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Supplementary Table 1: Search strategy for Ovid MEDLINE

- 1 exp Atrial Fibrillation/ (51406)
- 2 (atrial adj3 fibrillat*).ti,ab. (64727)
- 3 exp Atrial Flutter/ (5678)
- 4 atrial flutter.ti,ab. (5405)
- 5 (auricular adj3 fibrillat*).ti,ab. (975)
- 6 (supraventricul* adj3 arrhythmi*).ti,ab. (2562)
- 7 1 or 2 or 3 or 4 or 5 or 6 (81038)
- 8 *Internet/ (36349)
- 9 *Online systems/ (3566)
- 10 exp Information Services/ (958012)
- 11 exp Decision Making, Computer-Assisted/ (137569)
- 12 exp Wireless Technology/ (3176)
- 13 exp Educational Technology/ (107093)
- 14 *Computers, handheld/ (2348)
- 15 exp Microcomputers/ (20726)
- 16 exp Mobile Applications/ (4482)
- 17 mobile application*.mp. (6019)
- 18 mobile app*.mp. (7027)
- 19 app.ti,ab. (22608)
- 20 exp Cell Phone/ (9685)
- 21 (cellphone or cell phone).ti,ab. (1908)
- 22 (mobile or mobile phone).mp. (96184)
- 23 telephone.mp. (58946)
- 24 exp Smartphone/ (3237)
- 25 (smartphone or smart phone).mp. (8904)
- 26 android.mp. (2247)
- 27 (iphone or i-phone or ipad or i-pad or ipod or i-pod or tablet).mp. (26811)
- 28 (personal digital assistant or PDA).mp. (11129)
- 29 exp Remote Consultation/ (4612)
- 30 (remote consultation or remote monitoring).mp. (6531)
- 31 exp Telemedicine/ (25787)

32 (telemedicine or telehealth or telehealthcare).mp. (26029)

33 (telemonitor* or telepsych* or teletherap*).mp. (7770)

34 (ehealth or e-health or electronic health).mp. (30825)

35 (emedicine or e-medicine or electronic medicine).mp. (108)

36 (mhealth or m-health or mobile health).mp. (9266)

37 (etherap* or e-therap*).mp. (721)

38 (cyber or forum or chat or blog or messaging or social network* or social media or multimedia or multi-media or software or podcast or virtual or health messages).mp. (334012)

39 exp Text Messaging/ (2369)

40 text messag*.mp. (4562)

41 (portal or e-portal or eportal).mp. (86044)

42 (audio* or dvd or email or e-mail).mp. (105954)

43 (elibrary or e library).ti,ab. (56)

44 (digital adj3 (library or libraries)).ti,ab. (609)

45 ((electronic or online or on-line or internet or web* or intranet) adj3 (library or libraries)).ti,ab. (4523)

46 ((electronic or online or on-line or internet or web* or intranet) adj3 information).ti,ab. (11631)

47 ((electronic or online or on-line or internet or web* or intranet) adj3 resource*).ti,ab. (6680)

48 ((electronic or online or on line or internet or web* or intranet) adj3 database*).ti,ab. (40008)

49 ((computer* or electronic or online or on-line or internet or web* or digital) adj3 guideline*).ti,ab. (1526)

50 exp artificial intelligence/ (86475)

51 (artificial intelligence or AI).mp. (50510)

52 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 (2050668)

53 7 and 52 (3700)

54 limit 53 to yr="2005 -Current" (3192)

