-to-face consultations.

Table 5. Characteristics of patients who had a GP consultation by email, telephone, or face-to-face for diabetes in general practices that registered none, a few (n<25) or many (n≥25) email-consultations for diabetes.

	General practices that did not register any email-consultations for diabetes (n=351)		**General practices that registered a few (n<25) email-consultations for diabetes (n=69)**			**General practices that registered many (n≥25) email-consultations for diabetes (n=9)**		
Patient characteristics	**Telephone** n patients= 11 723	**Face-to-face (short + long)** n patients= 16 674	**Email** n patients= 132	**Telephone** n patients= 2 992	**Face-to-face (short + long)** n patients= 4 025	**Email** n patients= 233	**Telephone** n patients= 516	**Face-to-face (short + long)** n patients= 1 114
	Mean (SD) or n (%)	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*
Age	68.0 (sd=14.5)	65.5 (sd=12.9)	62.0 (sd=11.3)	67.8 (sd=14.8)	65.6 (sd=12.9)	61.2 (sd=11.8)	66.2 (sd=14.8)	64.7 (sd=12.5)
Gender (% male)	5 587 (47.7%)	9 053 (54.3%)	80 (60.6%)	1 361 (45.5%)	2 142 (53.2%)	133 (57.1%)	245 (47.5%)	662 (59.4%)
NSES	-0.17 (sd=1.19)	-0.20 (sd=1.14)	0.11 (sd= 1.01)	-0.15 (sd=1.10)	-0.17 (sd=1.06)	0.46 (sd=.69)	0.42 (sd=.78)	0.43 (sd=.71)

4. Discussion

Principal findings

This study aimed to acquire insights into the current status of email-consultation usage in the Netherlands, with a focus on the patient perspective. 32.0% of the general practices studied used email-consultations in 2010; this was more than half (52.8%) in 2014. However, in 2014 email-consultations comprised still less than one percent of the total number of GP consultations (home visits, face-to-face-, telephone- and email-consultations) in general practices that registered at least one email-consultation. Patients who had an email-consultation with their GP in 2014 were older compared to patients who had a telephone or face-to-face consultation. Furthermore, in general practices that registered many (≥100) email-consultations, almost 5% of the patients who had at least one GP consultation (face-to-face, telephone, or email-consultation), had an email-consultation. Most patients had an email-consultation with their GP for issues related to psychological, endocrine, metabolic, nutritional and circulatory health problems. These diagnosis categories seemed to appear less frequently in telephone and face-to-face consultations. Email-consultation was most used for the specific disorder of diabetes. Interestingly, patients with diabetes who had an email-consultation were younger. In general practices that registered many (≥25) email-consultations for diabetes, 12.5% of the patients with diabetes had at least one email-consultation for this condition. Patients' email-consultation usage is also dependent on its provision by the general practice: in general practices with a higher number of registered patients, located in more urban areas and with a younger patient population, email-consultation was more often used.

Strengths and weaknesses

The main strength of this study is that data were used from a large nationwide database comprising the electronic health records of Dutch general practices. This database is representative for the Dutch (general practice) population [19]. General practices that did not fulfil the criteria for completeness of registration were excluded; however, this caused minimal selection bias. We assumed that all registered consultations included in this study are actually performed according to the rules of national declaration policy of the Dutch College of General Practitioners [20] and the Dutch Healthcare Authority [21]. However, within the scope of this study we could not check if this was really the case with all included consultations. Nevertheless, using data from registered consultations of electronic health records seems to be the most representative source for the investigation of actual email-consultation usage.

To reduce variation between general practices, we split the dataset into three groups of general practices: those registering none, a few, or many email-consultations. The observation that general practices registered no email-consultations does not indicate whether these general practices actually offered a service to perform email-consultations. Although we do not have information about the online services offered in the general practices of our dataset, the annually published eHealth monitor about the status of eHealth in the Netherlands revealed that 49% of the surveyed general practices reported offering email-consultation in 2014 [25]. In comparison, 52.8% of the general practices in our dataset registered at least one email-consultation in 2014.

It might be expected that general practices only offer email-consultation for specific diagnoses (for example due to diagnosis specific procedures or applications); however, we found that all general

practices in our dataset registered email-consultations for a wide range of diagnoses, which suggests that it could be used for all kinds of health problems. However, due to requirements for reimbursement of email-consultation, it should be noted that not every email-consultation can be claimed. In addition, some health questions cannot be addressed by email. In our analyses, we did not make a distinction between consultations that could be done by email or not, because it is currently unclear what questions are appropriate for this type of consultation.

Another limitation of the study is that socioeconomic status was assessed at district level (postal code area); patients' individual socioeconomic status was unknown. Therefore, neighbourhood socioeconomic status (NSES) cannot be purely seen as an individual characteristic and is dependent on the area where the general practice is located. Furthermore, in this study, data of 2010 and 2014 were used. More recent data would probably show higher email-consultation rates. The annual Dutch eHealth monitor reported that the number of general practices that offer email-consultations increased from 49% in 2014 to 60% in 2016 [26]. Nevertheless, there are no indications that email-consultation is used by other patient groups.

Comparison with existing literature

Half of the Dutch general practices in our dataset registered email-consultation in 2014; in comparison, it is only offered in 6% of the general practices in the United Kingdom [27], but to all citizens in Denmark via a public health portal [28]. Even though it seems that email-consultation is offered by half the general practices in the Netherlands, its actual use is extremely low. This is not the case in Denmark, where, in 2013, more than 4 million GP email-consultations were done (in comparison to about 20 million face-to-face consultations) [29, 30], and a questionnaire study (n=684) showed that 52% of the respondents (or their closest relative) had used an email-consultation [29].

The lack of reimbursement is frequently mentioned as reason why eHealth is not yet fully adopted in primary care. A recently conducted systematic review of the factors influencing the implementation of eHealth found that cost related factors were mentioned by most studies as important barriers for the implementation of eHealth [31]. However, our study shows that funding for eHealth does not directly guarantee eHealth use.

Overall, patients that had an email-consultation were older. Studies have found that a younger age is associated with email-consultation usage [1, 16]. This is not found when analysing the entire patient population, however looking into the diagnosis group that had (relatively) the most email-consultations (patients with diabetes), we found that email-consultation users seemed to be younger, compared to patients of this diagnose group who had a telephone or face-to-face consultation with their GP. It should be noted that email-consultations in the Netherlands can only be reimbursed when it is not the first consultation for a health condition; this might explain the observation that, overall, patients who had an email-consultation were older, as the number of people with a prolonged or chronic disease was greater in the higher age groups.

This study focuses on email-consultation usage from the patient perspective. The use of email-consultation by patients, however, highly varies among general practices. Patients' email-consultation usage seems therefore partly dependent on its provision by the general practice. Therefore, the patient perspective cannot be studied in isolation; it is probably dependent on how general practices offer, promote and use it [32, 33].

Interestingly, email-consultations were most frequently used for diagnoses related to psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%) concerns, which were less frequently the topic of telephone and face-to-face consultations. In the scarce research that have been performed regarding the content of online consultations, it was found that, using an online patient-provider portal, more psychosocial messages were sent via the portal than by telephone [34]. In addition, a review of the impact of digital communication on marginalised groups suggests that online communication may reduce patients' inhibitions and sense of intimidation, resulting in more disclosure and asking of questions [13]. Moreover, a study of electronic health records with the possibility of exchanging secure messages showed that this was most frequently used by patients with a chronic condition [35]. In the current study, email-consultation was most used by patients with diabetes. It seems that this disease is highly convenient for the use of email-consultation, because of the prolonged characteristic of the disease and the frequency of contact with the GP. The latter might suggest that these patients have a well-established and trusting relationship with their GP, which is found to be related to successful digital communication among patients and care professionals [13]. In addition, it has been noted that patients use email to report a change in their condition or to discuss laboratory results, new conditions, changes in prescription dose and the need for new prescriptions [35]; all of these are frequently seen in diabetes management. In our study, we did not have information about the content of the email-consultations; only the type of diagnosis. This should be further investigated in future research.

Implications for research and practice

Email-consultation has the potential to become a routinely used communication service for patient-GP interaction, similarly to telephone consultations; it seem to be an appropriate service in this day and age, when digital communication plays an important part in many individuals' daily lives. However, this study has shown that, in the Netherlands, the actual use of email-consultation is extremely low.

