Northumbria Research Link

Citation: Mikkonen, Kristina, Yamakawa, Miyae, Tomietto, Marco, Tuomikoski, Anna-Maria, Utsumi, Momoe, Jarva, Erika, Kääriäinen, Maria and Oikarinen, Anne (2023) Randomised controlled trials addressing how the clinical application of information and communication technology impacts the quality of patient care—A systematic review and meta-analysis. Journal of Clinical Nursing, 32 (13-14). pp. 3295-3314. ISSN 0962-1067

Published by: Wiley-Blackwell

URL: https://doi.org/10.1111/jocn.16448 <https://doi.org/10.1111/jocn.16448>

This version was downloaded from Northumbria Research Link: https://nrl.northumbria.ac.uk/id/eprint/49572/

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: http://nrl.northumbria.ac.uk/policies.html

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

Northumbria University NEWCASTLE

University Library

Title Page (with author details and affiliations)
Click here to access/download;Title Page (with author details and affiliations);Title page.docx

**Title**: Randomized control trials to improve the quality of patient care by clinical applications of information and communication technology (ICT) – a systematic review and meta-analysis

**Authors**: Mikkonen K., Yamakawa M., Tomietto M., Tuomikoski AM., Utsumi M., Jarva E., Kääriäinen M., Oikarinen A.

**Authors' affiliations:**

First author: Kristina Mikkonen (corresponding author), Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; Kristina.mikkonen@oulu.fi; ORCID: https://orcid.org/0000-0002-4355-3428; Twitter: @Kristinamikkon

Mailing address:

Research Unit of Nursing Science and Health Management
Faculty of Medicine
P.O. Box 5000
FI- 90014 University of Oulu
Tel.: +358 40 4113913
Email: kristina.mikkonen@oulu.fi

Second author: Miyae Yamakawa (corresponding-author), Department of Evidence-Based Clinical Nursing, Division of Health Sciences, Graduate School of Medicine, Osaka University, Asakayama General Hospital; miyatabu@sahs.med.osaka-u.ac.jp

Mailing Address of corresponding author:

1-7 Yamadaoka Suita city, Osaka, Japan. 565-0871

Third author: Marco Tomietto, Department of Nursing, Midwifery and Healthcare, Faculty of Health and Life Sciences, Northumbria University, Newcastle Upon Tyne, UK. Research Unit of Nursing Science and Health Management, University of Oulu, Oulu, Finland. Email: marco.tomietto@northumbria.ac.uk; Twitter: @marco_tomietto; ORCID: https://orcid.org/0000-0002-3813-1490

Fourth author: Anna-Maria Tuomikoski, University of Applied Science of Oulu; The Finnish Centre for Evidence-Based Health Care: A Joanna Briggs Institute Centre of Excellence, Helsinki, Finland; annukka.tuomikoski@oamk.fi

Fifth author: Momoe Utsumi, Department of Evidence-Based Clinical Nursing, Division of Health Sciences, Graduate School of Medicine, Osaka University; utsumi@sahs.med.osaka-u.ac.jp

Sixth author: Erika Jarva, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; erika.jarva@oulu.fi

Seventh author: Maria Kääriäinen, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; maria.kaariainen@oulu.fi

Eighth author: Anne Oikarinen, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; anne.oikarinen@oulu.fi

**Author contributions**

| Criteria | Author Initials |
|---|---|
| Made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; | KM, MY, MT, AMT, MU, EJ, MK, AO |
| Involved in drafting the manuscript or revising it critically for important intellectual content; | KM, MY, MT, AMT, MU, EJ, MK, AO |
| Given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content; | KM, MY, MT, AMT, MU, EJ, MK, AO |
| Agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. | KM, MY, MT, AMT, MU, EJ, MK, AO |

- **Acknowledgments:**

We would like to thank and acknowledge library specialist Mrs. Sirpa Grekula for her involvement in this review to ensure the quality of the search strategy. Additionally, we would like to acknowledge Sees- Editing Ltd (http://www.seesediting.co.uk) service for improving the language and helping us to communicate our findings to readers of the journal.

- **Conflict of interests:**

The authors have no conflict of interests to declare.

- **Funding:**

No funding.

**IJNS author checklist V 3.0 (August 2021)**

| **IJNS AUTHOR CHECKLIST:** You will need to submit a completed version of this checklist plus the checklist from any relevant reporting guideline along with your paper. It is intended to help you to make sure your manuscript meets some basic requirements for the journal. It should be read in conjunction with the guide for authors, and is not a replacement for it. Additionally, to help ensure your manuscript is compliant, a manuscript template is available (linked from the guide for authors). | | Insert a tick, page number(s) or give detail |
|---|---|---|
| **Word count** | The paper is 7000 words or fewer | 6870 including references |
| **Abbreviations** | No abbreviations (including acronyms or "initialisms") are used anywhere in the paper (other than SI units, common statistical terms and other limited exceptions identified in the guide for authors). | only commonly used units |
| **Reporting guideline** | The paper has been prepared using a recognized reporting guideline appropriate to the method / type of paper. Please consult https://www.equator-network.org/ to help select an appropriate guide [research and reviews only]. **Please identify the reporting guideline used in the box to the right.** | yes PRISMA |
| | A checklist linked to the reporting guideline should be completed and uploaded as part of your submission. *If there is no applicable guideline, upload a blank file with the words 'not applicable' when requested at submission.* | |
| | Do not refer to *reporting* guidelines as a source for your *methods.* (i.e. the manuscript should not contain a statement such as "This trial was conducted according tothe CONSORT guideline"**.** | |
| **Title** | The title is in the format 'Topic / question: design/type of paper' [not applicable to letters / editorials] | YES |
| **Abstract** | A **structured** abstract of no more than 400 words (+ optional tweetable abstract) appropriate to the design of the study is included **at the beginning** of your paper. [not applicable to letters / editorials] | YES |
| | No references are cited in the title / abstract. | |
| **Study registration** | Give any study registration number (e.g. ISRCTN), the registration date and date the first participant was recruited (if relevant) in both the **abstract and in the body** of the paper or state 'not registered'[*1]. | Registration blinded for review, added to title page |
| | For clinical trials (as defined by the ICMJE), registration occurred before the first participant was recruited. | |
| **Key words** | Give between four and ten key words that identify the paper's subject, purpose, method and focus. Use the Medical Subject Headings (MeSH®) or Cumulative Index to Nursing and Allied Health (CINAHL) terms (see http://www.nlm.nih.gov/mesh/meshhome.html). | YES |
| **Contribution of the Paper statements** | Under the headings "What is already known" and "What this paper adds" give 2-3 (maximum) short, single sentence bullet points (each), summarising key contributions. No references are to be cited. [not applicable to letters / editorials] | YES |
| **Multiple publications** | Other published and in press accounts of the study from which data in this paper originate are referred to in the paper (author details can be redacted for review if desired) and the relationship between this and other publications from the same study is made clear in the paper. see below] | NA |
| | Full references to any such publications are provided for editors at the end of this checklist. | |
| **Ethical approval and informed consent** | Details of the ethical approval, including the body that granted it and reference number are included at **the end of you methods section** [**r**esearch papers only]. This should include confirmation of informed consent by participants and / or elaboration of the basis for any exception. | NA |
| **Statistical reporting** | Confidence intervals can be used as the basis for inference without reference to statistical significance & 'p-values'. ***If*** reporting statistical significance tests: | YES |

[1] While the journal endeavours to maintain a double blind-review process as far as possible, we give priority to transparent reporting and prospective registration. As it is important that reviewers are able to verify that reporting is complete and consistent with protocols to avoid (for example) selective outcome reporting or undocumented protocol changes, authors are not permitted to redact registration numbers for review.

| | | |
|---|---|---|
| | • Exact p-values are stated to an appropriate degree of precision (typically no more than 3 decimal points). | YES |
| | • The corresponding measure of effect or association and confidence interval are reported with all significance tests (including in the abstract). | YES |
| | • The term 'statistically significant' (not just 'significant') is used to refer to the result of tests. | YES |
| | • p-values>0.05 are not used to conclude that there is no effect/association. | YES |
| **Qualitative findings** | Where verbal data is used always include key quotations to support inferences and give meaningful (anonymous) individual subject identifiers for each quotation used. | NA |
| **Funding sources** | State sources of funding and the role of funders in the conduct of the research or include a statement 'no external funding' **at the end of the paper**. | YES |
| **Conflict of interests** | State any actual or potential conflicts of interest in a section **at the end of the paper**. If there are none, include a statement "Conflicts of interest: none". The substance of this declaration should match details provided in file(s) uploaded at submission. | YES, title page |

**Please provide below references for any other publications based on data from the same study (including papers using data from the same participants reporting other outcomes or time points) and describe the relationship to the current study.**

*Please provide full references. To assist editors, upload copies of papers where the abstract / full text is not readily available (including those under review elsewhere, which will be treated in strict confidence). Where your paper is based on analysis of a publically available data set or is part of a series of publications from a large cohort study (or similar) you can be selective in the references you provide and give a more general account of how this paper relates to others but it is essential that editors are able to verify the unique contribution of the paper you are submitting.*

*If unsure about declarations we encourage you to err on the side of openness and suggest you consult Norman, I., Griffiths, P., 2008. Duplicate publication and 'salami slicing': Ethical issues and practical solutions. International Journal of Nursing Studies 45 (9), 1257-1260.*

**We do NOT require you to use this space to copy your paper's reference list.**

*© Peter Griffiths, Ian Norman 2021*
*This work is licensed under a Creative Commons Attribution 4.0 International License.*

# PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a systematic review. | title page |
| **ABSTRACT** | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | ok |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | 2-3 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | 4 |
| **METHODS** | | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | 4 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | 4-5 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | 4-5 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | 5 |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | 4-5 |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | 4 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | 4 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | 5-6 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | 6 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | 6 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | 6 |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | 6 |

# PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **RESULTS** | | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | flow diagram |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | |
| Study characteristics | 17 | Cite each included study and present its characteristics. | 7 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | figures |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | 8 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | 7 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | 8-9 |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | 9 |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | 5-6 |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | figure |
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | 9-11 |
| | 23b | Discuss any limitations of the evidence included in the review. | 11-12 |
| | 23c | Discuss any limitations of the review processes used. | 11-12 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | 12 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | 4 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | title page |
| Competing interests | 26 | Declare any competing interests of review authors. | title page |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | NA |

*From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Manuscript (without Author Details)
Click here to access/download;Manuscript (without Author Details);Manuscript clean.docx
Click here to view linked References



# Title: Randomized controlled trials addressing how the clinical application of information and communication technology impacts the quality of patient care – a systematic review and meta-analysis

## Abstract:

Background: The number of people with chronic and long-term conditions has increased during recent decades; this has been addressed by leveraging information and communication technology to develop new self-care solutions. However, many of the developed technological solutions have not been tested in terms of impact(s) on patients' quality of life.

Objectives: This systematic review aimed to identify the current best evidence on the types of interventions that have been developed to improve care quality through the clinical application of information and communication technology in specialised, primary, or home care.

Design: A systematic review, including a meta-analysis, was conducted according to the JBI Manual for Evidence Synthesis guidelines.