Supplementary Table 2: Excluded studies and reason(s) for exclusion

Author, year, reference	Reason for exclusion
Wilson 2019 ¹	Wrong intervention (not a mobile app for AF management)
Risom 2019 ²	Wrong intervention (not a mobile app for AF management)
Richardson 2019 ³	Wrong intervention (not a mobile app for AF management)
Rakhshan 2019 ⁴	Wrong intervention (not a mobile app for AF management)
Orchard 2019 ⁵	Wrong intervention (not a mobile app for AF management)
Orchard 2019 ⁶	Wrong intervention (not a mobile app for AF management)
Montalescot 2019 ⁷	Wrong intervention (not a mobile app for AF management)
Goldenthal 2019 ⁸	Wrong intervention (not a mobile app for AF management)
Chaturvedi 2019 ⁹	Wrong intervention (not a mobile app for AF management)
Ferguson 2019 ¹⁰	Wrong outcomes
Ayyaswami 2019 ¹¹	Systematic review
Al-Arkee 2019 ¹²	Systematic review protocol
Peleg 2018 ¹³	Wrong outcomes ^a
Orchard 2018 ¹⁴	Wrong intervention (not a mobile app for AF management)
Malm 2018 ¹⁵	Wrong intervention (not a mobile app for AF management)
Kotecha 2018 ¹⁶	Review
Eckman 2018 ¹⁷	Wrong intervention (not a mobile app for AF management)
Desteghe 2018 ¹⁸	Wrong intervention (not a mobile app for AF management)
Aljuaid 2018 ¹⁹	Wrong intervention (not a mobile app for AF management)
Ahuja 2018 ²⁰	Wrong intervention (not a mobile app for AF management)
Talboom-Kamp 2017 ²¹	Wrong population and wrong outcomes
Roebuck 2017 ²²	Abstract only – no full text available
Peleg 2017 ²³	Wrong outcomes ^b
Maikranz 2017 ²⁴	Wrong intervention (not a mobile app for AF management)
Hickey 2017 ²⁵	Protocol paper for on-going study. Results reported in Goldenthal 2019. Wrong intervention (not a mobile app for AF management)
Kotecha 2017 ²⁶	Editorial/comment
Hendriks 2016 ²⁷	Editorial/comment
Cutting 2017 ²⁸	Abstract only – no full text available
Borodzicz 2017 ²⁹	Abstract for a full text of an included study (Balsam, 2019) ³⁰
Arts 2017 ³¹	Wrong intervention (not a mobile app for AF management)
Parimbelli 2016 ³²	Wrong outcomes ^c
Nieuwlaat 2016 ³³	Editorial/comment
Millman 2016 ³⁴	Wrong intervention (not a mobile app for AF management)
Hickey 2016 ³⁵	Protocol paper for on-going study. Results reported in Goldenthal 2019. Wrong intervention (not a mobile app for AF management)
Chelu 2016 ³⁶	Wrong intervention (not a mobile app for AF management)
Chalmers 2016 ³⁷	Wrong intervention (not a mobile app for AF management)
Carlson 2016 ³⁸	Abstract only no full text available
Abidi 2016 ³⁹	Abstract only no full text available
Hendriks 2014 ⁴⁰	Wrong intervention (not a mobile app for AF management)
Proclemer 2013 ⁴¹	Wrong intervention (not a mobile app for AF management)
Shacham 2012 ⁴²	Wrong intervention (not a mobile app for AF management)
Hendriks 2010 ⁴³	Wrong intervention (not a mobile app for AF management)
Amara 2009 ⁴⁴	Wrong intervention (not a mobile app for AF management)

^aDescribes the generic architecture of the Motivational Patient Assistant and a preliminary assessment of the proof-of concept prototype

^bDescribes the evaluation of MobiGuide's capability for supporting distributed decision-making and its' use by clinicians and patients but no outcomes of interest for this review

'Paper focuses on the nurses' time and tasks setting up the system and enrolling the patients but not outcome data relevant to the outcomes of interest

Supplementary Table 3: Risk of bias assessment with detailed explanation of decision for each domain rating

