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Review article

E-consulting in a medical specialist setting: Medicine of the future?

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ABSTRACT

Objective: Today's technology provides new ways of consulting between patients and medical specialists in health care, such as videoconferencing and web-messaging. In this systematic review we assessed the effects of e-consulting between medical specialists and patients.
Methods: We searched MEDLINE, EMBASE, Psychlit and Cochrane Library for randomized clinical trials assessing the use of e-consulting methods (videoconferencing (VC) or web-messaging (WM)), as compared to conventional care (face-to-face (FF) or telephone consultations (TC)) in a medical specialist setting. We extracted patient-related, physician-related, cost, time and follow-up outcomes.
Results: We included 21 trials, of which 17 addressed VC compared to FF, two compared WM with FF, one VC with TC, and one WM with TC. Physicians appeared to prefer face-to-face consultations over videoconferencing. Patients appeared to be as satisfied with videoconferencing as with face-to-face contacts, but preferred videoconferencing and web-messaging over telephone consultations. Videoconferencing was more expensive regarding equipment, but saved patient-related costs in terms of time, transportation, and missed work. Variable results were found for consult time and follow-up visits.
Conclusions and practice implications: We cautiously conclude that e-consulting seems a feasible alternative to medical specialists' face-to-face follow-up or telephone appointments, but may be less suitable for initial consultations requiring physical examination.

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1. Introduction

During the last decades, information and communication technology has advanced and expanded greatly [1]. Simultaneously, healthcare has also grown more complex, requiring more and more ICT-support for diagnostic, therapeutic and data management purposes [2]. Moreover, patients, particularly in the developed countries, show an increasing longevity, multi-morbidity [3], immobility and chronic illnesses, resulting in more visits to GPs and hospitals. Specialisation of (high-volume) hospitals tend to further increase travel distances and waiting times [4–6]. This has fuelled the development of e-health facilities, aiming at time- and cost-saving ways of digital consultation between healthcare professional and patient in hospital or out-patient settings, without negatively influencing their experiences with the interaction.

Nowadays various e-consulting possibilities exist [7]. For example in videoconferencing real-time images of a conversation are sent bi-directionally, mimicking a face-to-face consult as close as possible, although precluding physical examination. Web-messaging, in the form of text messages via the Internet, with or without photographs of the patient's lesions, lacks voices and real-time images, but these messages can be sent and replied whenever convenient to patient and healthcare professional [8]. A third option is e-monitoring, transferring information on a patient's blood pressure, glucose levels or body temperature via the Internet to a remote location where a healthcare professional interprets the data.

Despite these promising features, earlier systematic literature reviews on the usefulness of telemedicine showed limited evidence on their clinical benefits and cost-effectiveness [7,9]. Existing studies mostly focus on primary care and dermatology settings and psychotherapy via e-consulting. Patients seemed to be satisfied when e-consulting was applied in some general practices [10,11], but in clinical settings e-consulting is not yet common, apart from dermatology [12]. Available evidence on e-dermatology mainly focused on triage or on the communication between the general practitioner and the medical specialist rather than the patients themselves, while being still inconclusive about its (cost-) effectiveness [12–14]. Available studies about psychotherapy via e-consulting showed no significant differences between a conventional and an e-consult [15].

In this systematic literature review we appreciated the available evidence on the effects of e-consulting between medical specialists and their patients by videoconferencing or web-messaging as compared to usual care, i.e. face-to-face or telephonic consultations, in terms of the associated satisfaction, time, costs, and follow-up.

2. Methods

This systematic review was performed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement [16].

2.1. Eligibility criteria

2.1.1. Types of studies

We only included randomised clinical trials (RCTs) in which patient-healthcare professional e-consulting was compared with a standard consultation group as control. Conference abstracts were excluded.

2.1.2. Types of participants

We included all medical specialists in outpatient settings, also when parents or caregivers of children participated. All types of disorders and patients were eligible, regardless of age, gender and ethnicity. We excluded trials performed solely in a primary care setting and/or with general practitioners as main study participants.

2.1.3. Types of interventions

Eligible e-consulting interventions were (1) videoconferencing: live consultations via a video camera or webcam on the Internet or (2) web-messaging: consultations through typed messages, via e-mail or messages entered into a pro-forma. The standard consultation could either be a face-to-face consultation or a telephone consultation.

We excluded trials in which telemedicine was used for other purposes than clinical consultation, e.g. symptom monitoring, lifestyle support or websites supplying basic information. We also excluded trials in which (psycho) therapy or rehabilitation was given through telemedicine. Furthermore, we excluded trials that only involved inter-professional consultations.

2.1.4. Types of outcomes

We defined the following five types of outcomes:

patient-related outcomes associated with their experience with the consultation (e.g. patient satisfaction with convenience of care, specialist services, or communication), patients' self-management, or patients' health (e.g. quality of life or well-being).

Healthcare professional-related outcomes associated with their experience with the consultation, e.g. their satisfaction with communication, examination, or overall care.

Cost outcomes, e.g. costs of travelling to the site of consultation, loss of work time, or technologies used.

Time outcomes, e.g. duration of the consultation, patients' or healthcare professionals' travelling time or waiting time.

Follow-up outcomes, e.g. return visits or further appointments requested.

2.2. Information sources

We searched the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library), EMBASE (through OvidSP), MEDLINE (through PubMed) and PsychINFO (through OvidSP) from their inception up to May 2014. Furthermore, we examined reference lists of relevant reviews to find additional trials. No language or date restrictions were applied. The detailed search strategy is presented in Appendix 1.

2.3. Data collection and analysis

2.3.1. Trial selection

Two researchers (LZ and DU) independently assessed the potential relevance of all titles and abstracts obtained from the literature search. Any discrepancies were discussed with FK to reach an agreement. We collected full-text PDFs of all potentially relevant articles based on the titles and abstracts. When multiple publications about the same trial were identified, we extracted relevant data from each of these publications.

2.3.2. Assessment of risk of bias

Risk of bias was assessed using a validated questionnaire [17]. We investigated adequacy of randomization and concealment of

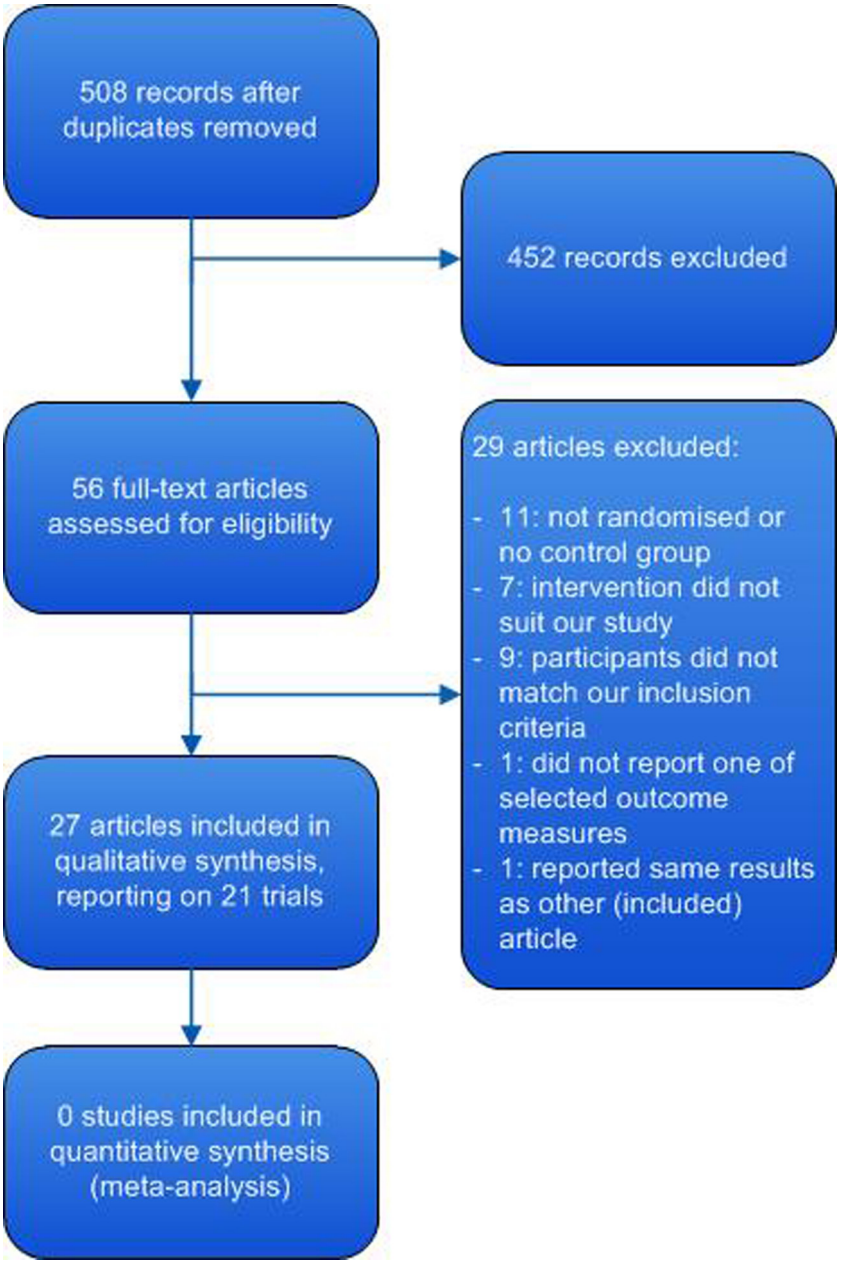

Fig. 1. Flow diagram of study inclusion.