Data sources: Relevant data were identified from four electronic databases: CINAHL; PUBMED; SCOPUS; and MEDIC.

Review methods: The eligibility criteria were formatted according to PICOS inclusion and exclusion criteria. At least two researchers performed the screening process separately, after which they agreed upon the results. The Cochrane Risk of Bias Assessment and JBI Critical Appraisal tool for randomized controlled studies was used to assess research quality. Data were extracted and a meta-analysis was performed if the research met quantitative requirements.

Results: Of the 528 initially identified studies, 11 studies were chosen for final data synthesis. All of the interventions integrated information and communication technology solutions into patient care to improve patient-centred care. Patients across all of the trials were educated through direct training, the provision of information relevant to their disease, or one-to-one educational coaching. The interventions included various interactions, e.g., health care expert visits and support, support provided by peers, group or family members. These interactions occurred through face-to-face coaching, virtual human coaching or virtual coaching that relied on an algorithm. The performed meta-analysis included six of the 11 identified studies, with one study demonstrating a significant post-intervention effect on patients' quality of care and quality of life. This specific intervention focussed on the efficacy of a management system for chronic liver failure patients which integrated telephone and delivery system designs, interaction with health care experts, family involvement and face-to-face coaching, patient training, and educational coaching.

Conclusions: The presented results suggest that information and communication technology based care should be developed in collaboration with health care professionals, involve patients in decision-making, and combine information and communication technology solutions with human interaction and coaching. Information and communication technology education was found to be essential to the success of an intervention.

Keywords: Randomized controlled trials, information and communication technology, ICT, quality of patient care, systematic review, meta-analysis

### What is already known about the topic?

- The increasing prevalence of chronic diseases, when considered together with decreasing numbers of health care staff, will challenge health care systems in the future.
- The WHO has stated that digitalised health care can improve patients' access to health services, reduce the burden of travel, and potentially reduce inequalities in health care.
- Versatile ICT solutions have been developed for patient-centred care, but the effectiveness of these solutions has not been adequately measured in the health care domain.

### What this paper adds

- The integration of ICT into patient-centred care requires human interactions and educational coaching.
- Educating both patients and health care professionals is essential to the success of ICT solutions.
- Any developed intervention should include measurements related to health care staff and other stakeholders in addition to patient-centric outcomes.
- Digital literacy measurements could be integrated into future studies to avoid bias in measurements and the reporting of results.

## Introduction

In recent years, patients with long-term/chronic illnesses have become more common and diverse (World Health Organization & United Nations Children's Fund, 2020). This can be explained by advances in medicine, which have enabled people with chronic and long-term conditions to live longer, as well as better cope with their ailment(s).

Furthermore, the digital age – which involves the rapid shift from 3G and 4G to 5G networks – has enriched various dimensions of health care services (Ting, et al., 2020). For example, patients' daily

lives have been improved by numerous technologies, e.g., monitoring devices to help patients understand their own physical condition, learning tools, solutions for communicating with health care professionals, as well as assisted living and robotics to reduce the burden of care on health care providers. New technological solutions can also substantially improve the way nurses work (Day & Beard, 2019). Electronic health records are being developed to manage workloads and to facilitate the efficient sharing of medical information between health care providers and stakeholders; these types of solutions will improve care by enabling the capture of detailed patient information and eliminating the potential for human error (Roehrs, et al., 2017; Symonts et al., 2019).

In this way, information communication technology (ICT) is highly relevant to the health care sector. ICT technology has developed rapidly due to the dedication of innovative engineers and companies, yet there is little evidence on how broadly these technologies have been adopted in health care.

In this ICT context, two relevant literature reviews exist. First, Koivunen & Saranto (2018) published a qualitative review which synthesised nursing professionals' experiences of which factors are facilitators and barriers to the use of online telehealth services. This systematic review scrutinized 25 articles and found that nurses' skills and attitudes are barriers to the implementation of telemedicine. Moreover, the analysed literature revealed that the shift from face-to-face nursing to the use of telemedicine will require local consensus and further professional discussions on how the change will be accepted and implemented (Koivunen & Saranto, 2018).

The field of digital technologies for care has already been explored in terms of acceptability, effectiveness and efficiency, with a recent scoping review clarifying how different solutions have been used in various target settings, target groups, and areas of support (Krick et al. 2019). This scoping review – which included more than 700 references published up until 2018 – comprehensively presented the extant evidence. However, the current evidence base is not sufficiently detailed about how specific innovations can improve the quality of care and/or nurses' clinical work. In addition, because the field of ICT is progressing at an incredibly rapid rate, many studies have reported results that are no longer relevant based on the technological developments that occurred in between the research process and the publication of the findings. Therefore, there is a need for another systematic review on the topic that includes the most recent evidence.

While conducting this systematic review, we focused on clarifying the extent to which ICT solutions can improve the quality of nursing care and examining whether ICT solutions can complement nurses' work with patients. As for nurses' acceptance of ICT solutions, the prerequisite is that the solution undoubtedly improves the quality of nursing care. We feel that the results of this systematic

review can benefit nurses by creating an atmosphere and forum for dialogue about relevant ICT solutions.

# Methods

## Study aim and research questions

The aim of this systematic review was to identify the current best evidence on the types of interventions that have been developed to improve care quality by the clinical application of ICT solutions in specialized, primary, or home care. The research was guided by the following study questions:

1) What types of interventions have been designed to improve the quality of specialised, primary, or home care via the use of ICT solutions?

2) How have these interventions, i.e., the clinical implementation of ICT solutions, affected the quality of specialised, primary, or home care?

## Search strategy

The systematic review was conducted according to JBI Manual for Evidence Synthesis guidelines (Aromataris and Munn, 2020), and the protocol was registered in PROSPERO 2020 (author-blinded). The PRISMA statement for systematic reviews and meta-analyses was followed to ensure that the findings were reported in a rigorous and transparent manner (Page et al. 2021). The eligibility criteria were formatted according to PICOS inclusion and exclusion criteria (see Table 1). The population (P) included patients involved in specialised, primary, or home care, interventions (I) of interest included the clinical application of ICT with the underlying goal of enhancing patient-centred care and self-management, comparison (C) mandated that the research had to include a control group that had not received the tested ICT intervention, and outcome (O) represented the quality of patient-centred care through at least one of the following outcomes: maintaining patient autonomy; empowering self-care; individualised and relationship-based care; shared decision-making; and creating a homelike environment. In addition, study type (S) included randomised controlled trials (RCTs) that were peer-reviewed and published between 2010-2020 in English, Finnish, or Japanese. Hence, non peer-reviewed publications, studies that did not follow a RCT study design, and/or were published prior to 2010 were excluded. The combination of keywords included “patient or client or user or consumer or customer” AND “specialized care or primary care or home care” AND “Information and communication technology or ICT” AND “Quality of patient-centred care” AND “Intervention or randomized/randomised controlled trial or experimental or trail study”. MESH terms

and the required acronyms were applied to develop the most inclusive search strategy. A library specialist from the [redacted], was consulted during the development and pilot testing of the search process. The precise searches developed for each database are shown in Supplementary File 1. A total of four electronic databases were screened for relevant data: CINAHL (EBSCO); PUBMED (Medline); SCOPUS; and MEDIC. Any instances of grey literature were not included in the review.

## Study selection

The selection of relevant research was conducted by four researchers (authors-blinded), who individually screened the identified studies by title, abstract, and full-text, after which they discussed – and agreed upon – the results together. The researchers used Covidence 2020 (Veritas Health Innovation, Melbourne, Australia) when importing and screening data. A total of 528 studies were identified during the literature search, with 455 remaining after duplicate removal (n=73). The studies were then assessed based on title and abstract (n=455), with 402 studies excluded. The remaining studies (n=53) were assessed based on the full-text article (n=53), after which 41 studies were excluded for the following reasons: no control group (n=1); intervention was not relevant (n=1); outcomes were not relevant (n=15); study design was not relevant (n=24). Eventually, 11 eligible studies were chosen for the risk of bias assessment and final synthesis. The flow chart of the study selection process, which was conducted according to PRISMA guidance, is presented in Figure 1.

## Assessment of risk of bias and study quality

During the next phase of the study progress, four researchers (authors-blinded) assessed the risk of bias and study quality. This was first done separately, after which all of the researchers discussed, and agreed upon, the results. The quality of the 11 chosen studies was assessed with seven criteria of the Cochrane Risk of Bias Assessment (Higgins et al. 2011): random sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessors; incomplete outcome data; selective outcome reporting; and other sources of bias (see Figure 2). For each of these criteria, a study could receive a high, low or unclear score. Out of the 11 identified studies, only one study (Chan et al. 2014) demonstrated low scores across all seven criteria. The article by Zhu et al. (2018) demonstrated high or unclear risk of bias scores for most criteria. On the other hand, most studies had an unclear risk of bias concerning incomplete outcome data and selective outcome reporting (Chan et al. 2014, Jansen et al. 2017, Khanna et al. 2019, Kravitz et al. 2018, Tung et al. 2019, Tutino et al. 2017, Waki et al. 2015, Wigg et al. 2013). The criteria '*blinding of participants and personnel'* and '*blinding of outcome assessors'* most commonly showed a high risk of bias. Only Chan et al. (2014), Hanberger et al. (2013) and Zhu et al. (2018) reported the blinding procedures in

the RCT methodologies. Additionally, a checklist for randomized controlled trials in a Critical Appraisal tool (JBI Systematic Reviews) was used to assess the quality of the identified studies (Tufanaru et al. 2020). Each study was assessed according to 13 critical statements related to RCT quality, validity and reliability, with the researchers selecting 'Yes', 'No' or 'Unclear' as the answer (see Supplementary File 2). In this assessment, Chan et al. (2014) scored 100%, Kravitz et al. (2018) scored 92%, Wigg et al. (2015) scored 85%, while the articles by Hanberger et al. (2013), Khanna et al. (2019), Tutino et al. (2017) and Zhu et al. (2018) all had scores of 77%. The remaining studies scored between 54-70% (Figures 2-3).

## Data extraction and meta-analysis

The following data were extracted from the 11 chosen RCT studies: study identification; study objective; population; intervention; comparison; outcome; measurements; and key findings (see Table 2). During the meta-analysis, the overall effect and heterogeneity indexes were calculated in the "metaan" package in Stata v12 (StataCorp., 2011; Kontopantelis & Reeves, 2010). The random-effects models incorporated the heterogeneity estimation in the weighting (Harris et al., 2008) as recommended by Veroniki et al. (2019) and Kontopantelis & Reeves (2010). The overall effect was calculated with the Profile Likelihood (PL) random-effects model (Kontopantelis & Reeves, 2010).