Randomised controlled trials (assessed by Cochrane Risk of Bias tool ⁴⁵)							
Study	Selection bias		Reporting bias	Performance bias	Detection bias	Attrition bias	Other bias
Author (year)	Random sequence generation	Allocation concealment	Selective reporting	Blinding participants and personnel	Blinding outcome assessors	Incomplete outcome data	Other sources of bias
Desteghe (2018) ⁴⁶	High	High	Unclear	High	Unclear	Low	Unclear
	Patients were only randomised to Group 1 or 2 (Group 1 was the intervention and Group 2 was those with internet connection). Group 3 were self-selected (those without a PC/tablet or smartphone or unable to use the device)	People without a smartphone or tablet could not be allocated to Group 1 or 2	No primary outcome or timing of this outcome specified. Several outcomes reported at several time-points	Due to nature of the intervention not possible to blind patients and personnel to treatment allocation	No information given	34/35 in Group 1 had complete outcome data (4 time-points) and 32/36 in Group 2. Group 3: 47/49 had baseline and follow-up data. Group 3 did not have questionnaire data for as many time-points; Group 3 only completed questionnaires when attending hospital (no data at 1-3 weeks prior to the procedure or post-procedurally)	Possible the Group 1 and 2 could have looked up the answers to the AF knowledge questionnaire or asked family/caregivers as this was completed on-line at home (although access to the m-health education was temporarily blocked when Group 1 filled in the questionnaire)
Guo (2017) ⁴⁷	Unclear	Unclear	Unclear	High	Low	High	Unclear
	No detail on randomisation procedure. Cluster design with only 2 sites; no individual randomisation	No detail on randomisation procedure	No primary outcome or timing of this outcome specified. Several outcomes reported at several time-points	Due to nature of the intervention not possible to blind patients and personnel to treatment allocation	Data input performed by 2 individuals blinded to treatment allocation. Independently double-checked by third investigator	Zero attrition at 3 months in usual care group; 37% in intervention group	Some outcome measures were self-report and it is possible that patients in the intervention group reported better improvements because they were in intervention group

			Only reports on patient version of the mAF app				
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Observational studies (assessed by Risk of Bias for non-randomised studies (RoBANS) tool ⁴⁸)						
Study	Selection bias	Confounding variables	Performance bias	Detection bias	Attrition bias	Reporting bias
Author (year)		Inadequate confirmation and consideration of confounding variables	Inadequate measurements of exposure	Inadequate blinding of outcome assessments	Incomplete outcome data	Selective outcome reporting
Balsam 2019 ³⁰	Low	Unclear	Low	High	Unclear	High
	Before and after study. Patients were recruited consecutively and data collected prospectively	No information given; unlikely for immediate recall but could be issue for long term outcomes	Hospitalised patients so exposure controlled	Blinding of outcome not completed	Numbers of drop-outs reported at all time-points (90% at 1 year) but data not complete at all time-points for all outcomes. No analysis reported for baseline between those who completed follow-up and those who did not	Timing of primary outcome not clear. No experimental protocol available.
Hirschey 2018 ⁴⁹	High	High	High	Unclear	High	High
	Purposeful sample via clinician referral; highly selected, N=12	Given potential selection bias the participants may be more tech-aware	Asked to explore predetermined app features but no verification of actual exposure	No information given	N=16 enrolled but only 12 participated. Two ineligible due to mobile phone incompatibility; 1 lost-to-follow-up; 1 dropped out after 1 week due to lack of interest	Primary outcome not explicit
Sheibani 2017 ⁵⁰	Unclear	Low	Low	High	Low	Low
	Before and after study. Cardiologists (n=10) are participants and they	Interrupted time series design reduces risk of bias. Possible factors	CDSS was used for 88% of patients in post-intervention	Blinding of outcome not completed. Paper reports were completed	Pre-post data reported fully	Primary outcome defined and reported fully