It seems that email-consultation is not just a service that can be merely installed. Without clear implementation strategies, including promotion strategies and defining for which patients it can be best used, it might not be adopted by patients. In this study, we found that email-consultation is most used by people with psychological, endocrine or circulatory concerns. Focusing on these target groups first, and investigating the effectiveness of email-consultation and the benefits it can bring for these patient groups, might be important to stimulate broader uptake among GPs and patients. In addition, investigating reasons why patients do not use email-consultation might provide important insights about patients' views regarding email-consultation and the barriers that need to be overcome. Experiencing the benefits of the use of email-consultation can be the drive for its routine use, for both patients and care professionals. Moreover, because patients' email-consultation usage is dependent on its provision by general practices, the implementation and use of it should be further studied as a two-layered issue. Qualitative research is recommended to investigate the experienced benefits and barriers of both patients and care providers regarding email-consultation usage.

5. Funding

This study is part of a PhD project, which is partly funded by a grant from the Netherlands Organization for Health Research and Development (ZonMw), grant 10-10400-98-009, and partly funded by Maastricht University/School for Public Health and Primary Care. The funding source had no role in the design, conduct, analyses, or reporting of the study or in the decision to submit the manuscript for publication.

6. Ethical approval

The Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of study containing no directly identifiable data (Dutch Civil Law, Article 7:458). This study has been approved according to the governance code of NIVEL Primary Care Database, under number NZR-00315.062.

7. Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: MH, IS, RF, OS and LW had financial support from ZonMw for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work. RV declares to have had financial support from Netherlands Institute for Health Services Research (NIVEL) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

8. Details of contributors

MH, IS, RV, RF, OS and LW conceived the study. RV supervised the data collection. MH performed the analyses. All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to the interpretation of the data. MH wrote the draft of the manuscript with the help of IS, RV, RF, OS and LW. All authors read and approved the final manuscript.

9. Transparency declaration

MH affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

10. Data sharing statement

Technical appendix, statistical code, and data set available on reasonable request by the corresponding author (MH).

11. Acknowledgements

We would like to thank Rodrigo Davids for helping in processing the data and Lucas van der Hoek and Peter Spreeuwenberg for their statistical advice and helping with statistical analyses.

Attachment 1.

General practice characteristics of data set 2 and of the three general practice groups of dataset 2

	Data set 2 (total) (n=429)	**GP's that did not register any email-consultations (n=211)**	**GP's that registered a few (<100)email-consultations (n=175)**	**GP's that registered many (≥100)email-consultations (n=43)**
Average number of registered patients per general practice	3752.2 (sd=2387.4)	3371.5 (sd=1735.625)	3975.7 (sd=2593.1)	4710.8 (sd=3645.1)
n general practice consultations	4 207 538	1 811 720	1 856 205	539 613
n patients that had a general practice consultation	1 177 123	511 947	516 039	149 137
Level of urbanization				
- *Very urban*	89 (20.8%)	31 (14.7%)	47 (26.9%)	11 (25.6%)
- *High*	96 (22.4%)	40 (19.0%)	42 (24.0%)	14 (32.6%)
- *Moderate*	84 (19.6%)	39 (18.5%)	35 (20.0%)	10 (23.3%)
- *Little*	85 (19.8%)	54 (25.6%)	27 (15.4%)	4 (9.3%)
- *Not urban*	73 (17.0%)	47 (22.3%)	22 (12.6%)	4 (9.3%)
- *Missing*	2 (0.5%)		2 (1.1%)	
Age of the study population	43.1 (sd=23.5)	43.9 (sd=23.6)	42.4 (sd=23.4)	42.3 (sd=23.0)
Gender (% male) of the study population	532 217 (45.2%)	232 793 (45.5%)	232 466 (45.1%)	66 958 (44.9%)
NSES of the study population	.08 (sd=1.10)	.03 (sd=1.02)	.05 (sd=1.19)	.37 (sd=.98)

Attachment 2.

General practice characteristics of data set 3 and of the three general practice groups of dataset 3 (patients with diabetes)

	Data set 3 (total) **(n=429)**	**GPs that did not register any email-consultations for diabetes (n=351)**	**GPs that registered a few (<25) email-consultations for diabetes (n=69)**	**GPs that registered many (≥25) email-consultations for diabetes (n=9)**
Average number of registered patients per general practice	3752.2 (sd=2387.4)	3486.7 (sd=1982.2)	4661.5 (sd=3227.4)	7132.6 (4627.6)
n general practice consultations for diabetes	80 867	59 170	17 630	4 067
n patients that performed a general practice consultation for diabetes	37409	28 397	7 149	1 863
Level of urbanization				
- *Very urban*	89 (20.8%)	66 (18.8%)	21 (30.4%)	2 (22.2%)
- *High*	96 (22.4%)	74 (21.1%)	19 (27.5%)	3 (33.3%)
- *Moderate*	84 (19.6%)	68 (19.4%)	15 (21.7%)	1 (11.1%)
- *Little*	85 (19.8%)	75 (21.4%)	9 (13.0%)	1 (11.1%)
- *Not urban*	73 (17.0%)	66 (18.8%)	5 (7.3%)	2 (22.2%)
- *Missing*	2 (0.5%)	2 (0.6%)		
Age of the study population	66.4 (sd=13.7)	66.5 (sd=13.7)	66.4 (sd=13.77)	64.7 (sd=13.15)
Gender (% male) of the study population	19 263 (51.5%)	14 640 (51.6%)	3 583 (50.1%)	1 040 (55.8%)
NSES of the study population	-.15 (sd=1.14)	-.19 (sd=1.16)	-.16 (sd=1.08)	.43 (sd=.73)

12. References

1. Newhouse N, Lupiáñez-Villanueva F, Codagnone C, Atherton H. Patient use of email for health care communication purposes across 14 European countries: an analysis of users according to demographic and health-related factors. *J. Med. Internet Res* 2014;17(3): e58-e
2. Huygens MWJ, Vermeulen J, Friele RD, van Schayck OCP, de Jong JD, de Witte LP. Internet services for communicating with the general practice: barely noticed and used by patients. *Interact J Med Res* 2015;4(4): e21
3. de Jong CC, Ros WJ, Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J. Med. Internet Res* 2014;16(1): e19
4. Maier CB, Aiken LH. Task shifting from physicians to nurses in primary care in 39 countries: a cross-country comparative study. *Eur J Public Health* 2016;26(6): 927-34
5. Kroneman M, Boerma W, van den Berg M, Groenewegen P, de Jong J, and van Ginneken E. Netherlands: Health system review. *Health Syst Transit* 2016;18(2): 1-240
6. Antoun J. Electronic mail communication between physicians and patients: a review of challenges and opportunities. *Fam. Pract* 2015;33(2): 121-126
7. Hanna L, May C, Fairhurst K. The place of information and communication technology-mediated consultations in primary care: GPs' perspectives. *Fam. Pract* 2011;29(3): 361-366
8. Bishop TF, Press MJ, Mendelsohn JL, Casalino LP. Electronic communication improves access, but barriers to its widespread adoption remain. *Health Aff* 2013;32(8): 1361-7
9. Atherton H, Pappas Y, Heneghan C, Murray E. Experiences of using email for general practice consultations: a qualitative study. *Br J Gen Pract* 2013;63(616): e760-e7
10. Goodyear-Smith F, Wearn A, Everts H, Huggard P, Halliwell J. Pandora's electronic box: GPs reflect upon email communication with their patients. *J Innov Health Inform* 2005;13(3): 195-202
11. Rosen P, Kwoh CK. Patient-physician e-mail: an opportunity to transform pediatric health care delivery. *Pediatrics* 2007;120(4):701-6
12. Houston TK, Sands DZ, Nash BR, Ford DE. Experiences of physicians who frequently use e-mail with patients. *Health Commun* 2003;15(4): 515-25
13. Huxley CJ, Atherton H, Watkins JA, Griffiths F. Digital communication between clinician and patient and the impact on marginalised groups: a realist review in general practice. *Br J Gen Pract* 2015;65(641) :e813-e21
14. de Lusignan S, Mold F, Sheikh A, Majeed A, Wyatt JC, Quinn T, et al. Patients' online access to their electronic health records and linked online services: a systematic interpretative review. *BMJ open* 2014;4(9): e006021.
15. Atherton H, Sawmynaden P, Sheikh A, Majeed A, Car J. Email for clinical communication between patients/caregivers and healthcare professionals. *Cochrane Database Syst Rev* 2009;3
16. Mehrotra A, Paone S, Martich GD, Albert SM, Shevchik GJ. Characteristics of patients who seek care via eVisits instead of office visits. *Telemed and e-Health* 2013;19(7): 515-9
17. Ye J, Rust G, Fry-Johnson Y, Strothers H. E-mail in patient–provider communication: A systematic review. *Patient Educ Couns* 2010;80(2): 266-73
18. Byrne JM, Elliott S, Firek A. Initial experience with patient-clinician secure messaging at a VA medical center. *J Am Med Inform Assoc* 2009;16(2): 267-70.
19. NIVEL. Primary Care Database http://www.nivel.nl/en/dossier/nivel-primary-care-database