Table 1
Study characteristics.

1st author/ year/ country	Setting	Intervention *N*/ control *N*; *N* physicians	Participants	Intervention	Control group	Outcomes
Videoconferencing (VC) compared to face-to-face contacts (FF)						
Agha [35] USA	Pulmonology Endocrinology Rheumatology	111/110; 9 physicians conducted VC as well as FF consultations	Patients visiting a physician at a Midwestern Veterans Administration hospital	Video consult at remote site, accompanied by nurse doing physical examinations, with physician at central site	Face-to-face outpatient visit at central site, without a nurse present	Patient-related outcomes Patient satisfaction (Patient Assessment of Communication during Telemedicine (PACT); 33 items (5-pt Likert scale), 4 factors) Time outcomes: visit length (min) *(reported as covariate)*
Ahmed [32] Canada	Neurology department	23/18; 1 physician conducted VC as well as FF consultations	Patients presenting to epilepsy clinic for follow-up, with access to tele-medicine, >65 km away	Video consult at remote site with physician at central site	Face-to-face visit at central site	Patient-related outcomes Patient satisfaction with quality of service (15 items, 5-pt Likert scale) Cost outcomes Patient costs (travel, parking, accommodation, lost work time) Total costs: patient costs, videoconferencing costs
Bishop [44] Canada	Psychiatry department	10/11; 1 psychiatrist conducted all consultations	Patients referred to psychiatry outpatient clinic	Video consult at remote clinic with physician at central clinic	Face-to-face consult with fly-in psychiatrist at remote clinic	Patient-related outcomes Patient satisfaction with services (Client Satisfaction Questionnaire (CSQ-8); 8-32), 4 months after initial consultation
Brennan [18,19] USA	Emergency department (ED)	54/50; 14 emergency physicians rotated between the two sites and conducted all consultations	Patients presenting to a peripheral emergency department with minor complaints	Video consult at remote site, accompanied by nurse, with ED physician at central site, using digital diagnostic aids. Next face-to-face evaluation by peripheral ED physician	Face-to-face evaluation by peripheral ED physician only	Patient-related outcomes Satisfaction with patient–physician interaction; overall patient satisfaction (5-pt Likert scale) Time outcomes:throughput time (min) Follow-up outcomes: emergency department return visits; need for additional care
Chua, [20,21] Northern Ireland	Neurology department	86/82; 2 neurologists conducted VC as well as FF consultations	Patients referred to a neurologist by their GP for a non-urgent matter	Video consult at remote site, accompanied by registrar, with neurologist at central site. Registrar examined the patient, directed by distant neurologist	Conventional face-to-face visit with neurologist at central site	Patient-related outcomes Patient satisfaction [21] (8 statements, 3-pt Likert scales) Cost outcomes: cost of consult in £ [20] Time outcomes: time of consult (min) [20] Follow-up outcomes No of investigations after the consultation; no of treatment prescriptions; discharge after first consultation [21]
Dorsey [33] USA	Neurology department	6/4; 2 specialists conducted VC, FF conducted by patient's PD physician	Patients with Parkinson's Disease residing in a remote community	Three video consults over 6 months at the peripheral site, accompanied by a nurse, with a physician at a central site	Conventional face-to-face visit with patient's usual PD physician	Patient-related outcomes Patient satisfaction (Modified GHAA's Consumer Satisfaction Survey (18-90); Quality of life (EuroQol-5D); -0.11–1.0); Parkinson's Disease Questionnaire (PDQ-39); 0–100); motor performance (UPDRS); 0–178, motor-subscale 0–108; cognition (Montreal Cognitive Assessment; 0–30); mood (Geriatric Depression Scale SF; 0–15)
Elford [41] Canada	Psychiatry department	23; 5 psychiatrists conducted VC as well as FF consultations	Children referred to a child psychiatrist for a non-emergency assessment	Video consult with physician at same hospital. Next day face-to-face consult with different physician; order randomized	Conventional face-to-face consult. Next day video consult with different physician at same hospital; order of consults randomized	Patient-related outcomes Children's satisfaction with consultation (3 items (yes-no)); Parents' satisfaction with consultation (6 items, 5-pt Likert scale) Physician-related outcomes

						Psychiatrist satisfaction with consultation (3 items 5-pt Likert-scale; 2 items yes–no)
Esmatjes [37] Spain	5 (university) hospital diabetes clinics	78/76; number of physicians conducting consultations not provided	Patients with type I DM for at least 5 years with poor glycaemic control, who test glucose >2 times a day, and have Internet access	Five video consultations and 1 face-to-face consultation. Patients reported results of a telemedicine system, allowing automatic downloading of self-monitoring of blood glucose values, once a month; the diabetes team would respond within 3 days with recommendations on treatment adjustments	Six face-to-face consultations at the hospital	Patient-related outcomes Hypoglycaemia: HbA1c, hypoglycaemia events, diabetes complications Quality of life: EuroQol (generic VAS score) and diabetes quality of life (DQoL): satisfaction (15–75), impact (17–85), social worry (7–35), diabetes worry (4–20); lower score: better perception Diabetes self-management: freq. of self-monitoring of blood glucose (SMBG); insulin modification (logbooks/metre downloads); Diabetes Knowledge Questionnaire (DKQ2); adherence to self-care (Diabetes Self-care Inventory (SCI-R)); Hypoglycaemia perception (Clarke test) Cost outcomes Patient costs (adjusted time spent, direct transport payments) Medical team costs (adjusted time spent) Time outcomes: *see Cost outcomes* Follow-up outcomes: need for extra visits or telephone consultations
Gattas [42] Australia	Clinical Genetics department	16/8; 2 doctors conducted VC as well as FF consultations	Patients referred to a clinical genetics clinic	Video consult at hospital, accompanied by counsellor managing VC equipment	Face-to-face consult at the same hospital	Patient-related outcomes Patient satisfaction with consultation (4 items, 5-pt Likert scales) Physician-related outcomes Physician satisfaction with consultation (4 items, 5-pt Likert scales)
Haukipuro [34] Finland	Orthopaedic department	76/69; 1 orthopaedic specialist conducted VC consultations	Patients referred to an orthopaedic outpatient clinic of a university hospital	Video consult at primary care clinic, accompanied by GP and nurse, with physician at central clinic	Conventional face-to-face visit at central site	Patient-related outcomes: Satisfaction with communication and specialist service (5-pt Likert scales) Physician-related outcomes: satisfaction with communication and overall success of examination (5-pt Likert scales) Time outcomes: total time (home-to-home) taken by the visit
Krier [40] USA	Gastro-enterology department at VAhospital	15/19; 1 IBD specialist conducted VC as well as FF consultations	Newly established patients in an inflammatory bowel disease clinic	Video consult at remote site, accompanied by GE fellow, with IBD specialist at central site	Standard face-to-face encounter with IBD specialist	Patient-related outcomes Patient satisfaction (Ware Specific Visit Questionnaire (WSVQ); 14 items, 5-pt Likert scale; 1 = excellent, 5 = poor) Time outcomes: duration of visit (min); wait time (min)
Krousel-Wood [36] USA	Hypertension section	62 patients, having in total 107 VC and 107 FF visits; 2 physicians conducted VC as well as FF consultations	Patients checking into the hypertension section of a multi-specialty clinic for a scheduled appointment	Video consult at hospital, physician could use digital diagnostic aids. Before or after: face-to-face consult in same hospital, same physician. Randomized order of visits	Conventional face-to-face consult at the hospital. Before or after: a video consult with the same physician, using tele-aids. Randomized order of visits	Patient-related outcomes Patient satisfaction: Group Health Association of America (GHAA) Consumer Satisfaction survey (0–100); scales: technical quality, interpersonal care, time spent Physician-related outcomes Physicians' evaluation of efforts related to encounter: Resource-Based Relative Value Scale Reimbursement System (RBRVSRS) (>100 = more, <100 = less): work; mental effort; technical skills; risk/psych stress

Table 1 (*Continued*)