	utilised the CDSS on 373 patients. Cardiologists selected using convenience sampling. Not clear if patients were enrolled consecutively. Data collected retrospectively	such as seasonal variation considered	phase (remainder had incomplete baseline data)	by clinicians (no electronic records in place)		
Ghanbari 2017 ⁵¹	High	High	Low	Unclear	Unclear	Unclear
	Recruitment via physician referral. No control group. N=10; highly selected	Given potential selection bias the participants may be more tech-aware	Number of assessments performed/day is reported clearly	No information given	No data given on drop-out rate	Feasibility study – primary outcome not clear
Desteghe 2017 ⁵²	High	High	Low	Unclear	Low	Unclear
	Participants not recruited consecutively. Only 15/114 (13.2%) eligible patients participated	Given potential selection bias the participants may be more tech-aware	App use is reported clearly across the study period	No information given	High rate of outcome data reporting. Only 1 patient did not complete 3-month study	Feasibility study – primary outcome not clear

REFERENCES

- [1] Wilson G, Davis A, Urbanczyk J, Banchs J, Erwin J, Michel J, Widmer R. Web-based patient portals are associated with higher readmission rates in atrial fibrillation. *Journal of the American College of Cardiology* 2019; **73**: 1845.
- [2] Risom SS, Lind J, Dickson VV, Berg SK. Exploring the Mechanism of Effectiveness of a Psychoeducational Intervention in a Rehabilitation Program (CopenHeartRFA) for Patients Treated With Ablation for Atrial Fibrillation: A Mixed Methods Study. *The Journal of cardiovascular nursing* 2019; **34**: 336-343.
- [3] Richardson CL, White S, Chapman S. A virtual patient educational programme to teach counselling to clinical pharmacists development and proof of concept. *Pharmacoepidemiology and Drug Safety* 2019; **28**: 14-15.
- [4] Rakhshan M, Najafi H, Valizadeh GA. Lifestyle of Patients with Atrial Fibrillation Following Self-Management Interventions: a Randomized Clinical Trial. *Journal of caring sciences* 2019; **8**: 83-88.
- [5] Orchard J, Neubeck L, Freedman B, Li J, Webster R, Zwar N, et al. eHealth Tools to Provide Structured Assistance for Atrial Fibrillation Screening, Management, and Guideline-Recommended Therapy in Metropolitan General Practice: The AF - SMART Study. *Journal of the American Heart Association* 2019; **8**: e010959.
- [6] Orchard J, Li J, Gallagher R, Freedman B, Lowres N, Neubeck L. Uptake of a primary care atrial fibrillation screening program (AF-SMART): a realist evaluation of implementation in metropolitan and rural general practice. *BMC family practice* 2019; **20**: 170.
- [7] Montalescot G, Brotons C, Cosyns B, Crijns HJ, D'Angelo A, Drouet L, et al. Educational Impact on Apixaban Adherence in Atrial Fibrillation (the AEGEAN STUDY): A Randomized Clinical Trial. *American journal of cardiovascular drugs : drugs, devices, and other interventions* 2020; **20**: 61-71.
- [8] Goldenthal IL, Sciacca RR, Riga T, Bakken S, Baumeister M, Biviano AB, et al. Recurrent atrial fibrillation/flutter detection after ablation or cardioversion using the AliveCor KardiaMobile device: iHEART results. *Journal of cardiovascular electrophysiology* 2019; **30**: 2220-2228.
- [9] Chaturvedi S, Kelly AG, Prabhakaran S, Saposnik G, Lee L, Malik A, et al. Electronic Decision support for Improvement of Contemporary Therapy for Stroke Prevention. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association* 2019; **28**: 569-573.
- [10] Ferguson C, Hickman LD, Phillips J, Newton PJ, Inglis SC, Lam L, et al. An mHealth intervention to improve nurses' atrial fibrillation and anticoagulation knowledge and practice: the EVICOAG study. *European journal of cardiovascular nursing : journal of the Working Group on Cardiovascular Nursing of the European Society of Cardiology* 2019; **18**: 7-15.
- [11] Ayyaswami V, Padmanabhan DL, Crihalmeanu T, Thelmo F, Prabhu AV, Magnani JW. Mobile health applications for atrial fibrillation: A readability and quality assessment. *International journal of cardiology* 2019; **293**: 288-293.
- [12] Al-Arkee S, Mason J, Lane DA, Fabritz L, Chu W, Yahyouche A, Singh K, Jalal Z. Mobile apps, cardiovascular disease and medication adherence: A systematic review. *International Journal of Pharmacy Practice* 2019; **27**: 35-36.
- [13] Peleg M, Michalowski W, Wilk S, Parimbelli E, Bonaccio S, O'Sullivan D, et al. Ideating Mobile Health Behavioral Support for Compliance to Therapy for Patients with Chronic Disease: A Case Study of Atrial Fibrillation Management. *Journal of medical systems* 2018; **42**: 234.
- [14] Orchard JJ, Neubeck L, Freedman B, Webster R, Patel A, Gallagher R, et al. Atrial Fibrillation Screen, Management And Guideline Recommended Therapy (AF SMART II) in the rural primary care setting: an implementation study protocol. *BMJ open* 2018; **8**: e023130.
- [15] Malm D, Fridlund B, Ekblad H, Karlstrom P, Hag E, Pakpour AH. Effects of brief mindfulness-based cognitive behavioural therapy on health-related quality of life and sense of coherence in atrial fibrillation patients. *European journal of cardiovascular nursing : journal of the Working Group on Cardiovascular Nursing of the European Society of Cardiology* 2018; **17**: 589-597.