Heterogeneity was represented by three indices: the Q-statistic in the $\chi^2$ distribution and the corresponding p-value (Hoaglin, 2016); the $I^2$ statistic; and the $\tau^2$ statistic (Higgins et al., 2019). A significant p-value for the Q-statistic indicated heterogeneity bias. However, heterogeneity was further assessed by calculating the I2 statistic because the Q-statistic should be interpreted with caution when the p-value does not show statistical significance (Higgins et al., 2019). According to the Cochrane standards, heterogeneity is not important if $I^2$ is between 0-40%, moderate if $I^2$ is between 30-60%, substantial if $I^2$ is between 50-90%, and considerable if $I^2$ is between 75-100% (Higgins et al., 2019). The $\tau^2$ statistic was also determined to estimate the amount of variation between the included studies. Studies characterised by a high degree of heterogeneity in the measurement of primary outcomes, i.e., to the extent that the results could not be pooled for the meta-analysis, were summarised narratively.

The funnel plot graphic was adopted to assess publication bias. A funnel plot provides a visual representation of the treatment effects reported in a set of studies; in cases in which the funnel plot has an asymmetrical shape, the meta-analysis may overestimate the effect of a studied treatment and, therefore, publication bias exists (Sterne & Harbord, 2004). The "metafunnel" package was used to generate the funnel plot in Stata v12 (StataCorp., 2011; Sterne & Harbord, 2004).

# Results

## Study characteristics

Most of the 11 identified studies were conducted in Asia, e.g., in Hong Kong (Chan et al. 2014), China (Tutino et al. 2017, Zhu et al. 2018), and Japan (Waki et al. 2015). The other RCT studies were conducted in the United States (Khanna et al. 2019, Kravitz et al. 2018, Tung et al. 2019), Australia (Wigg et al. 2013), and Europe, e.g., Sweden (Hanberger et al. 2013), Germany (Hermann et al. 2012), and the Netherlands (Jansen et al. 2017). The identified RCTs included a total of 6 128 participants (a minimum of 30 and a maximum of 3 586), of which 3 149 participants were in interventional groups and 2 979 were in control groups. The participants represented patients with type 2 diabetes mellitus (Chan et al. 2014, Hermann et al. 2012, Tutino et al. 2017, Waki et al. 2015), type 1 diabetes mellitus (Hanberger et al. 2013), cancer of the head and neck (Jansen et al. 2017), systemic sclerosis (Khanna et al 2019), chronic musculoskeletal pain (Kravitz et al. 2018), chronic liver failure (Wigg et al. 2013), and hypertension (Zhu et al. 2018), along with general primary care attendees (Tung et al. 2019).

## Types of interventions

All of the interventions included ICT utilisation to improve the quality of patient-centred care (see Table 3). The clinical application of ICT included the telephone (Chan et al. 2014, Khanna et al. 2019, Kravitz et al. 2018, Tung et al. 2019, Tutino et al. 2017, Wigg et al. 2013, Zhu et al. 2018), a web portal (Chan et al. 2014, Hanberger et al. 2013, Hermanns et al. 2017, Jansen et al. 2017, Khanna et al. 2019, Tutino et al 2017), interactive online educational resources (e.g. games and simulations) (Hanberger et al. 2013, Hermanns et al. 2017), mobile health applications (Kravitz et al. 2018, Waki et al. 2015), the utilisation of electronic health records (Tung et al. 2017) and delivery system design (e.g. algorithms) (Tung et al. 2019, Tutino et al. 2017, Waki et al. 2015, Wigg et al. 2013, Zhu et al. 2018). All of the studies, with the exception of one (Tung et al. 2019), reported that the patient ICT support system involved various interactions during the intervention. These interactions included visits and support from health care experts (e.g., nurse, inter-professional team, doctor), along with support from peers, groups, or family members. These interactions occurred via face-to-face coaching, virtual human coaching, or virtual coaching based on an algorithm. Patients in all of the RCT studies were educated through direct training, information and educational resources relevant to their disease, or one-to-one educational coaching. The research presented by Hermanns et al. (2013) and Khanna et al. (2019) combined all three of these methods in the described intervention.

## Outcome measures

All of the studies collected baseline measurements, with the length of the investigated intervention varying; the shortest duration was three months (Tung et al. 2019, Waki et al. 2015), while the longest duration was 24 months (Hanberger et al. 2013), with the other studies describing interventions which lasted six (Hermann et al. 2012), eight (Khanna et al. 2019, Zhu et al. 2018), or 12 months (Chan et al. 2014, Jansen et al. 2017, Kravitz et al. 2018, Tutino et al. 2017, Wigg et al. 2013). Of the 11 identified studies, six included measurements of clinical variables, e.g., haemoglobin, blood glucose, cholesterol, body weight, blood pressure (Chan et al. 2014, Hanberger et al. 2013, Hermann et al. 2012, Tutino et al. 2017, Waki et al. 2015, Zhu et al. 2018). In terms of the quality of patient-centred care, the described interventions measured the quality of life or care, self-efficacy or self-management. Quality of life was measured using the following instruments: EQ-5D Europol for Quality of Life (Chan et al. 2014, Jansen et al. 2017, Khanna et al. 2019); SF-36 Health-Related Quality of Life (Hermanns et al. 2012); DISABKIDS Quality of Life for Children (Hanberger et al. 2013); and Quality of Life Chronic Liver Disease Questionnaire (Wigg et al. 2013). Quality of care was measured using the following instruments: Quality of Care (Wigg et al. 2013); and Quality of Care from the Patient's Perspective (QPP) questionnaire (Hanberger et al. 2013). Self-efficacy was measured using the following instruments: DES-20 Diabetes Empowerment Scale for Self-efficacy (Chan et al. 2014); Chinese version of the Short-Form Chronic Disease Self-Efficacy Scale (Zhu et al. 2018); and PROMISE Self-efficacy scale (Khanna et al. 2019, Kravitz et al. 2018). Self-care or self-management was measured using the following instruments: SDSCA-14 Self-care Activities (Chan et al. 2014); SWE-DES-SF-10 Swedish Diabetes Empowerment Scale (Hanberger et al. 2013); Self-Care Activities scale (Hermanns et al. 2012); Patient Activation Measure (PAM) (Khanna et al. 2019); self-made items measuring self-management (Tung et al. 2019); and Compliance to Self-care (Waki et al. 2017).

## Effects of interventions based on a meta-analysis

Of the 11 studies included in this systematic review, six were eligible for a quantitative synthesis in the meta-analysis (Khanna et al., 2019; Kravitz et al., 2018; Jansen et al., 2017; Chan et al., 2014; Wigg et al., 2013; Hermanns et al., 2012). The other studies did not include the information required to perform a quantitative synthesis (e.g., summative mean scores, standard deviation or confidence intervals). The overall effect calculated in the meta-analysis supports that the tested interventions had a positive effect on the quality of care (PL=0.33); however, the confidence interval of this result (95% CI= -00.7-0.80) does not allow us to exclude a null effect. The forest plot (Figure 4) illustrates the effects reported in each study and the overall effect calculated in the meta-analysis with the associated

95% CIs (see Figure 4). According to the meta-analysis of six studies, only the intervention described by Wigg et al. (2013) significantly influenced patients' quality of care and quality of life. The effect size reported in the study was rather large, 1.50 (CI= 0.90-2.10). The intervention described by Wigg et al. (2013) focussed on the efficacy of a chronic disease management approach for patients with chronic liver failure which integrated a telephone and delivery system, interaction with health care experts, family involvement and face-to-face coaching, patient training and educational coaching.

The results of the meta-analysis revealed that the included studies included a certain degree of heterogeneity. More specifically, the Q-statistic was statistically significant (Q=28.17; df=5, $p<0.001$) while $I^2$ was 88.04% (95%CI=76.44-93.92); these results indicate a considerable level of heterogeneity. The $\tau^2$ statistic was 0.155 (95%CI=0.00-0.85). The funnel plot showed a symmetrical pattern; hence, the meta-analysis was not affected by publication bias and the results do not overestimate the effects of the described treatments (see Figure 5).

## Discussion

This review aimed to identify the current best evidence concerning which types of interventions have been developed to improve the quality of patient care by the application of ICT solutions in specialised, primary, or home care. The most important finding, which was revealed by the meta-analysis, was that only one study achieved a significant post-intervention effect on the quality of patient care and quality of life (Wigg et al. 2013). This aspect of health care has received prior research attention, as numerous earlier studies have reported how long-term digital care-paths impact the quality of life among patients with long-term illnesses (Chan et al. 2007, Cullington et al. 2018, Ryhänen et al. 2013, Wagenaar et al. 2018). The interventional study by Wigg et al. (2013) focused on integrated, multidimensional care in which ICT systems were complemented with human interactions (including health care experts and family involvement) along with patient training and education.

This systematic review provided mixed findings regarding whether the clinical application of ICT solutions improves the quality of life among patients in empowering self-care. The identified studies demonstrated that the clinical application of ICT solutions was effective in terms of behavioural parameters, including medication adherence (Herman et al 2012), along with glycaemic control (Chan et al. 2014, Tutino et al. 2017, Waki et al. 2015), self-care behaviour (Chan et al. 2014, Waki et al. 2015, Zhu et al. 2018), LDL cholesterol levels (Tutino et al. 2017), and blood pressure management (Zhu et al. 2018). Earlier studies have suggested that digitalised care pathways do not necessarily result in better self-care among patients with long-term illnesses (e.g. Mata et al. 2020). This was also

shown to hold true for interventions that included a long care relationship. Therefore, the current systematic review does not provide clear and consistent evidence that ICT interventions exert positive effects on a patient's quality of life in empowering self-care (Ammenwerth et al. 2019). This agrees with was was reported in another recent review, as Damant et al. (2017) concluded that ICT use in older patient populations does not improve quality of life.

Earlier reviews have also reported mixed results on the impact of digital patient portals (Carinini et al. 2021), digitalised care pathways (Neame et al. 2019; O'Connor et al 2016), and telemedicine interventions (Eze et al.2020) on the utilisation of health services as well as the quality and effectiveness of care. However, there is a lack of research into the quality of digitalised health care (Carinini et al. 2021). For example, there is previous evidence that patients are accepting of, and satisfied with, digitalised health care interventions, yet there are still notable barriers to the wider use of innovative solutions (Eze et al 2020). The digitalisation of health care can help strengthen relationships and communication between patients and health care professionals, empower the patient's well-being, and help health care professionals and patients make better decisions (ElKefi et al. 2021); however, the presented results indicate that – at this point – human interaction cannot be replaced by digital technology.

It is important to recognise that a patient's quality of life was measured using multiple instruments in this systematic review; furthermore, the impact on quality of life may differ depending on the characteristics of a specific disease, such as diabetes mellitus or chronic liver dysfunction. The subjects in this study did not noticeably vary in terms of age and, as such, their acceptance of ICT solutions did not strongly vary. However, it is possible that there are individual differences in ICT literacy. The technology acceptance model (TAM) is commonly used to gauge technology adoption in patients, and a systematic review of 134 studies found that the concepts of subjective norms and self-efficacy, as well as compatibility, experience, training, anxiety, habit, and facilitators, promote TAM (Rahimi, 2018). However, none of the studies included in the present review mentioned these factors. The results of the meta-analysis could be expected to change if these potential clinical heterogeneities could be minimised.

It is also necessary to consider whether the level of ICT literacy and the use of ICT can improve a patient's quality of life, since the quality of life of patients who do not use ICT has not been taken into account. In other words, how compatible the applied ICT solution is with users' ICT literacy will determine the strength of the impact on quality of life.