(accessed 5 July 2017)
20. Nederlands Huisartsen Genootschap (NHG). NHG-Checklist e-consult. 2014.
21. The Dutch Healthcare Authority (NZa) https://www.nza.nl/organisatie/sitewide/english/ (accessed 5 July 2017)
22. Lamberts H, Wood M. International classification of primary care. Oxford: Oxford University Press, 1987
23. Knol F, Veldheer V. Neighbourhood status development in the Netherlands 1998-2010, 2012
24. Galobardes B, Shaw M, Lawlor D, Smith G, Lynch J. Indicators of Socioeconomic Position: Methods in Social Epidemiology. *J Epidemiol Community Health* 2006;60: 47-85
25. Krijgsman J, Peeters J, Burghouts A, Brabers A, Jong Jd, Beenkens F, et al. Op naar meerwaarde! eHealth-monitor 2014, 2014
26. Krijgsman J, Swinkels I, Lettow van B, Jong de J, Out K, Friele R, et al. More than technology. eHealht-monitor 2016, 2016
27. Brant H, Atherton H, Ziebland S, McKinstry B, Campbell JL, Salisbury C. Using alternatives to face-to-face consultations: a survey of prevalence and attitudes in general practice. *Br J Gen Pract* 2016;66(648): e460-e6
28. Kierkegaard P. eHealth in Denmark: a case study. *J Med Syst* 2013;37(6): 9991
29. Bertelsen P, Petersen LS, editors. Danish Citizens and General Practitioners' Use of ICT for their Mutual Communication. In *MedInfo* 2015: 376-379
30. Danmarks Statestik. SYGK: Lægebesøg mv. med offentlig tilskud efter område, ydelsesart, alder, køn og socioøkonomisk status 2006-2013. 2015
31. Ross J, Stevenson F, Lau R, Murray E. Factors that influence the implementation of e-health: a systematic review of systematic reviews (an update). *Implement Sci* 2016;11(1): 146
32. Wolcott V, Agarwal R, Nelson DA. Is Provider Secure Messaging Associated With Patient Messaging Behavior? Evidence From the US Army. *J. Med. Internet Res* 2017;19(4): e103
33. Wells S, Rozenblum R, Park A, Dunn M, Bates DW. Organizational strategies for promoting patient and provider uptake of personal health records. *J Am Med Inform Assoc* 2014;22(1): 213-22
34. Lin C-T, Wittevrongel L, Moore L, Beaty BL, Ross SE. An Internet-based patient-provider communication system: randomized controlled trial. *J. Med. Internet Res* 2005;7(4): e47
35. Serrato CA, Retecki S, Schmidt DE. MyChart—a new mode of care delivery: 2005 personal health link research report. *Perm J.* 2007;11(2): 14-20

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5,6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6,7
		(*b*) Describe any methods used to examine subgroups and interactions	6,7
		(*c*) Explain how missing data were addressed	6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(*e*) Describe any sensitivity analyses	n.a.

Continued on next page

Results			page
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7,12,19,20
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	n.a.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,10,12,13,19,20
		(b) Indicate number of participants with missing data for each variable of interest	n.a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n.a.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	n.a.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n.a
		Cross-sectional study—Report numbers of outcome events or summary measures	7-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n.a.
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a.
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14,15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15,16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Understanding the use of email-consultation in primary care using a retrospective observational study with data of Dutch electronic health records

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-019233.R1
Article Type:	Research
Date Submitted by the Author:	02-Oct-2017
Complete List of Authors:	Huygens, Martine; Maastricht University CAPHRI School for Public Health and Primary Care, Health Services Research; Center for Care Technology Research Swinkels, Ilse; Nederlands Instituut voor Onderzoek van de Gezondheidszorg Verheij, Robert A; NIVEL, Netherlands Institute for Health Services Research, Friele, Roland; NIVEL, ; Tilburg University, Tranzo van Schayck, Onno; Maastricht University CAPHRI School for Public Health and Primary Care, Department of Family Medicine; Center for Care Technology Research de Witte, Luc; University of Sheffield , Centre for Assistive Technology and Connected Healthcare (CATCH)
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Health services research, Communication
Keywords:	PRIMARY CARE, Patient, email-consultation

Understanding the use of email-consultation in primary care using a retrospective observational study with data of Dutch electronic health records

Martine WJ Huygens[a,e], Ilse CS Swinkels[b,e], Robert A Verheij[b], Roland D Friele[b,c,e], Onno CP van Schayck[d,e], Luc P de Witte[f]

[a] School for Public Health and Primary Care (CAPHRI), Maastricht University, Department of Health Services Research, P.O. Box 616, 6200 MD, Maastricht, the Netherlands. m.huygens@maastrichtuniversity.nl

[b] NIVEL, Netherlands Institute for Health Services Research, Utrecht, the Netherlands, P.O. Box 1568, 3500 BN Utrecht, the Netherlands. i.swinkels@nivel.nl, r.friele@nivel.nl, r.verheij@nivel.nl

[c] Tilburg School of Social and Behavioral Sciences, Tilburg University, Tranzo, the Netherlands, P.O. Box 90153, 5000 LE Tilburg, the Netherlands.

[d] School for Public Health and Primary Care (CAPHRI), Maastricht University, Department of Family Medicine, P.O. Box 616, 6200 MD, Maastricht, the Netherlands. o.vanschayck@maastrichtuniversity.nl

[e] Center for Care Technology Research, Maastricht, The Netherlands.

[f] Centre for Assistive Technology and Connected Healthcare (CATCH), University of Sheffield, 217 Portobello, Sheffield S1 4DP, United Kingdom. l.p.dewitte@sheffield.ac.uk

Corresponding author: Martine Huygens
Email: m.huygens@maastrichtuniversity.nl
Postal address: P.O. Box 616, 6200 MD, Maastricht, The Netherlands.
Tel: +31 43 38 81 700

Abstract

Objectives

It is unclear why the use of email-consultation is not more widespread in Dutch general practice, particularly because, since 2006, its costs can be reimbursed. To encourage further implementation, it is needed to understand the current use of email-consultations. This study aims to understand the use of email-consultation by different patient groups, compared to other GP consultations.

Setting

For this retrospective observational study we used Dutch routine electronic health record data obtained from NIVEL Primary Care Database for the years 2010 and 2014.

Participants

200 general practices were included in 2010 (734 122 registered patients), 434 in 2014 (1 630 386 registered patients).

Primary outcome measures

The number and percentage of email-consultations, and patient characteristics (age, gender, neighbourhood socioeconomic status and diagnoses) of email-consultation users were investigated and compared to those who had a telephone or face-to-face consultation. General practice characteristics were also taken into account.

Results

32.0% of the Dutch general practices had at least one email-consultation in 2010, rising to 52.8% in 2014. In 2014, only 0.7% of the GP consultations were by email (the others comprised home visits, telephone, and face-to-face consultations). Its use highly varied among GP's. Most email-consultations were done for psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%) problems. These diagnosis categories appeared less frequently in telephone and face-to-face consultations. Patients who had an email-consultation were older than patients who had a telephone or face-to-face consultation. In contrast, patients with diabetes who had an email-consultation were younger.

Conclusion

Even though email-consultation was done in half the general practices in the Netherlands in 2014, the actual use of it is extremely low. Patients who had an email-consultation differ from those that had a telephone or face-to-face consultation. In addition, the use of email-consultation by patients is dependent on its provision by GPs.

Strengths and limitations

- In this study we used routine electronic health record data obtained from a large nationwide database, comprising general practice data that is representative for the Dutch population (including 734 122 registered patients in 2010 and 1 630 386 in 2014).
- The focus of this study is on the use of email-consultation in primary care, which is one of the first eHealth services provided in primary care, and its costs can already be reimbursed since 2006 in the Netherlands.
- In this study we investigated registered GP consultations. The observation that several general practices registered no email-consultations does not indicate whether these general practices actually offered a service to perform email-consultations; it could be that they offered it, but did not use or register email-consultations.
- In this study, data of 2010 and 2014 were used; more recent data might show higher email-consultation rates.