Commented [DL1]: References will be formatted once draft is finalised

- [16] Kotecha D, Chua WWL, Fabritz L, Hendriks J, Casadei B, Schotten U, et al. European Society of Cardiology smartphone and tablet applications for patients with atrial fibrillation and their health care providers. *Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology* 2018; **20**: 225-233.
- [17] Eckman MH, Costea A, Attari M, Munjal J, Wise RE, Knochelmann C, et al. Shared decision-making tool for thromboprophylaxis in atrial fibrillation - A feasibility study. *American heart journal* 2018; **199**: 13-21.
- [18] Desteghe L, Vijgen J, Koopman P, Dilling-Boer D, Schurmans J, Dendale P, et al. Telemonitoring-based feedback improves adherence to non-vitamin K antagonist oral anticoagulants intake in patients with atrial fibrillation. *European heart journal* 2018; **39**: 1394-1403.
- [19] Aljuaid M, Marashly Q, AlDanaf J, Tawhari I, Barakat M, Barakat R, et al. Smartphone ECG Monitoring System Helps Lower Emergency Room and Clinic Visits in Post-Atrial Fibrillation Ablation Patients. *Clinical Medicine Insights Cardiology* 2020; **14**: 1179546820901508.
- [20] Ahuja T, Raco V, Papadopoulos J, Green D. Antithrombotic Stewardship: Assessing Use of Computerized Clinical Decision Support Tools to Enhance Safe Prescribing of Direct Oral Anticoagulants in Hospitalized Patients. *Journal of patient safety* 2018.
- [21] Talboom-Kamp EP, Verdijk NA, Talboom IJ, Harmans LM, Numans ME, Chavannes NH. PORTALS: design of an innovative approach to anticoagulation management through eHealth. *BMC health services research* 2017; **17**: 213.
- [22] Roebuck AR, Wagner SW, Skaggs CS, Ahmed RA, Rohani Ghahari RRG, Toscos TT, Mirro MM. "I don't know how you can be the decision maker when you don't understand": Designing tailored E-health intervention to empower patients living with nonvalvular atrial fibrillation. *Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology* 2017; **19**: i47.
- [23] Peleg M, Shahar Y, Quaglini S, Fux A, Garcia-Saez G, Goldstein A, Hernando ME, Klimov D, Martinez-Sarriegui I, Napolitano C, Parimbelli E, Rigla M, Sacchi L, Shalom E, Soffer P. MobiGuide: A personalized and patient-centric decision-support system and its evaluation in the atrial fibrillation and gestational diabetes domains. *User Modeling and User-Adapted Interaction* 2017; **27**: 159-213.
- [24] Maikranz V, Siebenhofer A, Ulrich LR, Mergenthal K, Schulz-Rothe S, Kemperdick B, et al. Does a complex intervention increase patient knowledge about oral anticoagulation? - a cluster-randomised controlled trial. *BMC family practice* 2017; **18**: 15.
- [25] Hickey KT, Biviano A, Garan H, Sciacca RR, Riga T, Warren K, Frulla AP, Hauser NR, Wang DY, Whang W. Evaluating the utility of mHealth ECG heart monitoring for the detection and management of atrial fibrillation in clinical practice. *Journal of atrial fibrillation* 2017; **9**: 1546.
- [26] Kotecha D, Kirchhof P. ESC Apps for Atrial Fibrillation. *European heart journal* 2017; **38**: 2643-2645.
- [27] Hendriks JM, Walfridsson U, Johansson P, Stromberg A. E-health in patients with atrial fibrillation. *European journal of cardiovascular nursing : journal of the Working Group on Cardiovascular Nursing of the European Society of Cardiology* 2016; **15**: 200-202.
- [28] Cutting H, Edwards F. Pan London atrial fibrillation (AF) toolkit for the prevention of stroke. *International Journal of Stroke* 2017; **12**: 56.
- [29] Borodzicz S, Balsam P, Malesa K, Puchta D, Koltowski L, Peller M, Grabowski M, Opolski G. OCULUS study: Three-dimensional movie as a new weapon against poor compliance. *Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology* 2017; **2017**: Supplement 3.
- [30] Balsam P, Borodzicz S, Malesa K, Puchta D, Tyminska A, Ozieranski K, et al. OCULUS study: Virtual reality-based education in daily clinical practice. *Cardiology journal* 2019; **26**: 260-264.