Based on the results of the included interventional studies, a health care professional's competence in ICT use and delivery may have a large impact on how the patient experiences the potential benefits of the solution. According to a previous systematic review, sufficient digital health competence among staff members can ensure that patients receive high-quality care when ICT solutions are used during care delivery (Konttila et al. 2018). However, other studies have noted that health care professionals might lack the competence to motivate and advise patients in self-management (Kujala et al. 2018) or communicate through patient portals (Laukka et al. 2020). Moreover, previous research has concluded that the development of health care professionals' digital health competence requires systematic and individually-designed education (Nazeha et al. 2020). Additionally, organisational and collegial support (Jimenez et al. 2020, Konttila et al. 2018), as well as patient-friendly designs, are a starting point for the efficient use of ICT solutions by health care professionals (Lusigan et al. 2014).

The increasing prevalence of chronic diseases has led to considerable growth in health care costs (Boersma et al, 2020). This problem is not only restricted to high-income countries, but has been noticed on a global scale (Bommer et al, 2017: Hajat & Stein, 2018). The long progression of many chronic diseases means that prevention of severe illness and early detection of comorbidities are necessary. To achieve this, health care systems need solutions that adequately support self-management by patients and their families (Reynolds et al, 2018). The care for patients with chronic diseases needs to shift from the traditional focus on inpatient and outpatient care to community-based care interventions that are more in tune with patients' lifestyles (Stellefson et al, 2013). The studies included in this review investigated ICT-based care in situations when a patient was not admitted to a hospital or visited a clinic. The performed meta-analysis, which consisted of six studies, revealed that only one study achieved a significant post-intervention effect on care quality and the patient's quality of life (Wigg et al, 2013). Clearly, the impact of s-based care on a patient's quality of life is an area that warrants more research attention.

## Strengths and limitations

This paper provides an update to previous systematic reviews on the same topic, and widens the evidence base on the rapidly changing topic that is digital health. The findings of this systematic review are further supported by the results of a meta-analysis to enhance the strength of evidence on the topic. Nevertheless, the presented research was undoubtedly affected by certain limitations. First, our systematic review did not include some databases, such as PsycInfo, and even if we had included every relevant database it is still possible that some evidence would be overlooked. Second, the meta-

analytic approach could only be applied to six of the 11 identified studies due to partial quantitative reporting in five studies. As such, the presented findings suggest that the methodological quality of future studies on the topic could be improved; this would allow a more complete meta-analysis to be conducted. It should be noted that two studies included in the meta-analysis demonstrated risk of bias scores between 54% and 70%, even if they met the quantitative criteria for inclusion (Hermanns et al., 2012; Jansen et al., 2017); the risk of bias scores for the other studies were between 77% and 100%. Although most of the studies included in the meta-analysis reported a low risk of bias, the two studies with a higher risk of bias could have affected the overall effect size. Third, our systematic review and meta-analysis focussed on the effectiveness of clinical ICT applications in improving patients' quality of life across various clinical settings; focussing on a specific field of patient care could contribute to more targeted results. In this way, future studies could consider specific conditions (e.g., diabetes or oncological conditions) to enhance the evidence of how effective ICT interventions are at improving the patients' quality of life. When considered from a methodological perspective, this approach could also decrease the heterogeneity that was present in the meta-analytical synthesis.

## Conclusion

The increasing prevalence of chronic diseases and the decreasing number of health care staff will challenge health care systems in the future. According to the World Health Organization (WHO 2019), digitalised health care can improve patient access to health services, reduce travel costs, and potentially reduce inequalities in health care. However, digital solutions, for example, ICT-based care interventions, have shown mixed results on patients' quality of life. According to the presented results, we suggest that ICT-based care should be developed in collaboration with health care professionals, involve patients in decision-making, and combine technological solutions with human interaction and coaching. ICT education is essential, as our meta-analysis results found education to be an important element when ICT solutions are integrated into patient care. However, as only one of the six studies included in the meta-analysis showed that the ICT intervention exerted a significantly positive effect, more research into how ICT-based care can improve a patient's quality of life is needed. Future ICT-based interventions should also not only measure patient outcomes, but also determine how the intervention impacts health care staff and other stakeholders. Additionally, digital literacy measurements should be integrated into future studies to avoid bias in measurements and reported results.

## References


Ammenwerth, E., Schnell-Inderst, P., Hoerbst, A. (2012). The impact of electronic patient portals on patient care: a systematic review of controlled trials. Journal of Medical Internet Research, 14(6), e162. https://doi.org/10.2196/jmir.2238

Aromataris, E., Munn, Z. (Editors). (2020). JBI Manual for Evidence Synthesis. Adelaide, Australia: JBI. Available from: https://synthesismanual.jbi.global. https://doi.org/10.46658/JBIMES-20-01

Boersma, P., Black, L.I., Ward, B.W. (2020). Prevalence of multiple chronic conditions among US adults. Prev Chronic Dis., 7, E106. doi: 10.5888/pcd17.200130.

Bommer, C., Heesemann, E., Sagalova, V., Manne-Goehler, J., Atun, R., Bärnighausen, T., Vollmer, S. (2017). The global economic burden of diabetes in adults aged 20-79 years: a cost-of-illness study. Lancet Diabetes Endo., 5(6), 423–430. https://doi.org/10.1016/S2213-8587(17)30097-9

Carini,E., Villani, L., Pezzullo, AM., Gentili, A., Barbara, A., Ricciardi, W., Boccia, S. (2021). The Impact of Digital Patient Portals on Health Outcomes, System Efficiency, and Patient Attitudes: Updated Systematic Literature Review. J Med Internet Res, 23(9), e26189. doi: 10.2196/26189

Chan, J.C., Sui, Y., Oldenburg, B., Zhang, Y., Chung, H.H., Goggins, W., Au, S., Brown, N., Ozaki, R., Wong, R.Y., Ko, G.T., Fisher, E., & JADE and PEARL Project Team (2014). Effects of telephone-based peer support in patients with type 2 diabetes mellitus receiving integrated care: a randomized clinical trial. JAMA Intern Med., 174(6), 972–981. https://doi.org/10.1001/jamainternmed.2014.655

Chan, D.S., Callahan, C.W., Hatch-Pigott, V.B., Lawless, A., Proffitt, H.L., Manning, N.E., Schweikert, M., Malone, F.J. (2007). Internet-based home monitoring and education of children with asthma is comparable to ideal office-based care: results of a 1-year asthma in-home monitoring trial. Pediatrics, 119(3), 569-578.

Cullington, H., Kitterick, P., Weal, M., Margol-Gromada, M. (2018). Feasibility of personalised remote long-term follow-up of people with cochlear implants: a randomised controlled trial. BMJ Open, 8(4), e019640.

Damant, J., Knapp, M., Freddolino, P., Lombard, D. (2017). Effects of digital engagement on the quality of life of older people. Health Soc Care Community, 25(6), 1679-170.

Day, L., Beard, K.V.J. (2019). Meaningful inclusion of diverse voices: The case for culturally responsive teaching in nursing education. Prof Nurs., 35(4), 277-281. doi: 10.1016/j.profnurs.2019.01.002.

El Kefi, S., Asan, O. (2021). How technology impacts communication between cancer patients and their health care providers: A systematic literature review. Int J Med Inform., 149, 104430.

Eze, N.D., Mateus, C., Cravo, O., Hashiguchi, T. (2020). Telemedicine in the OECD: An umbrella review of clinical and cost-effectiveness, patient experience and implementation. PloS One, 15(8), e0237585. https://doi-org.pc124152.oulu.fi:9443/10.1371/journal.pone.0237585

Hajat, C., Stein, E. (2018). The global burden of multiple chronic conditions: A narrative review. Prev Med Rep., 12, 284-293.

Hanberger, L., Ludvigsson, J., Nordfeldt, S. (2013). Use of a web 2.0 portal to improve education and communication in young patients with families: Randomized controlled trial. J Med Internet Res., 15(8), e175. doi:10.2196/jmir.2425

Harris, R.J., Deeks, J.J., Altman, D.G., Bradburn, M.J., Harbord, R.M., Sterne, J.A. (2008). Metan: fixed-and random-effects meta-analysis. Stata J., 8(1), 3-28.

Hermanns, N., Kulzer, B., Maier, B., Mahr, M., Haak, T. (2012). The effect of an education programme (MEDIAS 2 ICT) involving intensive insulin treatment for people with type 2 diabetes. Patient Educ Counsel., 86(2), 226-232. doi:10.1016/j.pec.2011.05.017

Higgins, J.P.T., Altman D.J., Sterne J.A.C (2011). Chapter 8: Assessing risk of bias in included studies. In: Higgins, J.P.T., Green, S. (Eds.), Cochrane Handbook for Systematic Reviews of Interventions. Cochrane Collaboration. Version 5.1.0

Higgins, J.P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., Welch, V. A. (Eds.). (2019). Cochrane handbook for systematic reviews of interventions. John Wiley & Sons.

Hoaglin, D.C. (2016). Misunderstandings about Q and 'Cochran's Q test'in meta- analysis. Stat Med., 35(4), 485-495. http://doi:10.1002/sim.6632.

Jansen, F., Krebber, A.M.H., Coupé, V.M.H., Cuijpers, P., De Bree, R., Becker-Commissaris, A., ... Verdonck-de Leeuw, I.M. (2017). Cost-utility of stepped care targeting psychological distress in patients with head and neck or lung cancer. J Clin Oncol., 35(3), 314-324. doi:10.1200/JCO.2016.68.8739

Jimenez, G., Spinazze, P., Matchar, D., Huat, G.K.C., van der Kleij, R.M.J.J., Chavannes, N.H., Car J. (2020). Digital health competencies for primary healthcare professionals: a scoping review. International Journal of Medical Informatics, 143(2020). https://doi.org/10.1016/j.ijmedinf.2020.104260

Khanna, D., Serrano, J., Berrocal, V.J., Silver, R.M., Cuencas, P., Newbill, S.L., ... Poole, J.L. (2019). Randomized controlled trial to evaluate an internet-based self-management program in systemic sclerosis. Arthritis Care Res., 71(3), 435-447. doi:10.1002/acr.23595

Koivunen, M., Saranto, K. (2018). Nursing professionals' experiences of the facilitators and barriers to the use of telehealth applications: a systematic review of qualitative studies. Scand J Caring Sci., 32(1), 24-44. doi: 10.1111/scs.12445

Kontopantelis, E., Reeves, D. (2010). Metaan: Random-effects meta-analysis. Stata J., 10(3), 395-407.

Konttila, J., Siira, H., Kyngäs, H., Lahtinen, M., Elo, S., Kääriäinen, M., … Mikkonen K. (2018). Healthcare professionals' competence in digitalisation: a systematic review. Journal of Clinical Nursing, 28(5-6), 745-761. doi: 10.1111/jocn.14710

Kravitz, R.L., Schmid, C.H., Marois, M., Wilsey, B., Ward, D., Hays, R.D., ... Sim, I. (2018). Effect of mobile device-supported single-patient multi-crossover trials on treatment of chronic musculoskeletal pain: A randomized clinical trial. JAMA Intern Med., 178(10), 1368-1377. doi:10.1001/jamainternmed.2018.3981

Krick, T., Huter, K., Domhoff, D., Schmidt, A., Rothgang, H., Wolf-Ostermann, K.B. (2019). Digital technology and nursing care: a scoping review on acceptance, effectiveness and efficiency studies of informal and formal care technologies. Health Serv Res., 9(1), 400. doi: 10.1186/s12913-019-4238-3.