1st author/ year/ country	Setting	Intervention *N*/ control *N*; *N* physicians	Participants	Intervention	Control group	Outcomes
						Time outcomes: physician estimate of visit duration (min)
Oakley [24] and Loane [25] New Zealand	Dermatology department	109/94 [24] 110/93 [25]; number of physicians conducting consultations not provided	Patients with dermatological conditions referred to a specialist	Video consult at local health centre, accompanied by own GP, with dermatologist at regional hospital. The GP could make photos of skin lesions	Conventional face-to-face outpatient consult with dermatologist at the regional hospital	Cost outcomes Unit cost in NZ$ [25]: fixed costs (equipment and telecommunication) and variable costs (consultant, GP and patient time, patient travel) Time outcomes Total dermatologist consultation time (min) [25] Total patient time (min) [24,25] (travel, wait and consultation time) Follow-up outcomes Follow-up appointments at hospital, tele consultations and GP [24]
Pronovost [38] Canada	Anaesthesia department	38; 3 physicians conducted VC as well as FF consultations	Chronic pain patients returning for follow-up, with a travel distance > 100km	Video consult at remote site with physician at central site. Physician could use digital stethoscope. Thereafter a cross-over FF visit (3 months later).	Conventional face-to-face visit at central site. Thereafter a cross-over VC visit (3 months later)	Patient-related outcomes Patient satisfaction with format of the consultation (5-pt Likert scale) Pain score 0–10; Quality of life (Illness Intrusiveness Rating Scale (IIRS); 13 items, 7-pt Likert scales; 13–91; higher score: more intrusiveness) Cost outcomes Total patient cost in CAD$ (direct costs: travel expense, Indirect costs: lost productivity for patient and attendant, medical costs)
Stevens [43] Canada	Psychiatry department	20/20; 5 staff psychiatrists conducted VC as well as FF consultations	Patients in need of general psychiatric assessment, 19 of them psychotic (9VC, 10FF)	Video interview of patient at a remote site (Campbellford, 2 1/2 h north of Toronto) with psychiatrist at hub site (Toronto)	Face-to-face interview at remote site (Campbellford)	Patient-related outcomes Patient satisfaction (Interview Satisfaction Scale (ISS); 12 items, 5-pt Likert scales, lower score more positive); Patient-rated rapport (California Psychotherapy Alliance Scale (CPAS); 7-pt Likert scales; higher score more positive) Physician-related outcomes Physician satisfaction (ISS; 12 items, 5-pt Likert scales); physician-rated rapport (CPAS; 7-pt Likert scales)
Wallace [26] and Jacklin [27] England	Orthopaedics, urology, ENT, gastroenterology, endocrinology, neurology, general medicine, rheumatology, surgery	1051/1043; 20 hospital specialists conducted VC as well as FF consultations	Patients referred by GP for non-urgent matter to specialist in otolaryngology, general medicine, endocrinology, rheumatology, gastroenterology, orthopaedics, neurology, urology	Video consult ('virtual outreach') at the general practice, accompanied by their GP, with a specialist in a hub hospital	Standard face-to-face outpatient appointment	Patient-related outcomes Patient satisfaction (WSVQ); 14 items, 5-pt Likert scale); patient enablement (PEI; 6 items); quality of life (SF12; 0-100) [26] Cost outcomes Attributable NHS costs in £: consultation costs, costs for follow-up Patient costs: transport costs, Lost pay, Childcare costs [27] Time outcomes *See cost outcomes* Follow-up outcomes Follow-up over 6 months: hospital

						appointments, tests/ investigations, prescriptions (subsample), contact with care system [26]
Wootton [22] and Loane [23] Northern Ireland	Dermatology department	102/102 [22]; 126/148 [23]; number of physicians conducting consultations not provided	Patients with dermatological conditions referred by GP to a dermatologist	Video consult at patient's own health centre, accompanied by GP, with a dermatologist at the hospital	Conventional face-to-face outpatient consult with dermatologist at the hospital	Cost outcomes: net societal costs [22] /Unit cost [23]: variable costs (time and travel), fixed costs (equipment and telecommunication), savings due to gp learning Time outcomes: total patient time (min): travel, wait and consultation time [22,23]; physicians' estimated total consultation time (min) [23] Follow-up outcomes: mean no of additional primary/secondary care visits [22]; recommended and actual hospital appointments [22,23]
Videoconferencing (VC) compared to telephone contact (TC)						
Morgan [28] (pilot) and	McCrossan [29] Northern Ireland	Paediatric Cardiology department	35/24 (and 24 post-discharge); pilot: 16/14; no of physicians conducting consultations not provided;	(parents of) infants with major Congenital Heart Disease (CHD), requiring significant support following discharge from hospital	Video consultations at home, with clinician at hospital. VC: enquiry of concerns, systematic questioning, and visual assessment of the patient. Pulse oximetry was obtained from patients if needed.	Telephone consultations at home, with clinician at hospital. Same schedule and format as in the VC group was used, but the clinician was unable to visually assess the patient.
Patient-related outcomes Parental evaluation of	consultations: 3 items, 4-pt Likert scale Anxiety level (Spielberger's STAI; 20 items; 20–80) [28] Physician-related outcomes Clinician's evaluation (5-pt Likert scale): ability to address concerns Cost outcomes Total health care costs in £: healthcare use, specialist nurse contact Time outcomes: consultation duration (min) Follow-up outcomes *See cost outcomes*					
Web-messaging (WM) compared to face-to-face contacts (FF)						
Bergmo [30] Norway	Dermatology department	50/48; messages answered by dermatology resident (or trained nurse)	Children with atopic dermatitis (with internet access at home)	Parents could send message from home and include photos via secure messaging system; specialist responded with advice	Parents were encouraged to seek treatment through GP and hospital care	Patient-related outcomes Health outcome: severity scoring of atopic dermatitis (SCORAD; 0-83) Self-management behaviour: skin care treatments/week Cost outcomes: family costs in € Time outcomes: days of absence from work Follow-up outcomes: no of self-reported health care visits
	Dermatology department			Four follow-up e-visits at 6-week intervals: patients sent images of their	Four follow-up face-to-face visits at 6-week intervals	Patient-related outcomes Patient satisfaction with overall care, acne,

Table 1 (*Continued*)

1st author/ year/ country	Setting	Intervention *N*/ control *N*; *N* physicians	Participants	Intervention	Control group	Outcomes
Watson [31] USA		74/77; 5 dermatologists provided all care	Patients with mild to moderate facial acne, with access to a computer and internet connection	skin and disease-specific questionnaire to specialist, who responded with advice and prescriptions		time to complete visit Acne severity primary: total inflammatory Lesion count (TILC); secondary: frontal inflammatory Lesion count (FILC), Burke and Cunliffe Leeds Technique and forced choice Physician-related outcomes Physician satisfaction with overall care, acne, time to complete visit Time outcomes: duration of consult (min)
Web-messaging (WM) compared to telephone contact (TC)						
Lin [39] USA	Academic internal medicine practice	305/301; 14 physicians answered web messages as well as telephone calls	Patients visiting several physicians in a hospital, having experience using an Internet browser	Patients could send messages via portal; physician sent response or forwarded message with instructions to nurse. Patients could contact clinic by phone	Patients could contact the clinic by phone at their discretion or for urgent messages; They had access to a website providing general health advice	Patient-related outcomes Patients satisfaction (5-pt Likert scale), assessing satisfaction with: - Communication with the clinic - Communicating non-urgent messages to doctor and/or nurse - Cervices received from the clinic

allocation, blinding of patients, practitioners and outcome assessors, baseline comparability of groups, availability of follow-up for a sufficient proportion of patients, whether all patients were analysed in the group they were randomized to, and comparability of treatment of the groups apart from the intervention.

2.3.3. Data extraction and management

Data extraction was performed by using a predefined, structured data-abstraction sheet. FK performed the data extraction. LZ checked a random sample of the extracted data. Any discrepancies were discussed and solved amongst LZ, DU and FK.

The following trial characteristics were extracted: first author, year of publication, country of trial, trial setting and speciality, number of participants allocated to intervention and control groups, participant characteristics, description of intervention, description of control consultation, and description of outcome measures, including instruments used and scoring range. The trial results extracted were those mentioned in the Types of outcomes section.

2.3.4. Measures of outcomes

We report dichotomous data as numbers and percentages, and differences between the study groups as risk differences (RD) or relative risks (RR), including 95% confidence intervals (CI), if provided. For continuous data we report the means or medians of the two groups separately. If given, we also report the standard deviation (SD) or the interquartile range (IQR). If pertinent data were provided, we checked the statistical significance of the reported outcomes. Differences were judged significant if $p < 0.05$ or when a confidence interval (CI) did not enclose the value of 0 (RD) or 1 (RR).

2.3.5. Methods of analysis

We planned to do a meta-analysis only in case of clinical homogeneity of patients, interventions and outcome measures. If so, a random effects model would be used taking into account variation amongst the trials, expressed in the form of the I^2 statistic [17].

3. Results

3.1. Included trials

We included 21 trials, described in 27 publications (see Fig. 1), enrolling a total of 4570 patients/caregivers, ranging from 10 to 2094 patients/caregivers per trial. Trial characteristics are shown in Table 1. Studies referring to the same trial were Brennan et al. [18,19]; Chua et al. [20,21]; Wootton et al. [22] and Loane et al. [23]; Oakley [24] and Loane et al. [25]; and Wallace et al. [26] and Jacklin et al. [27]. For one trial, publications on a pilot study [28] and the main study [29] were included.

All trials were performed in high-income countries in Northern America, Europe and Oceania. Trials were carried out in various medical specialist settings; most common settings were dermatology (four trials [22–5,30,31]), and neurology (three trials [20,21,32,33]).