1. Introduction

In the past decade, interest has grown in digital services for communication in primary care between patients and health care professionals [1-3]. In several European countries, between 19 (United Kingdom) to 51 (Denmark) percent of patients sent or received an email from their doctor, nurse or health care organisation [1]. Email-consultation is an asynchronous way of communication by which patients can consult their health care professional at any time of the day, and health care professionals can respond when it is suitable for them. Email-consultations are consistent with the trend in primary care towards care processes being performed more efficiently, by shifting tasks from the general practitioner to the primary care nurse [4, 5]. However, in many countries, the use of email-consultation is not yet structurally embedded in daily care routines and is often not yet encouraged by national policies [6].

Numerous studies have been conducted to investigate the concerns and benefits regarding email-consultation. Identified concerns include an increase in the workload of physicians [7-9], privacy and safety issues [9, 10], and the exacerbation of existing inequalities in access to health care [7, 9]. In contrast, other studies found that email-consultation is time-saving [11, 12], and that it can offer increased opportunities for marginalised groups to access health care [13]. In addition, it is expected that, by the introduction of email-consultation, general practice consultations can be reduced, particularly telephone consultations; however, studies have shown inconsistent effects regarding this suggested reduction [14]. In general, evidence is still inconclusive regarding the impact of email-consultations [15].

Studies examining the consulting pattern of patient groups using email consultation, in comparison with office consultations, are scarce [1]. The few studies that have investigated the characteristics of frequent email-consultation users have shown mixed results; some found that email-consultation was used more by the younger [1, 16, 17] and higher educated groups [1], while others found that age [3] and employment status [16] did not seem to influence its use. In addition, little is known about the health issues about which patients communicate using email. It seems that patients use email to pose questions about biomedical concerns, medication, test results and to inform or update healthcare professionals about non-urgent health issues ('for your information' messages) [3, 18]. For further implementation, insight is needed to clearly understand the feasibility and acceptability of email-consultation by different patient populations and to compare these with other GP consultations [6].

In contrast to many other countries, since 2006 the costs of email-consultation in primary care can be reimbursed by the health insurance in the Netherlands. The Dutch Ministry of Health, Welfare and Sport acknowledges the potential benefits of eHealth and stimulate the use of online communication in health care [19]. In addition, the Dutch College of General Practitioners set up guidelines for the use of email-consultation and stimulates the use of it [20]. Nevertheless, the actual use of email-consultation seems low [2]. In addition, the effectiveness of email-consultation and the benefits it can bring are unclear. Understanding for which patients, and for what reasons, email is currently used might be important to maximise the benefits it can bring [9].

This study aims to acquire insights into the current status of email-consultation usage in the Netherlands, by using data from electronic health records of Dutch primary care practices. In particular, the focus is on the the number of email-consultations done by different patient groups (in terms of age, gender, socioeconomic status and health conditions) as registered by primary care

professionals. First, the email-consultation rates in the Netherlands in 2010 and 2014 will be investigated. Second, it will be investigated which patients (age, gender, and socioeconomic status) had an email-consultation and for what health problems; these characteristics will be compared to those that had telephone or face-to-face consultations in 2014. Third, for the patient group who had the most email-consultations (as percentage of al GP consultations in that group), characteristics will be investigated together with the impact of email-consultation (in terms of its percentage of use in comparison with telephone and face-to-face consultations) within this patient group. Because the use of email-consultation by patients might be dependent on its provision by the general practice, the general practice characteristics will also be taken into account.

2. Methods

2.1. Design, participants and care setting

We used routine electronic health record data from general practices, collected by NIVEL Primary Care Database [21] in 2010 and 2014. Representative data of 200 general practices in 2010, and 434 general practices in 2014 were used, representing on average 734 122 and 1 630 386 inhabitants, respectively (4.4% and 9.7% of the Dutch population). We used only data from practices that met certain criteria regarding data quality; only general practices were included that recorded more than 70% of their consultations with International Classification of Primary Care (ICPC) codes and provided data for the entire calendar year. Primary care practices voluntarily participate in NIVEL Primary Care Database.

All Dutch residents are registered in one general practice. Health insurance is mandatory, in which GP consultations are fully covered. The general practitioner is the gatekeeper for hospital- and specialist care. Since 2006, an email-consultation can be reimbursed: 1) when it is done by a patient who is registered at the general practice, 2) in the case of an existing treatment relationship, 3) when it is not the first consultation for a health condition, and 4) when it is a substitute for a regular consultation [22].

Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of study containing no directly identifiable data (Dutch Civil Law, Article 7:458). This study has been approved according to the governance code of NIVEL Primary Care Database, under number NZR-00315.062.

2.2. Measurements

2.2.1. Characteristics of general practices

The following general practice characteristics were included: average number of registered patients per general practice and level of urbanisation (from 1 being highly urban, to 5 being not urban).

2.2.2. General practice consultation

To compare the utilisation rate of email-consultation with other GP consultations, the following were included: email-consultations, short face-to-face consultations (20 minutes or less), long face-to-face

consultations (more than 20 minutes), short home visits (less than 20 minutes), long home visits (more than 20 minutes) and telephone consultations (consultation types according to reimbursement codes determined by the Dutch Healthcare Authority [23]).

To investigate and compare the patient characteristics of those who had an email-consultation with those who underwent another type of GP consultation, only email-consultations, telephone consultations and face-to-face consultations (short + long) were included. For every consultation, the date and diagnosis were included. Consultations and corresponding diagnoses were coded according to the International Classification of Primary Care (ICPC-1) [24]. Only consultations with a single ICPC were included in the analyses.

2.2.3. Patient characteristics

Age and gender were included as patient characteristics. In addition, neighbourhood status scores were provided by the Netherlands Institute for Social Research at postal code level (PC4). This score reflects the socioeconomic status score of a neighbourhood, compared to other neighbourhoods in the Netherlands [25] and is a common indicator of neighbourhood socioeconomic status (NSES) in the Netherlands [26]. The socioeconomic status scores were assessed in 2010 and 2014 and comprised four indicators: the average household income per particular postal code, the proportion of residents with low family income, the proportion of low-educated residents and the proportion of unemployed residents per postal code. A higher score means a higher status for the area of residence. Scores ranged from -6.75 to 3.06. The average NSES in the Netherlands is 0.0.

2.3. Statistical analyses

Three data sets were used for this study. First, to investigate the consultation rates in 2010 and 2014, all general practices in these years (from our dataset) were included and the following consultation types were analysed: email-consultation, face-to-face consultation, long face-to-face consultation, home visits, long home visits and telephone consultation. Descriptive analyses were conducted to calculate the consultation rate per 1000 registered patients (counted from the average number of registered patients per year) in 2010 and 2014, and to count the general practices that registered email-consultations in these years.

Second, to investigate which patient groups had email-consultations, and for what health problems, and to compare this with patients that had another GP consultation, only data from general practices in 2014 were used. The following consultation types were analysed: email-consultation, face-to-face consultation (short and long) and telephone consultation. Patients and consultations with incomplete datasets were excluded. This included observations with missing patient characteristics or consultations with none or two or more ICPC codes. 31.6% of the observations were excluded, of which 28.6% due to consultations with none or two or more ICPCs). Because the use of email-consultation by patients is dependent on its provision by the general practice, the dataset was split into three groups based on the number of email-consultations that general practices had in 2014; 1) general practices that did not register any email-consultation, 2) general practices that registered a few email-consultations ($n<100$) and 3) general practices that registered many email-consultations ($n\geq100$). Descriptive analyses were used to investigate general practice characteristics (the average number of registered patients per general practice and level of urbanisation) and patient characteristics (age, gender and NSES). The diagnosis categories for which email-consultations,

telephone consultations and face-to-face consultations (short + long) were done were calculated using descriptive analyses.

Every diagnosis category consisted of specific diagnoses. In the third dataset we included the patient group in which email-consultations, as percentage of all GP consultations in that group, were most often used The following consultation types were analysed: email-consultation, face-to-face consultation (short + long) and telephone consultation. This dataset was split into three, based on the number of email-consultations that general practices registered for that specific diagnosis in 2014: 1) general practices that did not register any email-consultation for that diagnosis, 2) general practices that registered a few email-consultations for that diagnosis (n<25) and 3) general practices that registered many email-consultations for that diagnosis (n≥25). Descriptive analyses were used to investigate general practice characteristics (the average number of registered patients per general practice and level of urbanisation) and patient characteristics (age, gender and NSES).

To identify significant differences of general practice characteristics between the three groups of practices, two-way Anova with Bonferroni correction (average number of registered patients, mean age and NSES of the general practice patient population and level of urbanisation per general practice) were conducted. Differences in patient characteristics within the three groups of general practices (patients who had an email, telephone- or face-to-face consultation) were not tested for statistical significance because of the large sample size. In large samples, small differences can be detected as significant, even though they are not practically relevant. Therefore, only relevant differences are reported. The statistical package STATA (version 14.0) was used to conduct the analyses.