Kujala, S., Rajalahti, E., Heponiemi, T., Hilama P. (2018). Health professionals' expanding eHealth competences for supporting patients' self-management. Studies in Health Technology and Informatics, 247, 181-185.

Laukka, E., Huhtakangas, M., Heponiemi, T., Kujala, S., Kaihlanen, A-M., Gluschkoff, K., Kanste O. (2020). Health care professionals' experiences of patient-professional communication over patient portals: systematic review of qualitative studies. Journal of Medical Internet Research, 22(12), e21623. DOI: 10.2196/21623.

Lusigan, S., Pearce, C., Munro N. (2013). Getting on who your computer is associated with job satisfaction in primary care: entrants to primary care should be assessed for their competency with electronic patient records systems. Informatics in Primary Care, 21(1), i-iii.

Mata, J., Pecorelli, N., Kaneva, P., Moldoveanu, D., Gosselin-Tardiff, A., Alhashemi, M., Robitaille, S., Balvardi, S., Lee, L., Stein, B.L., Liberman,, S., Charlebois, P., Fiore, J.F., Jr, Feldman, L.S. (2020). A mobile device application (app) to improve adherence to an enhanced recovery program for colorectal surgery: a randomized controlled trial. Surg Endosc, 34(2), 742-751.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med., 6(6), e1000097. doi:10.1371/journal.pmed1000097

Neame, M.T., Chacko, J., Surace, A.E., Sinha, I.P., Hawcutt, D.B. (2019). A systematic review of the effects of implementing clinical pathways supported by health information technologies. J Am Med Inform Assoc., 26(4), 356-363.

O'Connor, S., Hanlon, P., O'Donnell, C.A., Garcia, S., Glanville, J., Mair, F.S. (2016). Understanding factors affecting patient and public engagement and recruitment to digital health interventions: a systematic review of qualitative studies. BMC Med Inform Decis Mak., 16(1), 120.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. doi: 10.1136/bmj.n71

Rahimi, B., Nadri, H., Lotfnezhad Afshar, H., Timpka, T.A. (2018). Systematic review of the technology acceptance model in health informatics. Appl Clin Inform., 9(3), 604-634.

Reynolds, R., Dennis, S., Hasan, I., Slewa, J., Chen, W., Tian, D., Bobba, S., Zwar, N. (2018). A systematic review of chronic disease management interventions in primary care. BMC Fam Pract., 19(1), 11. https://doi.org/10.1186/s12875-017-0692-3

Roehrs, A., da Costa, C.A, Righi, R.D., de Oliveira, K.S.J. (2017) Personal health records: A systematic literature review. Med Internet Res., 19(1), e13. doi: 10.2196/jmir.5876.

Ryhänen, A.M., Rankinen, S., Siekkinen, M., Saarinen, M., Korvenranta, H., Leino-Kilpi, H. (2013). The impact of an empowering Internet-based Breast Cancer Patient Pathway program on breast cancer patients' clinical outcomes: a randomised controlled trial. J Clin Nurs, 22(7-8), 1016-1025.

Symons, J.D., Ashrafian, H., Dunscombe, R., Darzi, A. (2019). From EHR to PHR: let's get the record straight. BMJ Open, 9(9), e029582. doi: 10.1136/bmjopen-2019-029582.

StataCorp (2011). Stata Statistical Software: Release 12. College Station (TX): Stata Corporation LP.

Stellefson, M., Dipnarine, K., Stopka, C. (2013). The chronic care model and diabetes management in US primary care settings: a systematic review. Prev Chronic Dis., 10, E26. https://doi.org/10.5888/pcd10.120180

Sterne, J.A., Harbord, R.M. (2004). Funnel plots in meta-analysis. Stata J, 4(2), 127-141. https://doi.org/10.1177/1536867X0400400204

Ting, D.S.W., Lin, H., Ruamviboonsuk, P., Wong, T.Y., Sim, D.A. (2020). Artificial intelligence, the internet of things, and virtual clinics: Ophthalmology at the digital translation forefront. Lancet Digit Health, 2, E8–9.

Tufanaru, C., Munn, Z., Aromataris, E., Campbell, J., Hopp, L. (2020). Chapter 3: Systematic reviews of effectiveness. In: Aromataris, E., Munn, Z. (Editors), JBI Manual for Evidence Synthesis. Adelaide, Australia: JBI. Available from https://synthesismanual.jbi.global

Tung, E.L., Abramsohn, E.M., Boyd, K., Makelarski, J.A., Beiser, D.G., Chou, C., ... Lindau, S.T. (2019). Impact of a low-intensity resource referral intervention on patients' knowledge, beliefs, and use of community resources: Results from the CommunityRx trial. J Gen Intern Med. doi:10.1007/s11606-019-05530-5

Tutino, G.E., Yang, W.Y., Li, X., Li, W.H., Zhang, Y.Y., Guo, X.H., ... Zhu, Y. (2017). A multicentre demonstration project to evaluate the effectiveness and acceptability of the web-based joint asia diabetes evaluation (JADE) programme with or without nurse support in Chinese patients with type 2 diabetes. Diabet Med., 34(3), 440-450. doi:10.1111/dme.13164

Veroniki, A.A., Jackson, D., Bender, R., Kuss, O., Langan, D., Higgins, J.P., Knapp, G., Salanti, G. (2019). Methods to calculate uncertainty in the estimated overall effect size from a random-effects meta-analysis. Res Synth Methods, 10, 23-43. https://doi.org/10.1002/jrsm.1319.

Waki, K., Aizawa, K., Kato, S., Fujita, H., Lee, H., Kobayashi, H., . . . Ohe, K. (2015). Diabetics with a multimedia food recording tool, food log: Smartphone-based self-management for type 2 diabetes. J Diabet Sci Tech., 9(3), 534-540. doi:10.1177/1932296815579690

Wagenaar, K.P., Broekhuizen, B.D.L., Jaarsma, T., Kok, I., Mosterd, A., Willems, F.F., Linssen, G.C.M., Agema, W.R.P., Anneveldt, S., Lucas, C.M.H.B., Mannaerts, H.F.J., Wajon, E.,M.C.J., Dickstein, K., Cramer, M.J., Landman, M.A.J., Hoes, A.W., Rutten, F.H. (2019). Effectiveness of the European Society of Cardiology/Heart Failure Association website 'heartfailurematters.org' and an e-health adjusted care pathway in patients with stable heart failure: results of the 'e-Vita HF' randomized controlled trial. Eur J Heart Fail, 21(2), 238-246.

Waki, K., Aizawa, K., Kato, S., Fujita, H., Lee, H., Kobayashi, H., . . . Ohe, K. (2015). Dial betics with a multimedia food recording tool, food log: Smartphone-based self-management for type 2 diabetes. Journal of Diabetes Science and Technology, 9(3), 534-540. doi:10.1177/1932296815579690

Wigg, A.J., McCormick, R., Wundke, R., Woodman, R.J. (2013). Efficacy of a chronic disease management model for patients with chronic liver failure. Clin Gastroenterol Hepatol., 11(7), 850-858.e4. doi:10.1016/j.cgh.2013.01.014

World Health Organization & United Nations Children's Fund (2020). Operational framework for primary health care: Transforming vision into action. Geneva, Switzerland: World Health Organization.

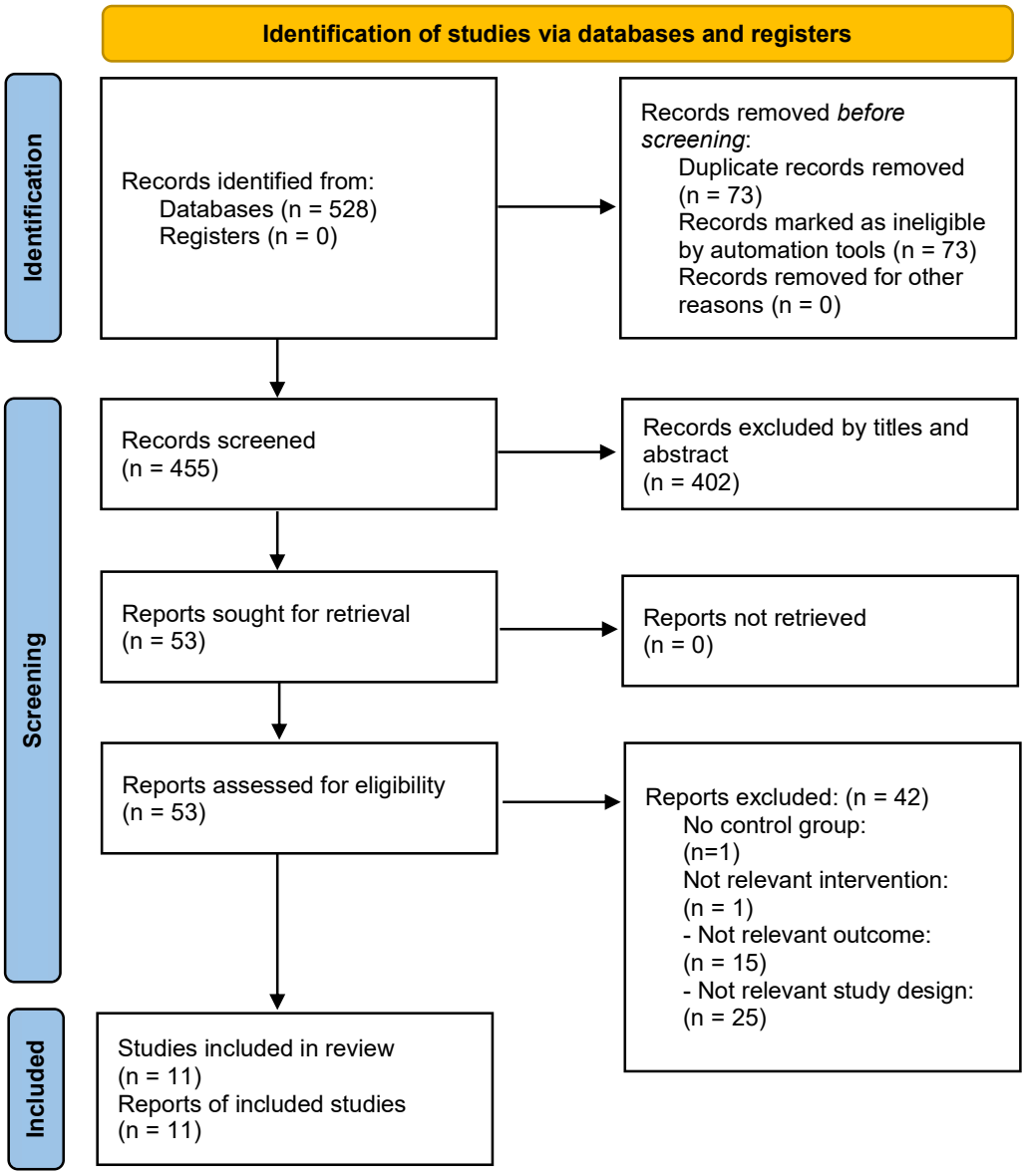
World Health Organization (2019). WHO guideline: recommendations on digital interventions for health system strengthening. Geneva, Switzerland: World Health Organization. Available at: https://www.who.int/publications/i/item/9789241550505.