3.2. Participants

Participants suffered from minor diseases (e.g. acne, atopic dermatitis) to more severe diseases such as congenital heart disease (Table 1).

Table 2
Risk of bias.

1st author	Was the allocation of the intervention to the patients randomized?	Was the allocation concealed?	Were participants blinded to the intervention?	Were reviewers of results blinded for intervention?	Were the groups at the beginning of the trial similar?	Is follow-up available of a sufficient% of patients?	Are all included patients analysed in the group they were randomized to?	Were the groups, apart from the intervention, treated the same?
Videoconferencing (VC) compared to face-to-face contacts (FF)								
Agha [35]	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Ahmed [32]	No (birth date)	No	No	?	Yes	Yes	Yes	Yes
Bishop [44]	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Brennan [18,19]	Yes	Yes	No	?	No (VC more females)	Yes	?	Yes
Chua [20,21]	No (hospital number)	No	No	?	Yes	Yes	Yes	Yes
Dorsey [33]	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Elford [41]	No (not clear how)	?	No	?	Yes	Yes	Yes	Yes
Esmatjes [37]	Yes	Yes	No	?	Yes	No	Not possible for all outcomes	No (VC-group also tele-monitoring blood glucose)
Gattas [42]	No (not clear how)	?	No	?	?	No	Yes	Yes
Haukipuro [34]	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Krier [40]	No (week of patient scheduling)	No	No	?	No (VC longer disease duration)	Yes	No (crossover after 1st consultation allowed)	Yes
Krousel-Wood [36]	No (not clear how)	?	No	?	Yes	Yes	Yes	Yes
Oakley [24] and Loane [25]	Yes	Yes	No	?	?	Yes	Yes	Yes
Pronovost [38]	Yes	No	No	?	Yes	Yes	Yes	Yes
Stevens [43]	No (not clear how)	?	No	?	Yes	Yes	Yes	Yes
Wallace [26] and Jacklin [27]	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Wootton [22] and Loane [23]	Yes	Yes	No	?	?	?	Yes	Yes
Videoconferencing (VC) compared to telephone contact (TC)								
McCrossan [29] and Morgan [28] (pilot)	Yes (pilot: no (equipment)	Yes	No	?	No (VC more males)	Yes	Yes	Yes
Web-messaging (WM) compared to face-to-face contacts (FF)								
Bergmo [30]	Yes	Yes	No	?	No (WM younger and fewer urban residents)	Yes	?	Yes
Watson [31]	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Web-messaging (WM) compared to telephone contact (TC)								
Lin [39]	Yes	Yes	No	?	Yes	No	Yes	Yes
Total	67%	62%	0%	5%	67%	76%	67%	95%

Table 3
Outcomes.

1st author	Outcomes	Significant effects
Videoconferencing (VC) compared to face-to-face contacts (FF)		
Agha [35]	**Patient-related outcomes**: satisfaction with communication: VC 3.76 (CI 3.57–3.96) vs FF 3.61 (CI 3.41–3.96) (difference −0.15 (95%CI −0.32–0.015); with clinical competence: VC 4.63 (CI 4.47–4.79) vs FF 4.52 (CI 4.36–4.68) (difference −0.11 (95%CI −0.26 to 0.04); with interpersonal skills: VC 4.79 (CI 4.67–4.90) vs FF 4.74 (CI 4.63–4.86) (difference −0.05 (95%CI −0.17 to 0.09); with convenience of care: VC 4.41 (CI 4.23–4.61) vs FF 2.37 (CI 2.18–2.56) **(difference) −2.04 (95%CI −2.3 to −1.79; $p < 0.001$)** **Time outcomes**: visit length (reported as covariate): VC 23.2 min vs FF 28.8 min ($p = 0.002$)	**Patient-related: 1 of 4** **Time: 1 of 1**
Ahmed [32]	**Patient-related outcomes** satisfaction with the quality of service: VC 'about 90%' vs FF 'about 90%' (no exact figure/statistic for each separate item) **Cost outcomes** total patient costs: VC CAD$35.85 vs FF CAD$466.00 (no statistics); videoconferencing costs: VC CAD$463.00 vs FF CAD$0 **Total costs**: VC CAD$ 498.85 vs FF CAD$ 459.40 (no statistics)	Patient-related: no statistics of 1 Cost: no statistics of 2
Bishop [44]	**Patient-related outcomes**: satisfaction with services: VC 21.6 (SD 2.5) vs FF 25.3 (SD 3.5) ($p = 0.07$)	Patient-related: 0 of 1
Brennan [18,19]	**Patient-related outcomes**: positive overall satisfaction: VC 98% vs FF 95% ($p = 0.54$); positive interaction: VC 98% vs FF 100% ($p = 0.32$) **Time outcomes**: throughput time: VC 106 min vs FF 117 min ($p = 0.99$) **Follow-up outcomes**: 72 h emergency department return visits: VC 0% vs FF 0%; need for additional care: VC 2.3 % vs FF 2.4% ($p = 0.99$)	Patient-related: 0 of 2 Time: 0 of 1 Follow-up: 0 of 2
Chua [20,21]	**Patient-related outcomes**: satisfaction with consultation process (*n* agree): I was able to say what I wanted: VC 34 vs FF 32 ($p = 0.97$); I felt the neurologist understood my problems: VC 34 vs FF 32 ($p = 0.97$); I felt the explanation of my symptoms was satisfactory: VC 27 vs FF 36 (**$p = 0.02$**)*; I felt the outpatient appointment was useful: VC 32 vs FF 33 ($p = 0.53$); I had confidence in the way the neurologist addressed my problems: VC 32 vs FF 32 ($p = 0.65$); Satisfaction with technical aspects (n Agree): I felt shy and nervous about speaking; VC 21 vs FF 9 (**$p = 0.005$**)*; I could hear everything the neurologist said; VC 40 vs FF 43 ($p = 0.08$); I was worried that others were listening or watching; VC 12 vs FF 1 (**$p = 0.017$**)* **Cost outcomes**: costs of consult: VC £72 vs FF £49 (no statistics) **Time outcomes**: time of consult: VC 12.9 min vs FF 20.8 min (no statistics) **Follow-up outcomes**: no of investigations after the consultation: VC 46 vs FF 11 (**$p < 0.001$**)*; no of treatment prescriptions: VC 14 (18.4%) vs FF 11 (16.9%) ($p > 0.5$); Discharge (no further neurological review) after first consultation: VC 54 (71.1%) vs 51 (78.5%) ($p = 0.42$)	**Patient-related: 3* of 8** Time: no statistics of 1 **Follow-up: 1* of 3**
Dorsey [33]	**Patient-related outcomes**: change in satisfaction[b]: VC 6.2 (SD 11.4) vs FF 0.8 (SD 6.7) ($p = 0.15$); quality of life on EQ-5D[b]: VC 0.1 (SD 0.3) vs FF 0.0 (SD 0.1) ($p = 0.66$); on PDQ-39[a]: VC −3.4 (SD 8.0) vs FF 10.3 (SD 7.2) (**$p = 0.04$**); motor performance[a]: VC −0.3 (SD 3.1) vs FF 6.5 (SD 4.4) (**$p = 0.03$**);Change in mood[a]: VC −0.3 (SD 1.5) vs FF −0.5 (SD 0.6) ($p = 0.46$); cognition[b]: VC −0.5 (SD 1.5) vs FF −0.5 (SD 2.6) ($p = 0.59$) [a]*Negative change indicates improvement*;[b]*positive change indicates improvement*	Patient-related: 2 of 6
Elford [41]	**Patient-related outcomes**[a]: children's satisfaction: did you like talking to the doctor? ($Chi^2 = 0.00$), could you understand the doctor? ($Chi^2 = 0.00$), did you have any problems in talking to the doctor? ($Chi^2 = 1.80$); parents' satisfaction: how easy was it for you to talk to the psychiatrist? ($p = 0.063$), how easy do you think it was for your child to talk to the psychiatrist? ($p = 0.613$), how helpful do you think the assessment was? ($p = 0.363$), how often were you able to tell the psychiatrist everything you wanted? (no *p*-value due to small no of differences), how comfortable were you during the assessment? ($p = 0.033$), how easy was it for you to understand the psychiatrist? ($p = 0.031$)[a] *p-values less than 0.025 were considered significant by the authors* Physician-related outcomes:satisfaction: how well do you think the assessment went? (**$p = 0.011$**)*, how well were you able to communicate with patient and parent? (**$p = 0.006$**)*, how well do you think patient and parent were able to understand you? (**$p = 0.002$**)*, was there anything you would have like to have changed or improved? (**$Chi^2 = 7.69$**)*, did you have any difficulties during the assessment (other than technical)? ($Chi^2 = 1.33$)	Patient-related: 0 of 9 **Physician-related: 4* of 5**
Esmatjes [37]	**Patient-related outcomes** (change between first and last visit) Hypoglycemia: HbA1c VC 9.2% (SD 1.5) to 8.7% (SD 1.5) ($p < 0.001$) vs FF 9.2% (SD 0.9) to 8.6% (SD 0.9) ($p < 0.001$) (similar reduction); No of severe and mild hypoglycemic episodes: similar; quality of life (EuroQol): VC 65.0 (SD 18.8) to 69.9 (SD 18.7) ($p = 0.90$) vs FF 67.1 (SD 17.7) to 66.9 (SD 17.4) ($p = 0.92$) (both no change); diabetes quality of life (DQoL): satisfaction; VC 35.1 (SD 10.4) to 34.5 (SD 8.9) ($p = 0.56$) vs FF 35.6 (SD 10.0) to 33.2 (SD 9.0) (**$p = 0.021$**) **(VC no change, FF more satisfied)***, impact: VC 34.1 (SD 8.4) to 32.3 (SD 7.8); $p = 0.061$ vs FF 33.9 (SD 8.4) to 33.5 (SD 8.4) ($p = 0.55$) (both no change), Social worry: 13.7 (SD 5.0) to 13.6 (SD 4.6) $p = 0.868$ vs FF 14.3 (SD 5.3) to 14.2 (SD 4.9) ($p = 0.93$) (both no change), Diabetes Worry; VC 8.9 (SD 3.0) to 8.8 (SD 3.0) ($p = 0.74$) vs FF 9.8 (SD 3.3) to 9.0 (SD 3.0) (**$p = 0.011$**) **(VC no change, FF reduced worries)***; diabetes self-management: blood glucose testing frequency/week: VC 25.8 (SD 8.5) to 28.5 (SD 7.9) ($p = 0.13$) vs FF 26.3 (SD 7.7) to 28.8 (SD 7.1) ($p = 0.006$) (similar increase), diabetes knowledge (DKQ2): VC 24.5 (SD 4.6) to 26.1 (SD 4.6) ($p = 0.008$) vs FF 24.8 (SD 4.4) to 26.8 (SD 4.0) ($p < 0.001$) (similar increase), adherence to self-care: VC 61.3% (SD 12.0) to 66.1% (SD 11.0); ($p = 0.003$) vs FF 64.1% (SD 10.7) to 69.8% (SD 9.6) ($p < 0.001$) (similar increase), hypoglycaemia perception: VC 17.3–17.0 ($p = 1.0$) vs FF 30.8 to 23.8 ($p = 0.32$) (both no change) **Cost outcomes**: patient time costs: mean estimated cost of visits for patient VC €38–116/353 min (SD 222) vs FF €90–270/823 min (SD 645) (**$p < 0.0001$**); transportation cost: VC €6.3 (SD 5.2) vs FF €32.1 (SD 30.0) (**$p < 0.0001$**); Diabetes team costs: VC €144/232 min (SD 105) vs FF €185.6/288 min (SD 89) (**$p < 0.001$**) **Time outcomes**: *see Cost Outcomes* Follow-up outcomes: extra visit during follow-up because of sustained hyperglycaemia: VC 0 vs FF 2 (no statistics); no of (extra) telephone consultations per patient during the study: VC 0.54 vs FF 0.30 (no statistics)	**Patient-related: 2* of 11** Cost: 3 of 3 Follow-up: no statistics of 2