3. Results

3.1. Study population

Dataset 1

In 2010, data from 200 general practices were used, including 2 708 191 general practice consultations (577 487 patients). The mean age of the study population was 41.7 (sd=23.1, missing data n=4 207), 45.5% male, and the mean NSES was -0.10 (sd=1.19, missing data n= 93 193). In 2014, data from 434 general practices were collected including 6 473 921 general practice consultations (1 307 822 patients). The mean age of the study population was 43.1 (sd=23.4, missing data n=9 298), 45.7% male (missing data n=98), and the mean NSES was 0.08 (sd=1.10, missing data n=28 209). The characteristics of these general practices can be found in Table 1.

Table 1. Characteristics of general practices in 2010 and 2014.

General practice characteristics	**2010** *Mean (SD) or n (%)*	**2014** *Mean (SD) or n (%)*
n general practices	200	434
n registered patients	734 122	1 630 386
n general practice consultations	2 708 191	6 473 921
n patients who had a general practice consultation	577 487	1 307 822
Average number of registered patients per general practice	3671 (sd=2501)	3757 (sd=2384)
Level of urbanisation		

Very urban	40 (20.0%)	89 (20.5%)
High	46 (23.0%)	99 (22.8%)
Moderate	38 (19.0%)	84 (19.4%)
Little	42 (21.0%)	85 (19.6%)
Not urban	32 (16.0%)	75 (17.3%)
Missing	2 (1.0%)	2 (0.5%)
n general practices that registered email-consultations	64 (32.0%)	229 (52.8%)

Dataset 2

In dataset 2, data from 2014 were used. Home visits, and patients and consultations with incomplete data were excluded. 429 general practices were included. Non-response analyses showed no differences after exclusion (compared to the complete dataset without home visits) regarding patient characteristics (age, gender and NSES) and general practice characteristics (average number of registered patients per general practice and level of urbanisation). Characteristics of the general practices in the total data set 2, and of the general practices that registered none, a few (<100) and many (≥100) email-consultations can be found in Attachment 1.

Examination of the differences in general practice characteristics between these three groups showed differences in number of registered patients per general practice (F=7.11, p<0.01), level of urbanization (F=11.81, p<0.01) and age (F=4.40, p=0.01). General practices that registered email-consultations had a higher number of registered patients per general practice, were located in more urban areas and had a younger patient population. No significant difference of NSES was found between these three groups (F=1.94, p=0.14).

3.2. Data set 1: the use of email-consultation in 2010 and 2014

The number of general practices that used email-consultation increased from 32.0% in 2010 to 52.8% in 2014. The consultation rates per consultation type for 2010 and 2014 can be found in Table 2. The utilisation of email-consultation increased from 8.4 per 1000 registered patients in 2010 to 17.6 in 2014. In comparison, 1033.9 telephone consultations per 1000 registered patients were carried out in 2010, and 1140.6 in 2014. In general practices that registered email-consultations, 0.6% (n=5 494) of the total GP consultations were by email in 2010; in 2014, this was 0.7% (n=24 556).

For 2014, the consultation rate per consultation type was calculated for general practices that did not register any email-consultations, that registered a few email-consultations (n<100) and that registered many email-consultations (n≥100). In general practices that registered many email-consultations, the utilisation of email-consultations was 95.8 per 1000 registered patients.

Table 2. Consultation rate per 1000 registered patients per year.

Year	General practices	n	Email	Face-to-face	Face-to-face long	Home visit	Home visit long	Tele-phone
2010	All general practices	200	8.4	2325.0	374.6	147.4	73.3	1033.9
2014	All general practices	434	17.6	2299.6	532.6	128.9	89.2	1140.6
2014	*GP that did not register email-consultations*	205	-	2241.3	510.8	145.0	94.5	1058.6
2014	*GP that registered <100 email-consultations*	163	8.1	2404.2	563.2	120.4	89.2	1176.3

2014	*GP that registered ≥100 email-consultations*	66	95.8	2222.2	524.9	99.7	72.5	1307.3

3.3. Data set 2: characteristics of email, telephone and face-to-face consultation users

Table 3 shows the characteristics of patients who had at least one email, telephone, or face-to-face consultation, distributed in terms of general practices that performed none, a few, or many email-consultations. In general practices that had a few email-consultations, 0.6% of the patients who had at least one GP consultation had an email-consultation. This was 4.8% in general practices that had many email-consultations.

In general practices that registered email-consultations, relevant differences were found in age between patients who had an email versus a telephone or face-to-face consultation; patients that had an email-consultation seemed to be older. In general practices that registered a few email-consultations, the mean age of patients that did an email-consultation was 46.4. This was 45.7 and 42.0 for patients that did a telephone and face-to-face consultation respectively. In general practices that registered many email-consultations the mean age of patients that did an email-consultation was 46.4. This was 45.2 and 42.1 for patients that did a telephone and face-to-face consultation respectively.

Table 3. Characteristics of patients who had an email, telephone, or face-to-face consultation in general practices that registered none, a few (n<100) and many (n≥100) email-consultations.

	General practices that did not register any email-consultation (n=211)		**General practices that registered a few (n<100) email-consultations (n=175)**			**General practices that registered many (n≥100) email-consultations (n=43)**		
Patient characteristics	**Telephone** n patients= 255 153	**Face-to-face (short + long)** n patients= 466 672	**Email** n patients= 3 214	**Telephone** n patients= 275 352	**Face-to-face (short + long)** n patients= 441 424	**Email** n patients= 7 225	**Telephone** n patients= 81 221	**Face-to-face (short + long)** n patients= 133 427
	Mean (SD) or n (%)	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*
Age	47.3 (sd=23.7)	43.6 (sd=23.4)	46.4 (sd=20.8)	45.7 (sd=23.5)	42.0 (sd=23.4)	46.4 (sd=19.9)	45.2 (sd=23.3)	42.1 (sd=22.9)
Gender (% male)	103 117 (40.4%)	212 399 (45.5%)	1 355 (42.2%)	110 337 (40.1%)	198 051 (44.9%)	3 055 (42.3%)	32 288 (39.8%)	59 850 (44.9%)
NSES	0.02 (sd=1.02)	0.02 (sd=1.02)	0.22 (sd=1.07)	0.06 (sd=1.18)	0.05 (sd=1.19)	0.36 (sd=.97)	0.35 (sd=.97)	0.38 (sd=.97)

3.4. Data set 2: diagnosis categories of email-consultations vs telephone and face-to-face consultations

The diagnosis categories for which patients had an email, telephone or face-to-face consultation in 2014 can be found in Table 4 (listed from the most to the least frequently used diagnosis category). Most email-consultations were associated with the following diagnosis categories: psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%). In comparison with other GP consultations, these diagnosis categories were less frequently associated with telephone consultations (psychological: 9.1%; endocrine, metabolic, nutritional: 7.3%; and circulatory: 8.2%) and face-to-face consultations (psychological: 5.8%; endocrine, metabolic, nutritional: 4.4%; and circulatory: 9.1%).

Considering specific diagnoses, the highest number of email-consultations were done for hypertension (5.3%, n=873 consultations), diabetes (5.0%, n=835 consultations) and depression (2.5%, n=409 consultations). This involved 1.8% (diabetes), 1.6% (depression), and 1.0% (hypertension) within the total number of GP consultations for diabetes, depression and hypertension, respectively, in general practices that registered email-consultations.

Table 4. Diagnosis categories associated with email, telephone, or face-to-face consultations in general practices that registered at least one email-consultation in 2014 (n general practices=218), listed from the most to the least frequently used diagnosis category.