Zhu, X., Wong, F.K.Y., Wu, C.L.H. (2018). Development and evaluation of a nurse-led hypertension management model: A randomized controlled trial. Int J Nurs Stud., 77, 171-178. doi:10.1016/j.ijnurstu.2017.10.006

1. Figure(s)

Click here to access/download;Figure(s);Figure 1. PRISMA_2020_flow_diagram_new_SRs_v1.docx

**PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only**




*From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Click here to access/download;Figure(s);Figure_4_5_Forest_Funnel_Plots_

Figure 4. Meta-analysis: forest plot.
(Positive values represent a favourable effect compared to the standard)

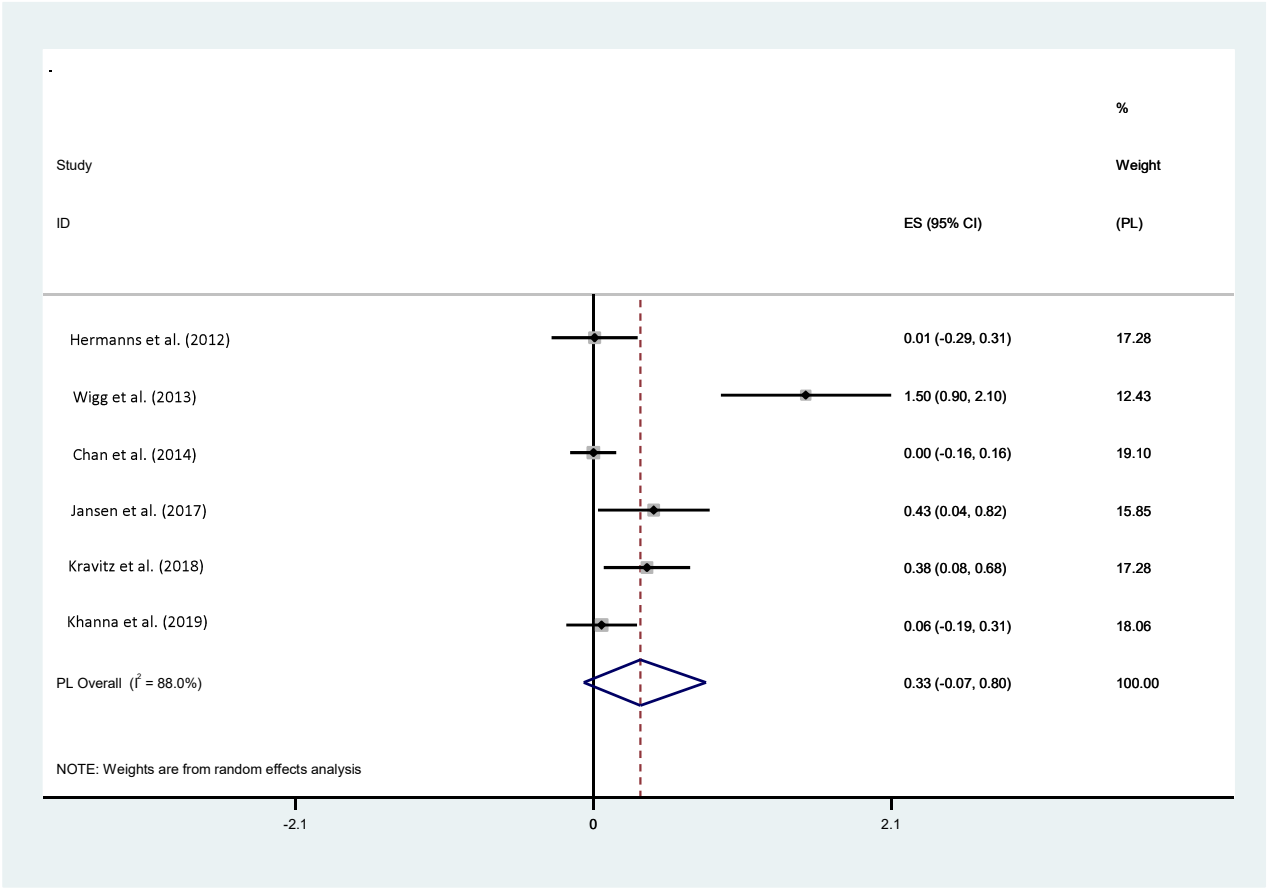
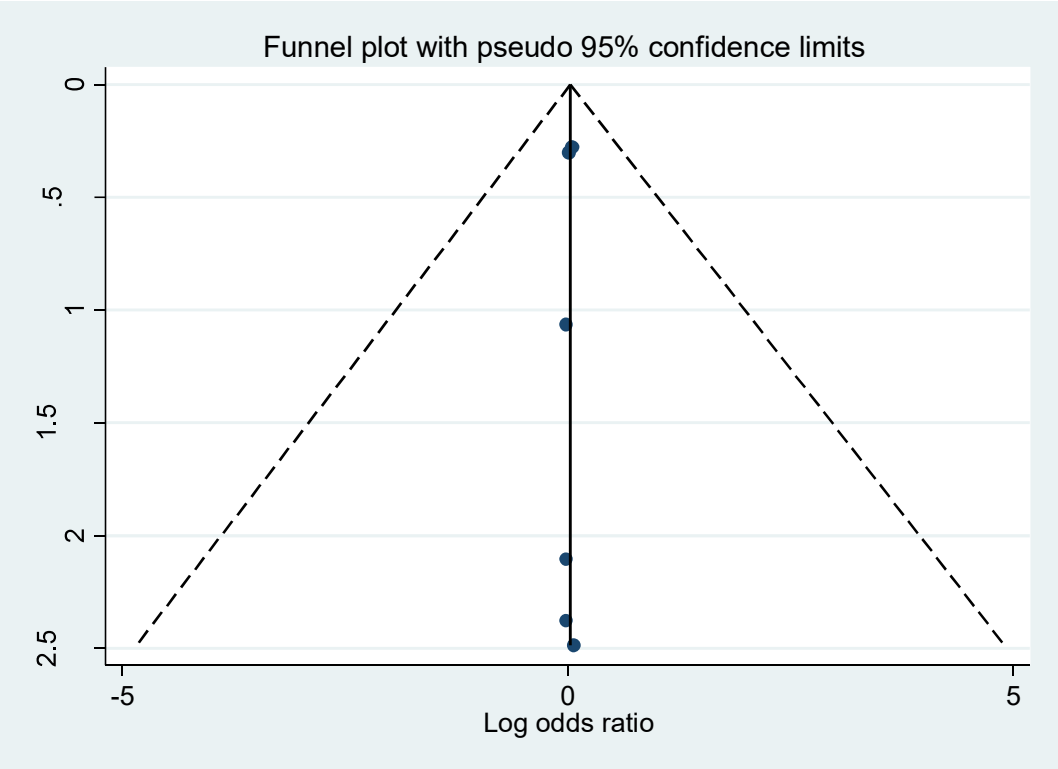


Figure 5. Publication bias assessment: funnel plot.

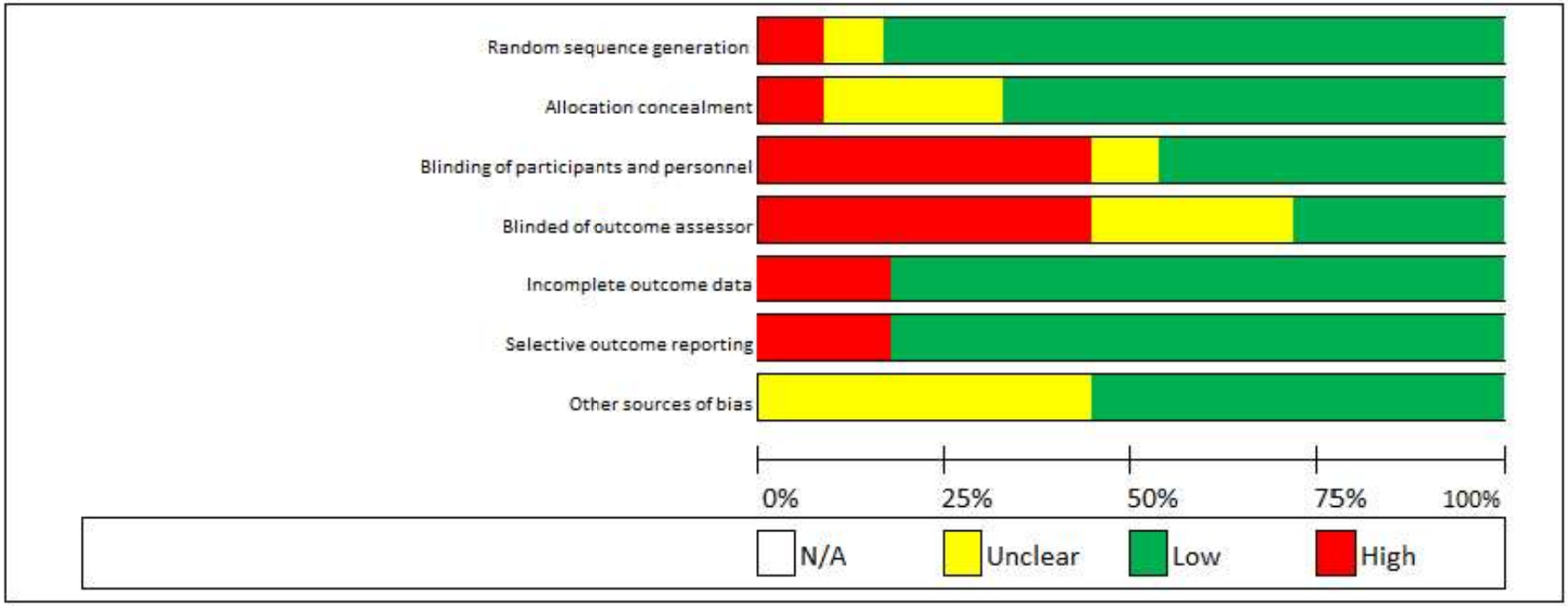


Figure(s) Click here to access/download;Figure(s);Figure 2-3. Risk of bias RCT (1).docx

Figure 2. Assessment of risk of bias using the Cochrane Risk of Bias Tool.

Legend: high, low, unclear

Figure 3. Overall risk of bias using the Cochrane Risk of Bias Tool (Higgins et al., 2019).