- [31] Arts DL, Abu-Hanna A, Medlock SK, van Weert HC. Effectiveness and usage of a decision support system to improve stroke prevention in general practice: A cluster randomized controlled trial. *PloS one* 2017; **12**: e0170974.
- [32] Parimbelli E, Sacchi L, Budasu R, Napolitano C, Peleg M, Quaglini S. The Role of Nurses in E-Health: The MobiGuide Project Experience. *Studies in health technology and informatics* 2016; **225**: 153-157.
- [33] Nieuwlaat R, Mistry N, Haynes RB. Mobile Text Messaging and Adherence of Patients to Medication Prescriptions: A txt a dA keeps da doctR awA? *JAMA internal medicine* 2016; **176**: 350-351.
- [34] Millman MD, Den Hartog KS. Optimizing Adherence Through Provider and Patient Messaging. *Population health management* 2016; **19**: 264-271.
- [35] Hickey KT, Hauser NR, Valente LE, Riga TC, Frulla AP, Masterson Creber R, et al. A single-center randomized, controlled trial investigating the efficacy of a mHealth ECG technology intervention to improve the detection of atrial fibrillation: the iHEART study protocol. *BMC cardiovascular disorders* 2016; **16**: 152.
- [36] Chelu MG, Margetts H, Kaur G, Tang W, Marrouche NF. Smartphone ECG in managing atrial fibrillation patients: Saving ER visits and changing paradigm. *Heart Rhythm* 2016; **1**: S263.
- [37] Chalmers L BL, Prasad R, Hancock N, MacIntyre PD, McKenzie DS, Boland CM, Frain BE, Buttfield-Addison P. SMART-AF: Development of a decision support smartphone app to improve antithrombotic prescribing in atrial fibrillation. *Research in Social and Administrative Pharmacy* 2016; **12**: e22-e23.
- [38] Carlson S, Berkley J, Luke D, Porterfield J, Huntsinger M, Doshi R, Saxon L. Smartphone application for AF surveillance and asynchronous communication post-ablation. *Journal of cardiovascular electrophysiology* 2016; **27**: 648.
- [39] Abidi SS AS, Abusharekh A, Hashemian N. A decision support framework integrating medical knowledge with live patient data for proactive chronic patient management. *European Journal of Epidemiology* 2016; **31**: S8.
- [40] Hendriks JM, Vrijhoef HJ, Crijns HJ, Brunner-La Rocca HP. The effect of a nurse-led integrated chronic care approach on quality of life in patients with atrial fibrillation. *Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology* 2014; **16**: 491-499.
- [41] Proclemer A, Zoppo F, Molon G, Zanolto G, Gasparini G, Catanzariti D, Baccillieri MS, Menard C, Gentili A, Grammatico A. Improving atrial fibrillation detection and stroke prevention capability by a web-based application: A multicenter Italian research on AFinder application. *European heart journal* 2013; **1**: 737.
- [42] Shacham J, Birati EY, Malov N, Yanay Y, Steinberg DM, Tamari M, et al. Telemedicine for diagnosing and managing paroxysmal atrial fibrillation in outpatients. The phone in the pocket. *International journal of cardiology* 2012; **157**: 91-95.
- [43] Hendriks JL, Nieuwlaat R, Vrijhoef HJ, de Wit R, Crijns HJ, Tieleman RG. Improving guideline adherence in the treatment of atrial fibrillation by implementing an integrated chronic care program. *Netherlands heart journal : monthly journal of the Netherlands Society of Cardiology and the Netherlands Heart Foundation* 2010; **18**: 471-477.
- [44] Amara W. [Management of atrial fibrillation in patients with cardiac stimulators or defibrillators: the possibilities of telemonitoring]. *Annales de cardiologie et d'angiologie* 2009; **58**: 226-229.
- [45] Higgins JP, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Clinical research ed)* 2011; **343**: d5928.
- [46] Desteghe L, Germeys J, Vijgen J, Koopman P, Dilling-Boer D, Schurmans J, et al. Effectiveness and usability of an online tailored education platform for atrial fibrillation patients undergoing a