	Email-consultations *n consultations=16 558*		**Telephone consultations** *n consultations=770 103*		**Face-to-face consultations (short + long)** *n consultations= 1 609 157*	
	Diagnosis category	*n (%)*	*Diagnosis category*	*n (%)*	*Diagnosis category*	*n (%)*
1	Psychological	2434 (14.7%)	Musculoskeletal	109 115 (14.2%)	Skin	259 034 (16.1%)
2	Endocrine, metabolic, nutritional	1802 (10.9%)	Digestive	75 508 (9.8%)	Musculoskeletal	245 441 (15.3%)
3	Circulatory	1777 (10.7%)	Respiratory	74 819 (9.7%)	Respiratory	172 494 (10.7%)
4	Musculoskeletal	1609 (9.7%)	General /Unspecified	70 539 (9.2%)	Circulatory	145 828 (9.1%)
5	Skin	1428 (8.6%)	Psychological	70 297 (9.1%)	Digestive	106 511 (6.6%)
6	General /Unspecified	1423 (8.6%)	Circulatory	62 924 (8.2%)	Ear	974 12 (6.1%)
7	Respiratory	1274 (7.7%)	Skin	56 879 (7.4%)	Psychological	93 820 (5.8%)
8	Digestive	1213 (7.3%)	Endocrine, metabolic, nutritional	55 952 (7.3%)	General /Unspecified	92 600 (5.8%)
9	Female Genital	649 (3.9%)	Female Genital	40 276 (5.2%)	Urological	90 444 (5.6%)
10	Pregnancy, Childbearing, Family Planning	574 (3.5%)	Neurological	24 262 (3.2%)	Endocrine, metabolic, nutritional	70 548 (4.4%)
11	Neurological	554 (3.4%)	Pregnancy, Childbearing, Family Planning	22 347 (2.9%)	Female Genital	47 670 (3.0%)
12	Social Problems	380	Eye	17 894	Eye	43 327

		(2.3%)		(2.3%)		(2.7%)
13	Urological	367 (2.2%)	Blood	13 757 (1.8%)	Neurological	42 980 (2.7%)
14	Male Genital	348 (2.1%)	Ear	12 812 (1.7%)	Pregnancy, Childbearing, Family Planning	32 618 (2.0%)
15	Eye	288 (1.7%)	Social Problems	12 124 (1.6%)	Blood	29 950 (1.9%)
16	Blood	242 (1.5%)	Male Genital	11 648 (1.5%)	Male Genital	19 839 (1.2%)
17	Ear	196 (1.2%)	Urological	3 895 (5.1%)	Social Problems	18 641 (1.2%)

3.5. Data set 3: email-consultations for diabetes

As described in the previous paragraph, the highest percentage of email-consultations was performed within diabetes consultations (1.8% of all GP consultations for diabetes). Therefore, in-depth analyses were carried out for this diagnosis group.

In 2014, 37 409 patients had at least one GP consultation for diabetes (80 867 GP consultations). The mean age of the study population was 66.4 (sd=13.7), 51.5% male and the mean NSES was -0.15 (sd=1.14). Characteristics of the general practices in the total dataset 3, and of the general practices that registered none, a few (<25) and many (≥25) email-consultations for diabetes, can be found in Attachment 2. Examination of the differences in general practice characteristics between these three groups showed differences in number of registered patients per general practice (F=17.44, p<0.01) and level of urbanization (F=5.72, p<0.01). General practices that registered email-consultations for diabetes had a significantly higher average number of registered patients and were located in more urban areas. No significant difference was found in mean age (F=1.17, p=0.31) and NSES (F=1.99, p=0.14).

3.5.1 Dataset 3: Characteristics of patients with diabetes who had a consult by email, telephone, or face-to-face

Characteristics of patients who had a diabetes consultation with their GP by email, telephone, or face-to-face in general practices that registered none, a few, or many email-consultations can be found in Table 5.

In general practices that registered email-consultations for diabetes, relevant differences were found in age of patients with diabetes who had an email-consultation versus a telephone and face-to-face consultation; patients that had an email-consultation seemed to be younger.

In general practices that registered many email-consultations for diabetes, 12.5% (n=233) of the patients with diabetes had at least one email-consultation, and in general practices that registered a few email-consultations for diabetes this was 1.8% (n=132). In addition, in general practices that registered many email-consultations for diabetes, 13.8% (n=560) of the GP consultations for diabetes were by email. In comparison, 29.0% (n=1 180) of the consultations were by telephone, and 57.2% (n=2 327) face-to-face. In general practices that did not register email-consultations for diabetes, 40.1% (n=23 722) were telephone and 59.9% (n=35 448) face-to-face consultations.

Table 5. Characteristics of patients who had a GP consultation by email, telephone, or face-to-face for diabetes in general practices that registered none, a few (n<25) or many (n≥25) email-consultations for diabetes.

	General practices that did not register any email-consultations for diabetes (n=351)		**General practices that registered a few (n<25) email-consultations for diabetes (n=69)**			**General practices that registered many (n≥25) email-consultations for diabetes (n=9)**		
Patient characteristics	**Telephone** n patients= 11 723	**Face-to-face (short + long)** n patients= 16 674	**Email** n patients= 132	**Telephone** n patients= 2 992	**Face-to-face (short + long)** n patients= 4 025	**Email** n patients= 233	**Telephone** n patients= 516	**Face-to-face (short + long)** n patients= 1 114
	Mean (SD) or n (%)	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*	*Mean (SD) or n (%)*
Age	68.0 (sd=14.5)	65.5 (sd=12.9)	62.0 (sd=11.3)	67.8 (sd=14.8)	65.6 (sd=12.9)	61.2 (sd=11.8)	66.2 (sd=14.8)	64.7 (sd=12.5)
Gender (% male)	5 587 (47.7%)	9 053 (54.3%)	80 (60.6%)	1 361 (45.5%)	2 142 (53.2%)	133 (57.1%)	245 (47.5%)	662 (59.4%)
NSES	-0.17 (sd=1.19)	-0.20 (sd=1.14)	0.11 (sd= 1.01)	-0.15 (sd=1.10)	-0.17 (sd=1.06)	0.46 (sd=.69)	0.42 (sd=.78)	0.43 (sd=.71)

4. Discussion

Principal findings

This study aimed to acquire insights into the current status of email-consultation usage in the Netherlands, with a focus on the patient perspective. 32.0% of the general practices studied used email-consultations in 2010; this was more than half (52.8%) in 2014. However, in 2014 email-consultations comprised still less than one percent of the total number of GP consultations (home visits, face-to-face-, telephone- and email-consultations) in general practices that registered at least one email-consultation. Patients who had an email-consultation with their GP in 2014 were older compared to patients who had a telephone or face-to-face consultation. Furthermore, in general practices that registered many (≥100) email-consultations, almost 5% of the patients who had at least one GP consultation (face-to-face, telephone, or email-consultation), had an email-consultation. Most patients had an email-consultation with their GP for issues related to psychological, endocrine, metabolic, nutritional and circulatory health problems. These diagnosis categories seemed to appear less frequently in telephone and face-to-face consultations. The highest percentage of email-consultations in comparison with all GP consultations within one specific disorder was related to diabetes. Interestingly, patients with diabetes who had an email-consultation were younger. In general practices that registered many (≥25) email-consultations for diabetes, 12.5% of the patients with diabetes had at least one email-consultation for this condition. Patients' email-consultation usage is also dependent on its provision by the general practice: in general practices with a higher number of registered patients, located in more urban areas and with a younger patient population, email-consultation was more often used.

Strengths and weaknesses

The main strength of this study is that data were used from a large nationwide database comprising the electronic health records of Dutch general practices. This database is representative for the Dutch (general practice) population [21]. General practices that did not fulfil the criteria for completeness of registration were excluded; however, this caused minimal selection bias. Email-consultations are recorded just as any other consultation in the Dutch electronic health record systems and thus are fully integrated. As there are clear financial incentives we assume that email consultations that fit the claims requirements, will be claimed, and thus recorded in the electronic health record systems. We assumed that all registered consultations included in this study are actually performed according to the rules of national declaration policy of the Dutch College of General Practitioners [22] and the Dutch Healthcare Authority [23]. However, within the scope of this study we could not check if this was really the case with all included consultations. Nevertheless, using data from registered consultations of electronic health records seems to be the most representative source for the investigation of actual email-consultation usage.

To reduce variation between general practices, we split the dataset into three groups of general practices: those registering none, a few, or many email-consultations. The observation that general practices registered no email-consultations does not indicate whether these general practices actually offered a service to perform email-consultations. Although we do not have information about the online services offered in the general practices of our dataset, the annually published eHealth monitor about the status of eHealth in the Netherlands revealed that 49% of the surveyed

general practices reported offering email-consultation in 2014 [27]. In comparison, 52.8% of the general practices in our dataset registered at least one email-consultation in 2014.

It might be expected that general practices only offer email-consultation for specific diagnoses (for example due to diagnosis specific procedures or applications); however, we found that all general practices in our dataset registered email-consultations for a wide range of diagnoses, which suggests that it could be used for all kinds of health problems. However, due to requirements for reimbursement of email-consultation, it should be noted that not every email-consultation can be claimed. In addition, some health questions cannot be addressed by email. In our analyses, we did not make a distinction between consultations that could be done by email or not, because it is currently unclear what questions are appropriate for this type of consultation. A limitation is that we excluded consultations with none or two or more conditions, due to methodological reasons. However, by redoing the analyses with these consultations included, results did not highly differ.