1 Table(s) Click here to access/download;Table(s);Table 1 (1).docx

Table 1. Inclusion criteria by PICOS review

| Inclusion Criteria for chosen studies (PICOS) | | Exclusion Criteria | Keywords |
|---|---|---|---|
| Population | Patient at specialized or primary or home care | User or customer not involved in specialized and/or primary and/or home care | patient or client or user or consumer or customer and specialized care or primary care or home care |
| Interventions | Intervention of clinical applications of information and communication technology (ICT) to enhance the quality of patient care | Non interventional study<br>Intervention protocol<br>Clinical applications of non-information and communication technology | Information and communication technology or ICT |
| Comparative | Control group (no intervention or no intervention of clinical applications of ICT) | No control group | |
| Outcome | Quality of patient-centered care (including maintaining patient autonomy', 'empowering self-care', individualized and relationship-based care', 'shared decision-making', and 'creating a homelike environment'). Measured with validated instruments. | Other than quality of patient-centered care<br>Measurements without validated instruments | Quality of patient-centered care (including maintaining patient autonomy', 'empowering self-care', individualized and relationship-based care', 'shared decision-making', and 'creating a homelike environment') |
| Study types | Peer-reviewed, RCT, published during years 2010-2020; languages English, Finnish, Japanese | Non peer-reviewed,<br>other than RCT,<br>published before 2010<br>other languages than English, Finnish or Japanese | Intervention or randomized controlled trial or experimental or trail study |

Click here to access/download;Table(s);Table 2. Extraction table clean.docx

Table 2. Data extraction of the 12 chosen RCT studies.

| Authors | Study objective | Population | Intervention | Comparison | Outcomes | Measurements | Key findings |
|---|---|---|---|---|---|---|---|
| Chan et al. (2014) Hong Kong | To investigate if frequent contacts through a telephone-based peer support programme (Peer Support, Empowerment, and Remote Communication Linked by Information Technology [PEARL]) would improve cardiometabolic risk and health outcomes by enhancing psychological well-being and self-care in patients receiving integrated care implemented through a web-based, multi-component quality improvement programme (JADE [Joint Asia Diabetes Evaluation]). | 628 Chinese patients with T2DM were randomised to the intervention JADE + PEARL (n = 312) or the control JADE (n = 316) groups. | Thirty-three motivated patients with well-controlled T2DM received 32 hours of training (four 8-hour workshops) to become peer supporters, with 10 patients assigned to each. Peer supporters called their peers at least 12 times in the JADE + PEARL group; these calls were guided by a checklist. | No peer PEARL programme, only JADE portal. | Primary outcomes: physiological measures (haemoglobin)<br><br>Secondary outcomes: quality of life, patient health for depression, Diabetes, empowerment for self-efficacy, and distress | Measurement at 0 and 12 months.<br><br>Instruments: EQ-5D (Euroqol for quality of life), PHQ-9 (Patient Health Questionnaire for depression), SDSCA-14 (self-care activities), DASS-21 (Depression Anxiety Stress Scale for psychological distress), DES-20 (Diabetes Empowerment Scale for self-efficacy), and CDDS-15 (Chinese Diabetes Distress Scale). | Both groups showed similar, and significant, improvements in most psychological-behavioural parameters, including medication, adherence, and self-efficacy. In the JADE + PEARL group, 90% of patients maintained contacts with their peer supporters, with a median of 20 calls per patient. Most of the discussion items were related to self-management. |
| Hanberger et al. (2013) Sweden | To develop a Web portal designed to facilitate self-management, including diabetes-related information and social networking functions, and to study its use and effects in paediatric patients with diabetes. | 474 children and adolescents with diabetes in a geographic population of two paediatric clinics in Sweden were randomised to the intervention group (n=244), with access | The Diabit Web portal was developed and offered to the intervention group with services of self-directed communication with health professionals, interaction with peers and access to information. | No access to the Diabit Web. | Primary outcomes: quality of life, empowerment, perception of quality of care.<br><br>Clinical variables: HbA1c, hypoglycaemia, blood glucose. | Measurements at 0, 1, and 2 years.<br><br>Instruments: DISABKIDS (Quality of Life for children), Quality from the Patients' Perspective (QPP) questionnaire, Swedish Diabetes Empowerment Scale. | The outcome variables did not differ between the intervention and control groups. No adverse treatment or self-care effects were identified. Peer interaction was a valued aspect. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | to the portal, or a control group (n=230) with no access. | | | | | |
| Hermann et al. (2012) Germany | To evaluate the effect of an education programme (MEDIAS 2 ICT) involving intensive insulin treatment for people with type 2 diabetes when compared with an established education programme as an active comparator condition (ACC). | 186 Type 2 diabetes patients were randomised to the intervention MEDIAS 2 ICT (n=94) or control ACC-established education programme without ICT (n=92) groups. | MEDIAS 2 ICT was designed to help patients perform multiple-injection insulin therapy and adjust their insulin doses depending on carbohydrate consumption, physical exercise, and pre-prandial glucose levels. In addition, MEDIAS 2 ICT focused on controlling metabolic risk factors such as elevated lipids and blood pressure. It was conducted as a group interactive programme comprising 10 lessons of 90 min each. | ACC-established education programme without ICT. | Primary outcomes: HbA1c, lipids, weight<br><br>Secondary outcomes: emotional distress, diabetes knowledge, self-care activity, health-related quality of life | Measurements at baseline, 5 weeks, 6 months.<br><br>Instruments: PAID diabetes related distress, diabetes knowledge test, Summary of Self-Care Activities Scale, SF-36 Health Survey | Diabetes education led to a significant improvement of glycaemic control in both education groups. The MEDIAS 2 ICT group showed a statistically significant reduction in diabetes-related distress. After the 6-month follow-up, participants in MEDIAS 2 ICT showed a significant improvement in the Physical Composite Score of the SF-12, indicating a significant improvement in health-related quality of life. Neither group showed a statistically significant change in the Mental Composite Score of the SF-12 during the study period. Both groups showed a significant improvement in diabetes knowledge. Self-reported self-care behaviour was significantly increased in MEDIAS 2 ICT. |
| Jansen et al. (2017) Netherlands | To assess the cost-utility of the stepped care (SC) programme compared | 156 patients with head and neck cancer or | The SC programme consisted of | Care-as-usual (CAU). | Primary outcomes: Intervention | Measurements at baseline, 12 months. | In the baseline case analysis, the intervention group had a significantly |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | with care-as-usual (CAU) in patients with head and neck cancer or lung cancer who have psychological distress. | lung cancer were randomised to intervention SC (n=75) or control CAU (n=81) groups. | four steps: (1) watchful waiting, (2) guided self-help via the Internet or a booklet, (3) face-to-face problem-solving therapy, and (4) specialised psychological interventions and/or psychotropic medication. | | costs, direct medical costs, direct nonmedical costs, productivity losses, and health-related quality-of-life data. | Instruments: Trimbos and Institute of Medical Technology Assessment Cost Questionnaire for Psychiatry, Productivity and Disease Questionnaire, and EuroQol-5 Dimension measures and data from the hospital information system. | higher number of QALYs and significantly lower cumulative costs than the control group. The probability that cumulative QALYs were higher and costs were lower was 96%, indicating that SC is highly likely to be cost-effective when compared with CAU. |
| Khanna et al. (2019) USA | To compare an internet-based self-management programme to a patient-focused educational book developed to assess measures of self-efficacy and other patient-reported outcomes in patients with Systemic sclerosis (SSc). | 267 patients with SSc were randomised to internet-based self-management programme intervention (n=134) and a patient-focused educational book control (n=133) groups. | Internet programme with a self-management website included 15 modules with basic overview, coping and body image, exercise, self-advocacy, pain management, activities of daily living, fatigue and energy conservation, tips for families and caregivers, muscle and lung disease. The programme included interactive discussions with moderators. | An educational book. | Primary outcomes: self-efficacy<br><br>Secondary outcomes: quality of life, self-management. | Measurements at baseline, 16 weeks.<br><br>Instruments: PROMIS Self-Efficacy for Managing Chronic Conditions instrument, The PROMIS-29 Profile instrument, The Patient Health Questionnaire, The Patient Activation Measure (PAM), The EuroQol 5-domain instrument (EQ-5D) and quality-adjusted life years (QALYs). | There were no statistical differences between the two groups in self-efficacy for managing symptoms. The quality of life was visually higher in the intervention group. Internet group participants agreed that the self-management modules were of importance to them, the information was presented clearly, and the website was easy to use and at an appropriate reading level. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Kravitz et al. (2018) USA | To determine whether patients randomised to participate in an n-of-1 trial supported by a mobile health (mHealth) app would experience less pain and improved global health, adherence, satisfaction, and shared decision making compared with patients assigned to usual care. | 215 patients with chronic musculoskeletal pain were randomised to intervention (n=108) and control (n=107) groups. | Intervention patients met with their clinicians and used a desktop interface to select treatments and trial parameters for an n-of-1 trial comparing two pain-management regimens. The mHealth app provided reminders to take designated treatments on assigned days and to upload responses to daily questions on pain and treatment-associated adverse effects. | Care-as-usual. | Primary outcomes: pain management.<br><br>Secondary outcomes: patient-reported pain intensity, overall health, analgesic adherence, trust in clinician, satisfaction with care, medication-related shared decision making, and, for the n-of-1 group only, participant engagement and experience. | Measurement at baseline, 6 months, 12 months.<br><br>Instruments: PROMIS (Patient-Reported Outcomes Measurement Information System) scale, Pain Medication in Primary Care Patient questionnaire; Trust in Physician scale; Consumer Assessment of Healthcare Providers and Systems survey. | At the 6-month follow-up, pain interference was reduced in both groups, although the difference between the intervention and control groups was insignificant. The intervention patients did not outperform the control patients in any secondary outcomes, with the exception of medication-related shared decision making at six months. Among patients assigned to the intervention group, 88% affirmed that the mHealth app could help people like them manage their pain. |
| Tung et al. (2019) USA | To evaluate the impact of CommunityRx, an automated, low-intensity resource referral intervention, on patients' knowledge, beliefs, and use of community resources. | 374 participants were randomised to intervention (HealthRx) (n=190) and control (n=184) groups. | CommunityRx generated an automated, personalised list of resources, known as HealtheRx, near each participant's home using condition-specific, evidence-based algorithms. Algorithms used patient demographic | Care-as-usual. | Primary outcomes: patient self-care including healthy eating classes, individual counseling, mortgage assistance, smoking cessation, stress management, and weight loss classes or groups. | Measurement at baseline, 1 month, 3 months.<br><br>Instruments: self-made items for the study. | Intervention recipients showed improved knowledge and beliefs about common resources in the community to manage health relative to control subjects. More specifically, they gained knowledge relevant to smoking cessation and weight loss. Positive changes in both knowledge and beliefs about community resources were associated with higher resource use. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | and health characteristics documented in the electronic health record to identify relevant resources from a comprehensive, regularly updated database of health-related resources in the study area. | | Secondary outcomes: beliefs about having resources in the community to manage health. | | |
| Tutino et al. 2017 China | To test the hypothesis that delivery of integrated care augmented by a web-based disease management programme and nurse coordinator would improve treatment target attainment and health-related behaviour. | 3586 diabetes mellitus participants were randomised to interventional (JADE) (n=1858) and control (DIAMOND) (n=1728) groups. | The web-based Joint Asia Diabetes Evaluation (JADE) and Diabetes Monitoring Database (DIAMOND) portals contain identical built-in protocols to integrate structured assessment, risk stratification, personalised reporting and decision support. The JADE portal contains an additional module to facilitate structured follow-up visits. | Diabetes Monitoring Database (DIAMOND) and no nurse visit in follow-up. | Primary outcomes: patients' clinical samples (incl. HbA, blood pressure, cholesterol).<br><br>Secondary outcomes: default rates, change in quality-of-life measures, frequency of hypoglycaemia, adherence to lifestyle modification/self-care activities, and new onset of physician-documented diabetes-related endpoints. | Measurements at baseline, 12 months.<br><br>Instruments: metabolic control, insulin, drugs, quality of life instrument. | The proportion of participants attaining treatment targets increased in both groups and there were similar absolute reductions in HbA1c and LDL cholesterol. The JADE group was more likely to self-monitor blood glucose and had fewer defaulters. There was no significant difference among the groups in the quality of life measurements. |
| Waki et al. (2015) Japan | To test a more patient-friendly version of DialBetics, the | 54 type 2 diabetes patients were | DialBetics as a smartphone-based application | Non-DialBetics general care. | Primary outcomes: blood | Measurements at baseline, 3 months. | Diet evaluations of the DialBetics group showed a significant decline in |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | development of which was based on the original participants' feedback about the previous version of DialBetics. | randomised to interventional (DialBetics) (n=27) and control (non-DialBetics) (n=27) groups. | that supports improved self-management among diabetics was implemented into patient self-care. DialBetics included components of data transmission, evaluation, exercise input, and food recording and dietary evaluation. | | glucose, blood pressure, weight.<br><br>Secondary outcomes: compliance, diet input, participants' experiences. | Instruments: a smartphone (Samsung Galaxy Note 1, Seoul, Korea), NFC-enabled glucometer (Terumo MS-FR201B, Tokyo, Japan) and Bluetooth enabled BP monitor (Omron HEM-7081-IT, Kyoto, Japan), pedometer (Omron HJ-720IT, Kyoto, Japan) with adapter (Omron HHX-IT1), and weight scale (Omron HBF-206IT), all able to transmit measurement readings by wireless network to the DialBetics server. | HbA1c. DialBetics with FoodLog was shown to be an effective and convenient tool, its new meal-photo input function helping provide patients with real-time support for diet modification. |
| Wigg et al. (2013) Australia | To investigate the effect of a chronic disease management (CDM) intervention on hospital use in a cohort of chronic liver failure (CLF) patients. | 60 patients with cirrhosis and complications from CLF were randomised to intervention (n=40) or usual care control (n=20) groups. | The intervention comprised four CDM components: delivery system redesign, self-management support, decision support, and clinical information systems. Delivery was coordinated through case management by hepatology | Care-as-usual. | Primary outcomes: number of days spent in a hospital bed for liver-related reasons.<br><br>Secondary outcomes: rates of other hospital use measures, rate of attendance at planned | Measurements at baseline, 6 months, 12 months.<br><br>Instruments: liver related OBDs expressed as a rate per person per year, hospitalisation reasons and length, monitoring of outpatient care, changes in disease severity, quality of | The intervention did not reduce the number of days patients spent in hospital beds for liver-related reasons, compared with usual care, or affect other measures of hospitalisation. Patients given the intervention had a 30% higher rate of attendance at outpatient care and significant increases in quality of care, based |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | nurses involving multidisciplinary team care (gastroenterologist, nurse, general practitioner, dietician, alcohol counselors), home visit by nurse within a week after discharge, initial weekly nurse telephone reviews of patients, rapid access to care pathway using a mobile telephone service for patients concerned about deterioration, and written and telephone patient reminders before appointments. | | outpatient care, disease severity, quality of life, and quality of care. | life- disease-specific Chronic Liver Disease Questionnaire, quality of care. | on adherence to hepatoma screening, osteoporosis and vaccination guidelines, and referral to transplant centers. |
| Zhu et al. (2018) China | To establish a nurse-led hypertension management model and to test its effectiveness at the community level. | 134 hypertensive patients with uncontrolled blood pressure were randomised to intervention (n =67) or control (n =67) groups. | The nurse-led hypertension management model included four components (delivery system design, decision support, clinical information system and self-management support). Patients in the intervention group received a | Care-as-usual. | Primary outcomes: blood pressure, self-care behaviours, self-efficacy, quality of life and satisfaction. | Measurements at baseline, after intervention (12 weeks), 16 weeks after the intervention.<br><br>Instruments: calibrated sphygmomanometer and stethoscope, patients' adherence to anti-hypertensive drugs, non-pharmacological | Blood pressure among intervention group members decreased significantly. In addition, the group's self-care behaviour and satisfaction improved significantly. No statistically significant difference in self-efficacy and quality of life was detected between the two groups after the intervention. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 12-week period of hypertension management. | | | behaviours, Chinese version of the Short-<br>Form Chronic Disease Self-Efficacy Scale, Chinese version of the Short-Form Health Survey, satisfaction assessment. | |