Table 3 (*Continued*)

1st author	Outcomes	Significant effects
Gattas [42]	**Patient-related outcomes**: patient satisfaction with consultation (no statistics; data estimated from graphs): communication was easy: VC 4.0 vs FF 3.9; I was able to maintain eye contact: VC 3.5 vs FF 3.9; The room was comfortable: VC 4.2 vs FF 3.6; I was satisfied with clinic format: VC 4.0 vs FF 4.0 **Physician-related outcomes**: physician satisfaction with consultation(no statistics; data from graphs): Communication was easy: VC 4.0 vs FF 4.5; I was able to maintain eye contact: VC 3.6 vs FF 4.5; The room was comfortable: VC 4.1 vs FF 4.2; I was satisfied with clinic format: VC 4.0 vs FF 4.5	Patient-related: no statistics of 4 Physician-related: no statistics of 4
Haukipuro [34]	**Patient-related outcome**: communication with staff: VC (very good:57%, good:41%, moderate:1%, bad:1%, very bad:0%) vs FF (very good:54%, good:40%, moderate:5%, bad:1%, very bad:0%)(p>0.05); satisfaction with specialist service: VC (very good:55%, good:38%, moderate:4%, bad:1%, very bad:1%) vs FF (very good:42%, good:41%, moderate:13%, bad:3%, very bad:2%) ($p > 0.05$) **Physician-related outcomes**: communication with the patient: VC (very good:29%, good:59%, moderate:11%, bad:1%, very bad:0%) vs FF (very good:85%, good:12%, moderate:3% bad:0%, very bad:0%) **($p < 0.001$)***; overall success of the examination: VC (very good:18%, good:62%, moderate:16%, bad:3%, very bad:1%) FF (very good:84%, good:15%, moderate:1%, bad: 0%, very bad:0%) **($p < 0.001$)*** **Time outcomes**: total time taken by the visit (home-to-home): VC 1.5 h vs FF 8 h (no statistics)	Patient-related: 0 of 2 **Physician-related: 2* of 2** Time: no statistics of 1
Krier [40]	**Patient-related outcomes**: patient satisfaction/ "Clinic experiences": VC 1.2 (SD 0.4) vs FF 1.3 (SD 0.5) ($p = 0.53$) **Time outcomes**: appointment time: VC 60 min (SD 14) vs FF 59 min (SD 10) ($p = 0.81$); wait time: VC 25 min (SD 25) vs FF 18 min (SD 14.5) ($p = 0.31$)	Patient-related: 0 of 1 Time: 0 of 2
Krousel-Wood, [36]	**Patient-related outcomes**: satisfaction with technical quality: VC 82.9 (SD 19.3) vs FF 87.9 (SD 18.5) **($p = 0.0007$)***; with interpersonal care: VC 90.4 (SD 13.3) vs FF 91.1 (SD 13.4)($p = 0.23$); with time spent: VC 80.8 (SD 22.7) vs FF 88.0 (SD 17.1) **($p = 0.015$)*** **Physician-related outcomes**: evaluation of overall work: VC 144.5 (SD 37.9) vs FF 136.1 (SD 35.2) **($p = 0.005$)***; mental effort: VC 144.9 (SD 39.8) vs FF 135.7 (SD 35.9) **($p = 0.003$)***; technical skills: VC 142.1 (SD 39.6) vs FF 132.7 (SD 35.9)**($p = 0.012$)***; risk/psychological stress: VC 149.0 (SD 46.2) vs FF 134.0 (SD 37.0) **($p < 0.0001$)*** **Time outcomes**: visit duration: VC 18.1 min (SD 8.2) vs FF 16.2 min (SD 7.4) **($p = 0.006$)***	**Patient-related: 2* of 3** **Physician-related: 4* of 4** **Time: 1* of 1**
Oakley [24] and Loane [25]	**Cost outcomes**: unit cost: VC NZ$279.23 vs FF NZ$283.79 (no statistics) [25] **Time outcomes**: total dermatologist consultation time (average): VC 20.04 min vs FF 21.60min [25]; Total patient time (average): VC 52.59 min vs FF 259.18 min [25] /VC 51 min (22–130) vs FF 259 min (127–440) [24] (no statistics) **Follow-up outcomes**: Follow-up appointments at the hospital: VC 7% vs FF 12%; via tele consultation: VC 6% vs FF 5%; with GP: VC 38% vs FF 29% (no statistics) [24]	Cost: no statistics of 1 Time: no statistics of 2 Follow-up: no statistics of 3
Pronovost [38]	**Patient-related outcomes**: patient satisfaction with format of the consultation: VC (strongly agree: 56% agree: 32% neutral: 12% disagree: 0% strongly disagree: 0%) vs FF (strongly agree: 24% agree: 48% neutral: 16% disagree: 8% strongly disagree: 4%) (**$p < 0.05$**, comparing 'strongly agree' category); pain score: day of consultation: VC 6.7 (SD 2.5) vs FF 6.8 (SD 2.6) ($p = 0.79$); day after consultation: VC 6.9 (SD 2.9) vs FF 6.9 (SD 2.6) ($p = 0.81$); first week: VC 6.8 (SD 2.5) vs FF 6.7 (SD 2.5) ($p = 0.84$); quality of life: IIRS score: VC 66.7 (SD 15.2) vs FF 64.1 (SD 19.8) ($p = 0.61$) **Cost outcomes**: total patient cost: VC median: CAD$ 133 (IQR: 28–377) vs FF median: CAD$ 442 (IQR: 292–1075) **($p < 0.001$)**	**Patient-related: 1 of 5** **Cost: 1 of 1**
Stevens [43]	**Patient-related outcomes**: satisfaction with interview: VC 1.87 (SD 0.63) vs FF 1.59 (SD 0.69)($p = 0.18$); patient-rated rapport: VC 5.76 (SD 0.61) vs FF 5.72 (SD 0.91) ($p = 0.89$) **Physician-related outcomes**: Satisfaction with Interview: VC 2.13 (SD 0.50) vs FF 1.58 (SD 0.43) **($p = 0.001$)***; Psychiatrist-rated rapport: VC 5.55 (SD 0.89) vs FF 5.73 (SD 0.84) ($p = 0.52$)	Patient-related: 0 of 2 **Physician-related: 1* of 2**
Wallace [26] and Jacklin [27]	**Patient-related outcomes**: patient satisfaction: VC 3.97 (SD 0.99) vs FF 3.64 (SD 1.06) (difference 0.33 **(95% CI 0.23 to 0.43); $p < 0.001$)**; patient enablement: VC 2.5 (SD 3.2) vs FF 2.4 (SD 3.1) (difference 0.07 (95%CI −0.24 to 0.38); $p = 0.67$); SF12 physical: VC 43.1 (SD 12.0) vs FF 42.7 (SD 12.2) (difference 0.34 (95%CI −0.96 to 1.63); $p = 0.61$); SF12 mental: VC 47.5 (SD 11.8) vs FF 48.1 (SD 11.9) (difference -0.51 (95%CI −1.78 to 0.76); $p = 0.43$) [26] **Cost outcomes**: Attributable NHS costs (incl. follow-up): VC £393.33 (SD 388.93) vs FF £285.75 (SD 406.95); **difference £107.58 (95%CI 73.35 to 141.8; $p < 0.0001$)***; Total patient costs: VC £3.69 (SD 16.89) vs FF £11.38 (SD 33.85); **difference £-7.70 (95%CI −10.35 to −5.05; $p < 0.0001$)** [27] **Time outcomes**: *see cost outcomes*[27] **Follow-up outcomes**:offered follow-up over 6 months: hospital follow-up appointments: VC 502 (52%) vs FF 400 (41%); **OR 1.53 (95% CI 1.27 to 1.83; $p < 0.0001$)***, no of tests and investigations: VC 3.22 (SD 4.48) vs FF 4.01 (SD 5.25); **difference −0.76 (95%CI −1.21 to −0.37; $p = 0.0002$)**, prescriptions: VC 8.72 (SD 13.0) vs FF 8.15 (SD 12.5) (difference 0.57 (95%CI -0.64 to 1.78; $p = 0.36$), contacts with GP: VC 3.47 (SD 3.65) vs FF 3.27 (SD 3.39) (difference 0.20 (95%CI −0.11 to 0.50; $p = 0.21$), emergency visits: VC 0.06 (SD 0.30) vs FF 0.06 (SD 0.28)(difference 0.002 (95%CI −0.02 to 0.03; $p = 0.85$), inpatient stays: VC 0.11 (SD 0.35) vs FF 0.13 (SD 0.39) (difference -0.02 (95%CI −0.06 to 0.01; $p = 0.15$), day surgery/inpatient procedures: VC 0.11 (SD 0.36) vs FF 0.12 (SD 0.38) (difference −0.01 (95%CI −0.04 to 0.02; $p = 0.52$) [26]	**Patient-related: 1 of 4** **Cost: 2 of 2 (1 positive and 1 negative*)** **Follow-up: 2 (1 positive and 1 negative*) of 7**
Wootton [22] and Loane [23]	**Cost outcomes**: net societal cost/patient: VC £132,10 (SD £24,63) vs FF £48,73 (SD £18,40) [22]; Unit cost: VC £326.70 vs FF £95.90 [22] (no statistics) **Time outcomes**:total patient time: VC 52.2 min (SD 32.2; 95% CI 43.9 to 60.5) vs FF 83.0 min (SD 50.3; 95%CI 72.4 to 93.6) (no further statistics) [22] and: total patient time involved: VC 5007.46 min vs FF 10,734.45	Cost: no statistics of 2 Time: no statistics of 3 Follow-up: no statistics of 3