Another limitation of the study is that socioeconomic status was assessed at district level (postal code area); patients' individual socioeconomic status was unknown. Therefore, neighbourhood socioeconomic status (NSES) cannot be purely seen as an individual characteristic and is dependent on the area where the general practice is located. Furthermore, in this study, data of 2010 and 2014 were used. More recent data would probably show higher email-consultation rates. The annual Dutch eHealth monitor reported that the number of general practices that offer email-consultations increased from 49% in 2014 to 60% in 2016 [28]. Nevertheless, there are no indications that email-consultation is used by other patient groups.

Comparison with existing literature

Half of the Dutch general practices in our dataset registered email-consultation in 2014; in comparison, it is only offered in 6% of the general practices in the United Kingdom [29], but to all citizens in Denmark via a public health portal [30]. Even though it seems that email-consultation is offered by half the general practices in the Netherlands, its actual use is extremely low. This is not the case in Denmark, where, in 2013, more than 4 million GP email-consultations were done (in comparison to about 20 million face-to-face consultations) [31, 32], and a questionnaire study (n=684) showed that 52% of the respondents (or their closest relative) had used an email-consultation [31].

The lack of reimbursement is frequently mentioned as reason why eHealth is not yet fully adopted in primary care. A recently conducted systematic review of the factors influencing the implementation of eHealth found that cost related factors were mentioned by most studies as important barriers for the implementation of eHealth [33]. However, our study shows that funding for eHealth does not directly guarantee eHealth use.

Overall, patients that had an email-consultation were older. Studies have found that a younger age is associated with email-consultation usage [1, 16]. This is not found when analysing the entire patient population, however looking into the diagnosis group that had the most email-consultations (patients with diabetes), we found that email-consultation users seemed to be younger, compared to patients of this diagnose group who had a telephone or face-to-face consultation with their GP. It should be noted that email-consultations in the Netherlands can only be reimbursed when it is not the first consultation for a health condition; this might explain the observation that, overall, patients

who had an email-consultation were older, as the number of people with a prolonged or chronic disease was greater in the higher age groups.

This study focuses on the consulting pattern of patient groups using email-consultation, in comparison with other GP consultations. The use of email-consultation by patients, however, highly varies among general practices. Patients' email-consultation usage seems therefore partly dependent on its provision by the general practice. Therefore, the patient perspective cannot be studied in isolation; it is probably dependent on how general practices offer, promote and use it [34, 35].

Interestingly, email-consultations were most frequently used for diagnoses related to psychological (14.7%), endocrine, metabolic, nutritional (10.9%) and circulatory (10.7%) concerns, which were less frequently the topic of telephone and face-to-face consultations. In the scarce research that have been performed regarding the content of online consultations, it was found that, using an online patient-provider portal, more psychosocial messages were sent via the portal than by telephone [36]. In addition, a review of the impact of digital communication on marginalised groups suggests that online communication may reduce patients' inhibitions and sense of intimidation, resulting in more disclosure and asking of questions [13]. Moreover, a study of electronic health records with the possibility of exchanging secure messages showed that this was most frequently used by patients with a chronic condition [37]. In the current study, email-consultation was most used by patients with diabetes. It seems that this disease is highly convenient for the use of email-consultation, because of the prolonged characteristic of the disease and the frequency of contact with the GP. The latter might suggest that these patients have a well-established and trusting relationship with their GP, which is found to be related to successful digital communication among patients and care professionals [13]. In addition, it has been noted that patients use email to report a change in their condition or to discuss laboratory results, new conditions, changes in prescription dose, the need for new prescriptions or other requests for actions regarding medications or treatments [37-39]; all of these are frequently seen in diabetes management. In our study, we did not have information about the content of the email-consultations; only the type of diagnosis. This should be further investigated in future research.

Implications for research and practice

Email-consultation has the potential to become a routinely used communication service for patient-GP interaction, similarly to telephone consultations; it seem to be an appropriate service in this day and age, when digital communication plays an important part in many individuals' daily lives. However, this study has shown that, in the Netherlands, the actual use of email-consultation is extremely low.

It seems that email-consultation is not just a service that can be merely installed. Without clear implementation strategies, including promotion strategies and defining for which patients it can be best used, it might not be adopted by patients. In this study, we found that email-consultation is most used by people with psychological, endocrine or circulatory concerns. Focusing on these target groups first, and investigating the effectiveness of email-consultation and the benefits it can bring for these patient groups, might be important to stimulate broader uptake among GPs and patients. In addition, investigating reasons why patients do not use email-consultation might provide important insights about patients' views regarding email-consultation and the barriers that need to be overcome. Experiencing the benefits of the use of email-consultation can be the drive for its routine

use, for both patients and care professionals. Moreover, the use of email-consultation by patients highly varies among general practices. It is recommended to qualitatively study the use of email-consultation in general practices that use many email-consultations and in general practices that offer it, but use it less frequently. Investigating why it works in 'good practices' and why it is less frequently used in others will give more insight in the process that is needed to successfully implement and use email-consultation. These studies should be focused on the two-layered issue; from both perspectives of patients and providers.

5. Funding

This study is part of a PhD project, which is partly funded by a grant from the Netherlands Organization for Health Research and Development (ZonMw), grant 10-10400-98-009, and partly funded by Maastricht University/School for Public Health and Primary Care. The funding source had no role in the design, conduct, analyses, or reporting of the study or in the decision to submit the manuscript for publication.

6. Ethical approval

The Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of study containing no directly identifiable data (Dutch Civil Law, Article 7:458). This study has been approved according to the governance code of NIVEL Primary Care Database, under number NZR-00315.062.

7. Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: MH, IS, RF, OS and LW had financial support from ZonMw for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work. RV declares to have had financial support from Netherlands Institute for Health Services Research (NIVEL) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

8. Details of contributors

MH, IS, RV, RF, OS and LW conceived the study. RV supervised the data collection. MH performed the analyses. All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to the interpretation of the data. MH wrote the draft of the manuscript with the help of IS, RV, RF, OS and LW. All authors read and approved the final manuscript.

9. Transparency declaration

MH affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

10. Data sharing statement

Technical appendix, statistical code, and data set available on reasonable request by the corresponding author (MH).

11. Acknowledgements

We would like to thank Rodrigo Davids for helping in processing the data and Lucas van der Hoek and Peter Spreeuwenberg for their statistical advice and helping with statistical analyses.

Attachment 1.

General practice characteristics of data set 2 and of the three general practice groups of dataset 2

	Data set 2 (total) **(n=429)**	**GP's that did not register any email-consultations (n=211)**	**GP's that registered a few (<100)email-consultations (n=175)**	**GP's that registered many (≥100)email-consultations (n=43)**
Average number of registered patients per general practice	3752.2 (sd=2387.4)	3371.5 (sd=1735.625)	3975.7 (sd=2593.1)	4710.8 (sd=3645.1)
n general practice consultations	4 207 538	1 811 720	1 856 205	539 613
n patients that had a general practice consultation	1 177 123	511 947	516 039	149 137
Level of urbanization				
- *Very urban*	89 (20.8%)	31 (14.7%)	47 (26.9%)	11 (25.6%)
- *High*	96 (22.4%)	40 (19.0%)	42 (24.0%)	14 (32.6%)
- *Moderate*	84 (19.6%)	39 (18.5%)	35 (20.0%)	10 (23.3%)
- *Little*	85 (19.8%)	54 (25.6%)	27 (15.4%)	4 (9.3%)
- *Not urban*	73 (17.0%)	47 (22.3%)	22 (12.6%)	4 (9.3%)
- *Missing*	2 (0.5%)		2 (1.1%)	
Age of the study population	43.1 (sd=23.5)	43.9 (sd=23.6)	42.4 (sd=23.4)	42.3 (sd=23.0)
Gender (% male) of the study population	532 217 (45.2%)	232 793 (45.5%)	232 466 (45.1%)	66 958 (44.9%)
NSES of the study population	.08 (sd=1.10)	.03 (sd=1.02)	.05 (sd=1.19)	.37 (sd=.98)

Attachment 2.