direct current cardioversion or pulmonary vein isolation. *International journal of cardiology* 2018; **272**: 123-129.

[47] Guo Y, Chen Y, Lane DA, Liu L, Wang Y, Lip GYH. Mobile Health Technology for Atrial Fibrillation Management Integrating Decision Support, Education, and Patient Involvement: mAF App Trial. *The American journal of medicine* 2017; **130**: 1388-1396.e1386.

[48] Kim SY, Park JE, Lee YJ, Seo HJ, Sheen SS, Hahn S, et al. Testing a tool for assessing the risk of bias for nonrandomized studies showed moderate reliability and promising validity. *Journal of clinical epidemiology* 2013; **66**: 408-414.

[49] Hirschey J, Bane S, Mansour M, Sperber J, Agboola S, Kvedar J, et al. Evaluating the Usability and Usefulness of a Mobile App for Atrial Fibrillation Using Qualitative Methods: Exploratory Pilot Study. *JMIR human factors* 2018; **5**: e13.

[50] Sheibani R, Sheibani M, Heidari-Bakavoli A, Abu-Hanna A, Eslami S. The Effect of a Clinical Decision Support System on Improving Adherence to Guideline in the Treatment of Atrial Fibrillation: An Interrupted Time Series Study. *Journal of medical systems* 2017; **42**: 26.

[51] Ghanbari H, Ansari S, Ghannam M, Lathkar-Pradhan S, Kratz A, Oral H, et al. Feasibility and Usability of a Mobile Application to Assess Symptoms and Affect in Patients with Atrial Fibrillation: A Pilot Study. *Journal of atrial fibrillation* 2017; **10**: 1672.

[52] Desteghe L, Kluts K, Vijgen J, Koopman P, Dilling-Boer D, Schurmans J, et al. The Health Buddies App as a Novel Tool to Improve Adherence and Knowledge in Atrial Fibrillation Patients: A Pilot Study. *JMIR mHealth and uHealth* 2017; **5**: e98.