Click here to access/download;Table(s);Table 3. Types of interventions.docx

Table 3. Types of interventions

| Studies | Chan et al. (2014) | Hanberger et al. (2013) | Hermanns et al. (2012) | Jansen et al. (2017) | Khanna et al. (2019) | Kravitz et al. (2018) | Tung et al. (2019) | Tutino et al. (2017) | Waki et al. (2015) | Wigg et al. (2013) | Zhu et al. (2018) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ICT CLINICAL APPLICATIONS TYPES | | | | | | | | | | | |
| Telephone | X | | | | X | X | X | X | | X | X |
| Web portal | X | X | X | X | X | | | X | | | |
| Interactive online educational resources (e.g. games, simulations) | | X | X | | | | | | | | |
| Mobile health application | | | | | | X | | | X | | |
| Electronic health record | | | | | | | X | | | | |
| Delivery system design (e.g. algorithms utilization) | | | | | | | X | X | X | X | X |
| INTERACTION | | | | | | | | | | | |
| Healthcare expert (e.g. nurse, inter-professional team, doctor) | X | X | X | X | X | X | | X | | X | X |
| Peer | X | X | X | | | | | | | | |
| Group | | X | X | | | | | | | | |
| Family involvement | | X | X | | | | | | | X | |
| Face-to-face coaching | X | | | X | | X | | X | | X | X |
| Virtual human coach | | X | | | X | | | X | | | X |
| Virtual coach | | | | X | | X | | | X | | |
| EDUCATION AND COMPETENCE DEVELOPMENT | | | | | | | | | | | |
| Training | X | | X | | X | | | X | | X | |
| Bank of information and educational knowledge | | X | X | X | X | X | X | | X | | |
| Educational coaching / one-to-one mentoring | | X | X | X | X | X | | | | X | X |
| QUALITY OF PATIENT-CENTERED CARE OUTCOMES | | | | | | | | | | | |
| Quality of care | | X | | | | | | | | X | |
| Health related quality of life | X | X | X | X | X | X | | X | | X | X |
| Self-efficacy | X | | | | X | | | | | | X |
| Empowering self-care / self-management | X | X | X | X | X | | X | X | X | | X |
| INSTRUMENTS MEASURING QUALITY OF PATIENT-CENTERED CARE | | | | | | | | | | | |
| EQ-5D (Euroqol for Quality of Life) | X | | | X | X | | | X | | | |
| SF-36 Health Related Quality of Life | | | X | | | | | | | | |
| DISABKIDS (Quality of Life for Children) | | X | | | | | | | | | |
| Quality of Life- Chronic Liver Disease Questionnaire | | | | | | | | | | X | |
| Short-Form Health Survey | | | | | | | | | | | X |
| Quality of Care | | | | | | | | | | X | |
| QPP (Quality of Care from the Patients' Perspective questionnaire) | | X | | | | | | | | | |
| DES-20 (Diabetes Empowerment Scale for Self-efficacy) | X | | | | | | | | | | |
| Chinese version of the Short-Form Chronic Disease Self-Efficacy Scale | | | | | | | | | | | X |
| PROMISE (Self-Efficacy) | | | | | X | X | | | | | |
| SDSCA-14 (Self-care Activities) | X | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SWE-DES-SF-10 (Swedish Diabetes Empowerment Scale) | | X | | | | | | | | | |
| Self-Care Activities Scale | | | X | | | | | | | | |
| PAM (Patient Activation Measure) | | | | | X | | | | | | |
| Self-made items measuring Self-Management | | | | | | | X | | | | |
| Compliance to Self-care | | | | | | | | | X | | |

1 Supplementary Material

Click here to access/download

**Supplementary Material**

Supplementary file 1.  (1).docx

2 Supplementary Material

Click here to access/download

**Supplementary Material**

Supplementary file 2 JBI evaluation .docx

- **Conflict of interests:**

The authors have no conflict of interests to declare.

**Authors**: Mikkonen K., Yamakawa M., Tomietto M., Tuomikoski AM., Utsumi M., Jarva E., Kääriäinen M., Oikarinen A.

**Authors' affiliations:**

First author: Kristina Mikkonen (corresponding author), Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; Kristina.mikkonen@oulu.fi; ORCID: https://orcid.org/0000-0002-4355-3428; Twitter: @Kristinamikkon

Mailing address:

Research Unit of Nursing Science and Health Management
Faculty of Medicine
P.O. Box 5000
FI- 90014 University of Oulu
Tel.: +358 40 4113913
Email: kristina.mikkonen@oulu.fi

Second author: Miyae Yamakawa (corresponding-author), Department of Evidence-Based Clinical Nursing, Division of Health Sciences, Graduate School of Medicine, Osaka University, Asakayama General Hospital; miyatabu@sahs.med.osaka-u.ac.jp

Mailing Address of corresponding author:

1-7 Yamadaoka Suita city, Osaka, Japan. 565-0871

Third author: Marco Tomietto, Department of Nursing, Midwifery and Healthcare, Faculty of Health and Life Sciences, Northumbria University, Newcastle Upon Tyne, UK. Research Unit of Nursing Science and Health Management, University of Oulu, Oulu, Finland. Email: marco.tomietto@northumbria.ac.uk; Twitter: @marco_tomietto; ORCID: https://orcid.org/0000-0002-3813-1490

Fourth author: Anna-Maria Tuomikoski, University of Applied Science of Oulu; The Finnish Centre for Evidence-Based Health Care: A Joanna Briggs Institute Centre of Excellence, Helsinki, Finland; annukka.tuomikoski@oamk.fi

Fifth author: Momoe Utsumi, Department of Evidence-Based Clinical Nursing, Division of Health Sciences, Graduate School of Medicine, Osaka University; utsumi@sahs.med.osaka-u.ac.jp

Sixth author: Erika Jarva, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; erika.jarva@oulu.fi

Seventh author: Maria Kääriäinen, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; maria.kaariainen@oulu.fi

Eighth author: Anne Oikarinen, Research Unit of Nursing Science and Health Management, University of Oulu; The Finnish Centre for Evidence-Based Health Care: A JOANNA Briggs Institute Centre of Excellence, Helsinki, Finland; Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Finland; anne.oikarinen@oulu.fi