General practice characteristics of data set 3 and of the three general practice groups of dataset 3 (patients with diabetes)

	Data set 3 (total) (n=429)	**GPs that did not register any email-consultations for diabetes (n=351)**	**GPs that registered a few (<25) email-consultations for diabetes (n=69)**	**GPs that registered many (≥25) email-consultations for diabetes (n=9)**
Average number of registered patients per general practice	3752.2 (sd=2387.4)	3486.7 (sd=1982.2)	4661.5 (sd=3227.4)	7132.6 (4627.6)
n general practice consultations for diabetes	80 867	59 170	17 630	4 067
n patients that performed a general practice consultation for diabetes	37409	28 397	7 149	1 863
Level of urbanization				
- *Very urban*	89 (20.8%)	66 (18.8%)	21 (30.4%)	2 (22.2%)
- *High*	96 (22.4%)	74 (21.1%)	19 (27.5%)	3 (33.3%)
- *Moderate*	84 (19.6%)	68 (19.4%)	15 (21.7%)	1 (11.1%)
- *Little*	85 (19.8%)	75 (21.4%)	9 (13.0%)	1 (11.1%)
- *Not urban*	73 (17.0%)	66 (18.8%)	5 (7.3%)	2 (22.2%)
- *Missing*	2 (0.5%)	2 (0.6%)		
Age of the study population	66.4 (sd=13.7)	66.5 (sd=13.7)	66.4 (sd=13.77)	64.7 (sd=13.15)
Gender (% male) of the study population	19 263 (51.5%)	14 640 (51.6%)	3 583 (50.1%)	1 040 (55.8%)
NSES of the study population	-.15 (sd=1.14)	-.19 (sd=1.16)	-.16 (sd=1.08)	.43 (sd=.73)

12. References

1. Newhouse N, Lupiáñez-Villanueva F, Codagnone C, Atherton H. Patient use of email for health care communication purposes across 14 European countries: an analysis of users according to demographic and health-related factors. *J. Med. Internet Res* 2014;17(3): e58-e
2. Huygens MWJ, Vermeulen J, Friele RD, van Schayck OCP, de Jong JD, de Witte LP. Internet services for communicating with the general practice: barely noticed and used by patients. *Interact J Med Res* 2015;4(4): e21
3. de Jong CC, Ros WJ, Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J. Med. Internet Res* 2014;16(1): e19
4. Maier CB, Aiken LH. Task shifting from physicians to nurses in primary care in 39 countries: a cross-country comparative study. *Eur J Public Health* 2016;26(6): 927-34
5. Kroneman M, Boerma W, van den Berg M, Groenewegen P, de Jong J, and van Ginneken E. Netherlands: Health system review. *Health Syst Transit* 2016;18(2): 1-240
6. Antoun J. Electronic mail communication between physicians and patients: a review of challenges and opportunities. *Fam. Pract* 2015;33(2): 121-126
7. Hanna L, May C, Fairhurst K. The place of information and communication technology-mediated consultations in primary care: GPs' perspectives. *Fam. Pract* 2011;29(3): 361-366
8. Bishop TF, Press MJ, Mendelsohn JL, Casalino LP. Electronic communication improves access, but barriers to its widespread adoption remain. *Health Aff* 2013;32(8): 1361-7
9. Atherton H, Pappas Y, Heneghan C, Murray E. Experiences of using email for general practice consultations: a qualitative study. *Br J Gen Pract* 2013;63(616): e760-e7
10. Goodyear-Smith F, Wearn A, Everts H, Huggard P, Halliwell J. Pandora's electronic box: GPs reflect upon email communication with their patients. *J Innov Health Inform* 2005;13(3): 195-202
11. Rosen P, Kwoh CK. Patient-physician e-mail: an opportunity to transform pediatric health care delivery. *Pediatrics* 2007;120(4):701-6
12. Houston TK, Sands DZ, Nash BR, Ford DE. Experiences of physicians who frequently use e-mail with patients. *Health Commun* 2003;15(4): 515-25
13. Huxley CJ, Atherton H, Watkins JA, Griffiths F. Digital communication between clinician and patient and the impact on marginalised groups: a realist review in general practice. *Br J Gen Pract* 2015;65(641) :e813-e21
14. de Lusignan S, Mold F, Sheikh A, Majeed A, Wyatt JC, Quinn T, et al. Patients' online access to their electronic health records and linked online services: a systematic interpretative review. *BMJ open* 2014;4(9): e006021.
15. Atherton H, Sawmynaden P, Sheikh A, Majeed A, Car J. Email for clinical communication between patients/caregivers and healthcare professionals. *Cochrane Database Syst Rev* 2009;3
16. Mehrotra A, Paone S, Martich GD, Albert SM, Shevchik GJ. Characteristics of patients who seek care via eVisits instead of office visits. *Telemed and e-Health* 2013;19(7): 515-9
17. Ye J, Rust G, Fry-Johnson Y, Strothers H. E-mail in patient–provider communication: A systematic review. *Patient Educ Couns* 2010;80(2): 266-73
18. Byrne JM, Elliott S, Firek A. Initial experience with patient-clinician secure messaging at a VA medical center. *J Am Med Inform Assoc* 2009;16(2): 267-70.
19. Krijgsman J, de Bie J, Burghouts A, de Jong J, Cath G, et al. eHealth, verder dan je denkt. eHealth-

monitor 2013, 2013
20. Jansen P. Implementatie van e-consult in de praktijk. *Huisarts & Wetenschap*. 2006;49(8):616–617
21. NIVEL. Primary Care Database http://www.nivel.nl/en/dossier/nivel-primary-care-database (accessed 5 July 2017)
22. Nederlands Huisartsen Genootschap (NHG). NHG-Checklist e-consult. 2014.
23. The Dutch Healthcare Authority (NZa) https://www.nza.nl/organisatie/sitewide/english/ (accessed 5 July 2017)
24. Lamberts H, Wood M. International classification of primary care. Oxford: Oxford University Press, 1987
25. Knol F, Veldheer V. Neighbourhood status development in the Netherlands 1998-2010, 2012
26. Galobardes B, Shaw M, Lawlor D, Smith G, Lynch J. Indicators of Socioeconomic Position: Methods in Social Epidemiology. *J Epidemiol Community Health* 2006;60: 47-85
27. Krijgsman J, Peeters J, Burghouts A, Brabers A, de Jong J, Beenkens F, et al. Op naar meerwaarde! eHealth-monitor 2014, 2014
28. Krijgsman J, Swinkels I, Lettow van B, Jong de J, Out K, Friele R, et al. More than technology. eHealht-monitor 2016, 2016
29. Brant H, Atherton H, Ziebland S, McKinstry B, Campbell JL, Salisbury C. Using alternatives to face-to-face consultations: a survey of prevalence and attitudes in general practice. *Br J Gen Pract* 2016;66(648): e460-e6
30. Kierkegaard P. eHealth in Denmark: a case study. *J Med Syst* 2013;37(6): 9991
31. Bertelsen P, Petersen LS, editors. Danish Citizens and General Practitioners' Use of ICT for their Mutual Communication. In *MedInfo* 2015: 376-379
32. Danmarks Statestik. SYGK: Lægebesøg mv. med offentlig tilskud efter område, ydelsesart, alder, køn og socioøkonomisk status 2006-2013. 2015
33. Ross J, Stevenson F, Lau R, Murray E. Factors that influence the implementation of e-health: a systematic review of systematic reviews (an update). *Implement Sci* 2016;11(1): 146
34. Wolcott V, Agarwal R, Nelson DA. Is Provider Secure Messaging Associated With Patient Messaging Behavior? Evidence From the US Army. *J. Med. Internet Res* 2017;19(4): e103
35. Wells S, Rozenblum R, Park A, Dunn M, Bates DW. Organizational strategies for promoting patient and provider uptake of personal health records. *J Am Med Inform Assoc* 2014;22(1): 213-22
36. Lin C-T, Wittevrongel L, Moore L, Beaty BL, Ross SE. An Internet-based patient-provider communication system: randomized controlled trial. *J Med Internet Res* 2005;7(4): e47
37. Serrato CA, Retecki S, Schmidt DE. MyChart—a new mode of care delivery: 2005 personal health link research report. *Perm J.* 2007;11(2): 14-20
38. Mirsky JB, Tieu L, Lyles C, Sarkar U. A mixed-methods study of patient-provider e-mail content in a safety-net setting. *J Health Commun* 2016;21:85-91
39. Sittig D. Results of a content analysis of electronic messages (email) sent between patients and their physicians. *BMC Med Inform Decis Mak* 2003;3:11

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5,6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6,7
		(*b*) Describe any methods used to examine subgroups and interactions	6,7
		(*c*) Explain how missing data were addressed	6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(*e*) Describe any sensitivity analyses	n.a.

Continued on next page

Results			**page**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7,12,19,20
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	n.a.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,10,12,13,19,20
		(b) Indicate number of participants with missing data for each variable of interest	n.a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n.a.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	n.a.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n.a
		Cross-sectional study—Report numbers of outcome events or summary measures	7-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n.a.
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a.
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14,15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15,16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.