



Article

Mobile health applications for managing atrial fibrillation for healthcare professionals and patients: a systematic review

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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

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

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