Table 3 (*Continued*)

1st author	Outcomes	Significant effects
	[23]; Physicians' estimated total consultation time: VC 1655.22 min vs FF 2162.52 min [23] (no statistics) **Follow-up outcomes**: mean no of additional visits to primary/secondary care: VC 1.63 (SD 0.78; 95%CI 1.43–1.83) vs FF 2.12 (SD 1.93; 95%CI 1.62–2.62)(no further statistics) [22]; recommended further hospital appointments: VC 47 (46%) vs FF 46 (45%) [40]; VC 56% vs FF 70% [23]; actual further hospital appointments: VC 42 (41%) vs FF 41 (40%) [40] VC 53% vs FF 56% [23] (no statistics)	
Videoconferencing (VC) compared to telephone contact (TC)		
McCrossan [29] Morgan [28] (pilot study)	**Patient-related outcomes**: parental evaluation of consultations: the doctor was able to understand my concerns during the consultation: VC median 4 (IQR 3.8–4) vs TC 3.6 (IQR 3.4–3.7) (**$p = 0.001$**); the problem/questions I had were satisfactorily resolved following the consultation: VC median 4 (IQR 3.9–4) vs TC 3.5 (IQR 3.4–3.8) (**$p = 0.001$**); on this occasion, the consultation was beneficial: VC median 4 (IQR 4–4) vs TC 3.6 (IQR 3.4–3.8) (**$p = 0.001$**) Decrease in state anxiety level (dA): VC (median: 5 IQR: 4–15) vs TC (median: 3 IQR: 1–8) (numbers visually derived from figure) (**$p < 0.05$**) [28] **Physician-related outcomes**: clinician believed he could address concerns: VC median% 100 (IQR 100–100) vs TC median% 64 (IQR 56–78) (**$p = 0.01$**) **Cost outcomes**: total health care costs: VC £822.32 vs TC £2381.75 **(mean difference/patient £1563; 95%CI £502 to £2600)** **Time outcomes**: consultation duration: VC 10.5 min (SD 2.0) vs TC 8.0 min (SD 1.3); mean difference 2.5 min (**95%CI 1.6–3.5 min; $p = 0.04$**)*	**Patient-related: 4 of 4** **Physician-related: 1 of 1** **Cost: 1 of 1** **Time: 1* of 1**
Web-messaging (WM) compared to face-to-face contacts (FF)		
Bergmo [30]	**Patient-related outcomes**: severity of eczema: no improvement in both groups; no significant difference between the groups ($p = 0.55$); self-management behaviour (skin treatments) per week: decrease in both groups; no significant difference between the groups ($p = 0.48$) **Cost outcomes**: family costs: no reduction in both groups; no significant difference between the groups ($p = 0.74$) **Time outcomes**: days absence from work: no reduction in both groups; no significant difference between the groups ($p = 0.45$) **Follow-up outcomes**: total health care visits: decrease in both groups; no significant difference between the groups ($p = 0.48$)	Patient-related: 0 of 2 Cost: 0 of 1 Time: 0 of 1 Follow-up: 0 of 1
Watson [31]	**Patient-related outcomes**: patients satisfied with overall care: WM 91% vs FF 98% ($p = 0.054$); with improvement of acne: WM 91% vs FF 88% ($p = 0.64$); patients agreeing that the visit took too much time of their day: WM 4% vs FF 34% (**$p < 0.001$**); reduction in lesions (TILC): WM 6.67 vs FF 9.39; difference 2.72, 95% CI −5.54 to 10.99 ($p = 0.49$); reduction in FILC: WM 3.19 vs FF 5.03 ($p = 0.33$); reduction in Leeds: WM 0.19 vs FF 0.21 ($p = 0.89$); forced choice examination: WM 55% vs FF 55% ($p = 0.98$) **Physician-related outcomes**: satisfaction with overall care: WM 9.04 vs FF 9.39 ($p = 0.16$); with acne improvement: WM 8.34 vs FF 8.92 ($p = 0.06$) **Time outcomes**: duration of consult: WM 4 min 42 s vs FF 4min8 sec ($p = 0.57$)	**Patient-related: 1 of 7** Physician-related: 0 of 2 Time: 0 of 1
Web-messaging (WM) compared to telephone contact (TC)		
Lin [39]	**Patient-related outcomes**: satisfaction of communication with the clinic is a little/a lot better than at beginning of study: WM 77 (44%) vs TC 18 (11%) (**$p < 0.001$**), satisfaction of communicating non urgent messages to doctor and/or nurse is very good/excellent: WM 77 (55%) vs TC 43 (31%) (**$p < 0.001$**), satisfaction of the services received from the clinic is very good/excellent: WM 103 (59%) vs TC 78 (48%) (**$p = 0.04$**)	**Patient-related: 3 of 3**

Results in bold indicate a significant effect; *: Unbeneficial effect intervention.

3.3. Interventions

Of the 21 trials, 17 compared videoconferencing (VC) with face-to-face contact (FF), two compared web-messaging (WM) with FF, one compared VC with telephone contact (TC), and one compared WM with TC.

Videoconferencing was realised in multiple ways. Some trials allowed a nurse [18,19,33–36] and/or their general practitioner [22,23,25–27,34] to accompany the patient. Only two trials performed the videoconferencing from the patient's home [28,29,37]. In some trials aids like a tele-stethoscope or a tele-oximetry pulse metre were used [18,19,29,36,38], in addition to the video conversation. In one trial, patients in the intervention group also used an online telemedicine system to monitor their blood glucose values [37]. In the web-messaging group patients, one trial was limited to text only [39], while the other two trials could also include photographs [30,31]. All web-messages were sent from the patients' homes.

3.4. Risk of bias assessment

Risk of bias of the included trials is summarized in Table 2. In general, methodological quality of the included trials was fairly good. All of the 21 included trials stated to have used random allocation. However, 14 of the 21 trials (67%) allocated using valid methods. Due to the nature of the interventions, blinding of participants was not feasible. In one trial the outcome observers were adequately blinded [31]; trials mostly used questionnaires for relevant outcome measures, obviating the need for a blinded reviewer. In four trials (19%) differences were found in gender [18,19,29], disease duration [40], or age and urban residency [30]. In four trials (33%) it was not clear whether patients were analysed in the group they were randomised to.

3.5. Outcomes

Effects of interventions are described in Table 3 and summarized below.

3.5.1. Videoconferencing (VC) compared to face-to-face (FF) care

Seventeen trials compared videoconferencing (VC) to face-to-face (FF) care. Fig. 2 shows a graphical summary of the outcomes for this comparison.

3.5.1.1. Patient-related outcomes. Nine trials reported on*patient satisfaction with communication/interaction*[18,21,34–36,38,41–43]. Two trial reported higher satisfaction in the VC group, on convenience of visit [35] and format of the consultation [38]. In contrast, one trial [21] reported higher satisfaction in the FF group on explanation of symptoms, confidentiality and feelings of embarrassment. Likewise, another trial [36] reported higher satisfaction in the FF group on satisfaction with technical quality of the consultation and time spent. Four trials reported no significant differences [18,34,41,43], while one trial did not report statistical analyses [42]. Three trials reported on *patient satisfaction with (quality of) the service*, but found no significant differences [32,34,44]. Four trials reported on *patient overall satisfaction* [18,26,33,40], of which one reported significant differences in favour of the VC group [26].

Trials reporting on *patient-rated rapport*,i.e. the physician's and patient's ability to work together and develop rapport [43], or *patient enablement*,i.e. patients' ability to understand the nature of their problems and cope with their illness [26], reported no significant differences.

One trial reported on patients' diabetes-related *self-management* [37], and found no differences between VC group and FF group on 4 measures (blood glucose testing frequency, diabetes knowledge, adherence to self-care and hypoglycaemia perception).

Four trials reported on several *health outcomes* [26,33,37,38]. In one trial, involving Parkinson's disease patients, the VC group experienced significant more improvement in two out of four self-reported health outcomes: quality of life and motor performance [33]. Another trial [37] assessed change in several health outcomes after 6 months of follow-up, and found improvement in two out of four scales of the diabetes quality of life (satisfaction and diabetes worry) in het FF group, whereas the VC group showed no improvement. The other trials found no significant differences in health outcomes [26,38].

3.5.1.2. Healthcare professional-related outcomes. Four trials reported on*physician satisfaction with communication/interaction* [34,41–43]. Three trials reported statistical analyses and found a significantly higher satisfaction in the FF group [34,41,43]. Two trials reported on *physician satisfaction with assessment/clinical examination*,and also found significantly better results for face-to-face contacts [34,41].

One trial assessed*physician evaluation of efforts related to the encounter*, and found that physicians reported significant increases in overall work, mental effort, technical skill and risk/psychological stress for the VC visit as compared to the face-to-face visit [36]. One trial reported no significant differences regarding to *physician-rated rapport* [43].

3.5.1.3. Cost outcomes. Four trials [27,32,37,38] reported about *patient costs*. In one trial, patients in the VC group reported significantly lower costs, including transportation costs, lost pay and childcare costs [27]. Also another trial reported significantly lower patient costs in in relation to VC [38], especially regarding patients' travel expenses. Likewise, in another trial [37] patients' time costs and estimated transportation costs were considerably lower in the VC group. Another trial [32] demonstrated 'significant' cost savings for patients with teleconferencing (in terms of transportation, accommodation, and missed work), but did not report statistics.

*Costs of consultation*were reported in two trials. One trial reported on time costs for a diabetes team based on length of appointments, and found that costs were lower in the CV group [37]. The other trial [20] did not provide statistical data.

Four trials reported *total costs* [22,23,25,27,32]. One trial reported significantly higher costs for the VC group, including consultation costs and costs for patients' follow-up [27]. In that trial, a general practitioner was present during the VC consultation, leading to higher physicians' time costs. Two trials reported 'considerably higher' costs for the VC group due to additional costs of equipment and general practitioner time, without providing statistics [22,23,25]. Also the fourth trial [32] reported on extra consultation costs of videoconferencing, including equipment and line costs, administrative staff, facility costs and service costs, versus no extra consultation costs for the FF group, but did not report statistical analyses.

*3.5.1.4. Time outcomes. Patient time*was reported by four trials, e.g. waiting and travel time [22–25,34,40]. The one trial reporting statistical analyses assessed patients' waiting time and found no significant differences between groups [40]. *Time of consultation* was reported by seven trials [18,20,22,23,25,35,36,40]. Of the three trials that conducted statistical analysis, one showed no significant differences [40], one showed a shorter consultation duration in the FF group [36], and one – reporting visit length as a covariate – showed a shorter duration in the VC group [35].

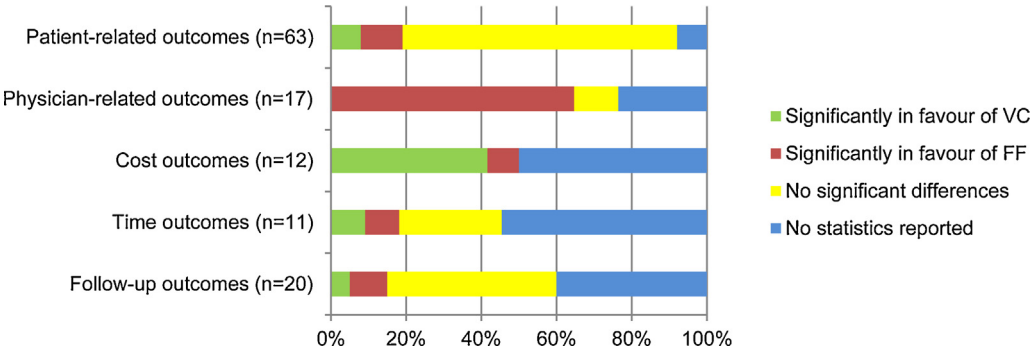

Fig. 2. Graphical summary of outcomes for videoconferencing (VC) vs. face-to-face (FF) consultations. *N* = number of outcome variables reported.

3.5.1.5. Follow-up outcomes. Six trials reported on follow-up outcomes [18,21–24,26,37]. One trial reported no significant differences in emergency department return visits or need for follow-up care [18]. Another trial found that significantly more follow-up appointments were offered in the VC group, especially in surgical specialties, while there were significantly fewer tests and investigations per patient in the VC group than in the FF group, especially in Gastroenterology patients [26]. Other contacts with healthcare services in that trial did not differ between the groups. In yet another trial patients in the VC group had more investigations, but there was no difference in treatment prescription numbers or further neurological review appointments between the groups [21].

3.5.2. Videoconferencing (VC) compared to telephone contact (TC)

One trial compared videoconferencing (VC) to telephone contact (TC) [28,29]. In this trial, parents of infants with major congenital heart disease received videoconferencing support or telephone support at home, as compared to standard care (i.e. no additional support). For this review, we only compared the VC-group versus the TC-group.

3.5.2.1. Patient-related outcomes. The trial found significantly higher *patient satisfaction with communication/interaction* in the VC group [29]. The pilot study of the trial [28] found significantly lower *anxiety levels*in parents using VC as compared to parents using TC.

3.5.2.2. Healthcare professional-related outcomes. The trial assessed the *clinician's satisfaction with the consultation* and reported significantly better results for videoconferencing [29].

3.5.2.3. Cost outcomes. The trial reported that *total healthcare resource use costs* per patient were significantly lower in the VC group compared with the TC group [29], supposedly due to fewer hospital admissions and visits to emergency department or GPs.

3.5.2.4. Time outcomes. A video consult took significantly longer as compared to a telephone consult [29].

3.5.2.5. Follow-up outcomes. Health service utilisation [29] is reported under 'Costs'.

3.5.3. Web-messaging (WM) compared to face-to-face (FF) care

Two trials, both in a dermatology setting, compared web-messaging (WM) to face-to-face (FF) care [30,31]. In one of these trials, only 19 out of 31 parents (38%) in the WM group actually used web-messaging [30].

3.5.3.1. Patient-related outcomes. One trial reported on *satisfaction with time required to complete the visit*, and found significantly greater satisfaction in the WM group [31]. The trial reporting on *satisfaction with acne improvement* found no significant difference between the groups [31].

The trial that reported on *patients'satisfaction with overall care* found no significant differences [31]. One trial [30] reported on *self-management behaviour*, i.e. the mean number of skin care treatments per week performed by parents, and found no significant difference between WM and FF. Both trials reported on *health outcomes*, and showed no significant differences [30,31].

3.5.3.2. Healthcare professional-related outcomes. One trial reported on *physicians'overall satisfaction and satisfaction with acne improvement,* and found no significant differences [31].

3.5.3.3. Cost outcomes. Bergmo et al. found no significant differences in *patient costs* between WM and FF [30].

3.5.3.4. Time outcomes. In the trial assessing time outcomes, i.e. *time of consult*and *patients'time*no significant differences were found [30].

3.5.3.5. Follow-up outcomes. One trial assessed *resource use*, i.e. the total number of health care visits, and found no significant differences [30].

3.5.4. Web-messaging (WM) compared to telephone contact (TC)

One trial compared web-messaging (WM), sent through a patient portal, to telephone contact (TC) [39]. In this trial, of the 305 patients who were allocated to the patient portal, 256 (84%) obtained a user account for the patient portal, and 95 (31%) used the portal during the trial period. The trial only reported patient-related outcomes.

3.5.4.1. Patient-related outcomes. The trial reported a significantly higher *satisfaction* in the WM group, for communication with the clinic as well as for communicating non-urgent messages to doctor and/or nurse [39]. The trial also found a significantly higher satisfaction with services for the web-messaging group [39].

4. Discussion and conclusion

4.1. Discussion

This is the first systematic review on the effects of e-consulting between medical specialists and patients. E-consulting between patients and clinical healthcare professionals seems to try and hitch a ride on the modern wagon of electronic communication. So far, however, the evidence about arguments supporting its usage runs behind. Most available studies on physician-related outcomes are around 15 years old. The comparison between videoconferencing and face-to-face communication has been studied most, as opposed to comparisons of videoconferencing with telephonic contact or between web-messaging and conventional consultations. Although electronic consultations tend to have a favourable effect on costs for patients (transportation) and healthcare, patients may not always be comfortable with it, while physicians in the included studies are still reluctant. On the other hand – although the number of studies in this area is still limited – videoconferencing and web-messaging do seem to outperform conversations by telephone, while web-messaging is considered as useful as face-to-face contacts.

The best application for telemedicine seems to be for frail, elderly or remote patients and for periodic monitoring of patients with chronic diseases [36]. Improvement in technical quality of the video-consultations could improve its acceptability for patients and physicians [36]. Although technology necessary equipment has become increasingly widespread and less expensive [33], more robust and easy systems are necessary [37]. In addition, current reimbursement and insurance coverage for telemedicine is inconsistent [33].

4.1.1. VC compared to FF

Physicians appeared less satisfied with the clinical examination or assessment of the patient after VC. One of the drawbacks of videoconferencing is that the physician cannot perform the physical examination, in particular examinations where palpation is an important component [8]. This may be related to the finding that physicians ordered more follow-up consultations or

investigations in the VC-group. In some cases, the specialist may rely on the examination by another health-care professional, e.g. a general practitioner or nurse present with the patient. Although attention from two healthcare professionals is related to higher total costs [22,27], it may also promote patient confidence [35] and general practitioners' confidence in managing patients as a result of learning benefits during the VC [22].

The trials we found on physician-related outcomes were all conducted about 15 years ago. Nowadays physicians may be more familiar and confident with VC, and VC-systems have become easier to work with, which may positively impact the perceived mental effort, workload and time related to these consultations. Nevertheless, e-consulting may result in fundamental changes in clinical practice which have to be taken into account, as physicians may need to use specific communication skills and different approaches to information giving [7], for example when engaging patients in shared decision-making [45].

Patient satisfaction was the most studied outcome. In contrast with physicians, patients appeared to be as satisfied with videoconferencing as with face-to-face contacts. In some of the older trials, however, patient satisfaction with communication was somewhat lower after videoconferencing [21,36]. This may have been due to poor connections and technical quality [36,46], but also with embarrassment, feeling uncomfortable in front of a camera, and concern about confidentiality in the VC group [21,36]. In some of the later trials, on the other hand, patients in the VC group were more satisfied with communication [35,38]. This was attributed to patients' positive perceptions of quality of care due to the use of technology [35], and to patients' preference to receive care that is convenient and saves time by avoiding travel and reducing costs [35,38,46].

Indeed, patient-related costs were generally lower using videoconferencing, which was mainly related to saving costs of time, transportation, and missed work. Total costs, however, appear to be higher, especially when the patient was accompanied by a general practitioner. However, costs of videoconferencing, e.g. equipment and internet connections, will likely decrease over time.

4.1.2. VC compared to TC

The advantages patients perceived may be due to improved objective assessment and resolution of family concerns, or by reassurance provided by having visual contact during the VC [28,29]. Physicians may benefit from visual assessment of the patient, like evaluation of well-being, respiratory rate and wound integrity [29]. Furthermore, facial expressions can be observed and emotions can be seen [8].

4.1.3. WM compared to FF and TC

One of the possible reasons for greater satisfaction with web messaging as compared to face-to-face or telephone contacts appears to be convenience for the patient: it saves patients a telephone call or a clinic visit, and messages can be sent at all times [39]. Besides, the portal may reduce barriers to communication, with patients raising more sensitive issues [9,39].

4.1.4. Limitations of this study

Most of the included studies had a small number of participants. Thus, they may not have been able to detect significant differences, but important differences should have been found.

Outcome measures were very heterogeneous. The trials used different questionnaires to measure patient satisfaction and measured different health outcomes. These results are therefore hard to compare, and could not be used for meta-analyses.

E-consulting was conducted with a wide range of attending healthcare professionals, which made cost comparisons difficult. Furthermore, travel distances – which are highly related to patient costs – differed greatly between the countries where trials were conducted. This may have a large influence on the cost-effectiveness in various countries.

Finally, half of the included trials was performed more than a decade ago. Given the rapid developments in digital communication, studies may nowadays provide different outcomes, e.g. regarding costs and participants' experiences.

4.2. Conclusion

A total of 21 trials of a fairly good methodological quality were found that compared videoconferencing, web-messaging, telephone consulting and face-to-face contacts in a clinical specialist setting.

Based on the available evidence we can conclude that physicians are not satisfied with videoconferencing compared to face-to-face consultations, which is probably related to the inability to perform physical examination. This may make follow-up consultations more suitable for videoconferencing than initial consultations. The results of videoconferencing and web-messaging compared to telephone consultations were mainly positive, especially regarding to patient-related outcomes, although the number of studies in this area is still limited.

4.3. Practice implications

From earlier literature, we know e-consulting is feasible [7]. Based on the findings in this systematic review, we can cautiously provide recommendations for practice. We would not recommend e-consulting as a replacement for the first diagnostic specialist consultation, especially in cases where a physician's diagnosis and treatment recommendations heavily rely on physical examination. In follow-up consultations, however, e-consulting may be a good alternative for a traditional consultation, especially when travel distances or efforts for the patient are high. The scarcity of the literature on this topic, particularly regarding telephonic consultation and web-messaging, warrants more research in these areas to reach a definite conclusion. Also the rapid developments in digital communication and electronic (patient) data storage will facilitate e-consulting and therefore call for further research. Further research should also address whether and how the various options for e-consulting, and which of their characteristics, affect the underlying patient-provider communication process. In particular it would be interesting to appreciate whether e-consulting requires specific communication skills, and whether the different setting may offer patients a safer means of communication, e.g. reducing barriers to ask questions, share emotions and be open about their health. Currently available evidence indicates that especially replacing telephone consultations with videoconferencing consultations or web-messaging may improve patient, physician and cost outcomes.

5. Conflict of interest

The authors declare no conflicts of interest.

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Appendix 1. Literature search in Pubmed

Pubmed search

((randomized controlled trial[pt] OR controlled clinical trial [pt]) OR drug therapy[mesh] OR (random*[tiab] OR placebo[tiab] OR trial[tiab] OR groups[tiab])) AND

("Remote consultation"[Mesh] OR remote consult*[tiab] OR electronic consult*[tiab] OR e-consult*[tiab] OR "Electronic Mail"[Mesh] OR electronic mail*[tiab] OR e-mail*[ti] OR "Video-conferencing"[Mesh] OR videoconferenc*[tiab] OR videoconsult* [tiab] OR web-based consultation*[tiab] OR patient portal*[tiab] OR electronic communication*[tiab] OR telemedicine[ti])

AND

("Physician–patient relations"[Mesh] OR physician-patient relation*[tiab] OR professional–patient relation*[tiab])

OR

("Consumer satisfaction"[Mesh] OR consumer satisfaction* [tiab] OR patient satisfaction*[tiab] OR "Attitude of Health Personnel"[Mesh] OR attitude of health personnel*[tiab])

OR

("Costs and Cost Analysis"[Mesh] OR costs and cost analys* [tiab] OR costs analys*[tiab] OR cost-benefit analys*[tiab] OR "Health Care Costs"[Mesh] OR health care cost*[tiab] OR costs [tiab])

OR

("Time Factors"[Mesh] OR time factor*[tiab])

NOT

("General Practitioners"[Mesh] OR "General Practice"[Mesh] OR "Primary Health Care"[Mesh] OR "Monitoring, Physiologic"[Mesh] OR monitor*[ti] OR "Education"[Mesh] OR "Psychotherapy"[Mesh] OR "Telepathology"[Mesh] OR "Teleradiology"[Mesh] OR "Telemetry"[Mesh] OR dentist*[tiab] OR teleophthalmolog*[tiab])

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