Screening for atrial fibrillation: improving efficiency of manual review of handheld electrocardiograms

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SAFER study

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Background

- AF affects approximately 3.3% of UK population [1]
- Intermittent and asymptomatic episodes

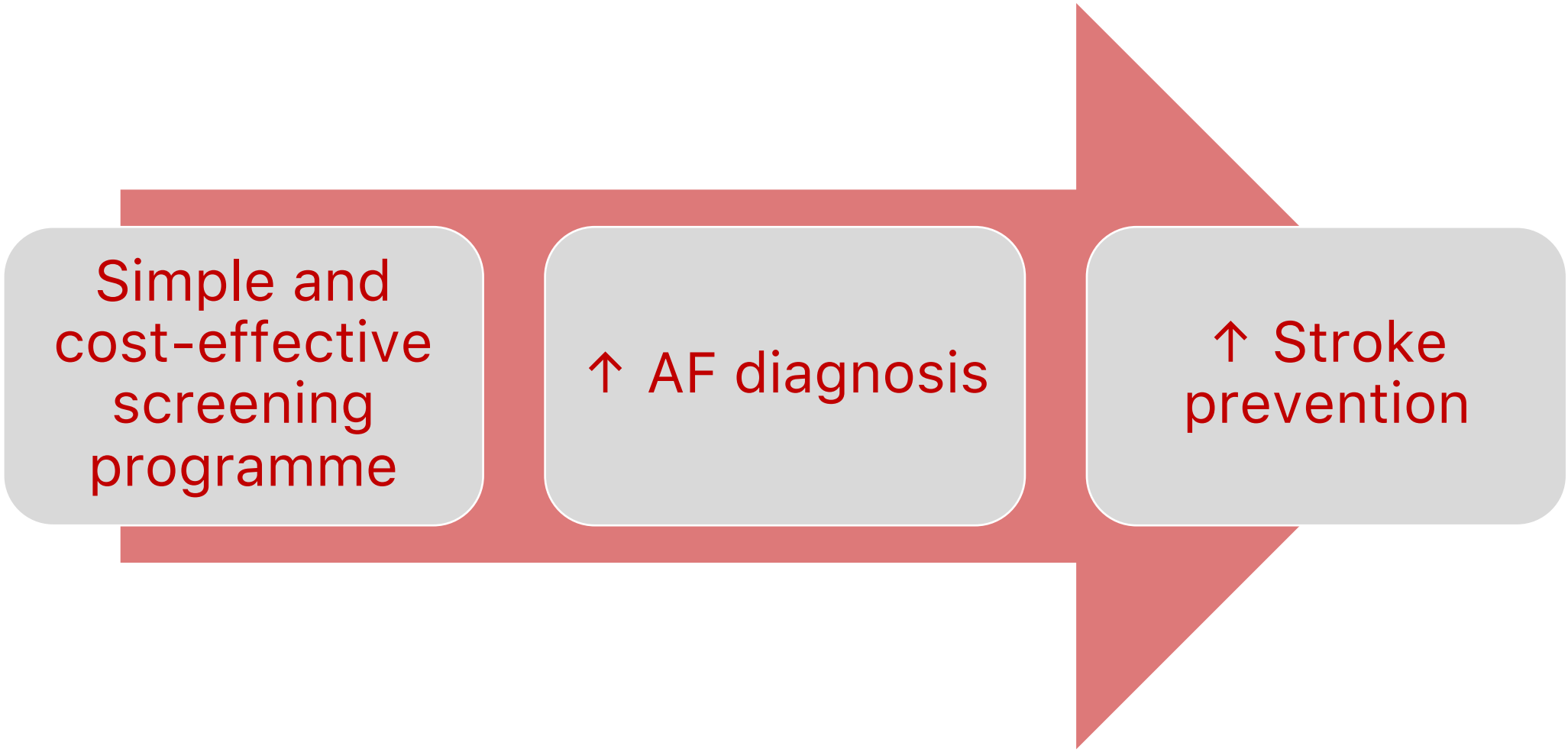
- 5x increased risk of thromboembolic stroke [2]
- Associated with 28% of all strokes [3]

- CHA_2DS_2-VASc score for stroke risk assessment
- Oral anticoagulation

Criteria	Points
Congestive heart failure history	1
Hypertension history	1
Age ≥ 75	2
Age 65-74	1
Diabetes history	1
Stroke / TIA / thromboembolism history	2
Vascular disease history (prior MI, peripheral artery disease, or aortic plaque)	1
Sex category (female)	1

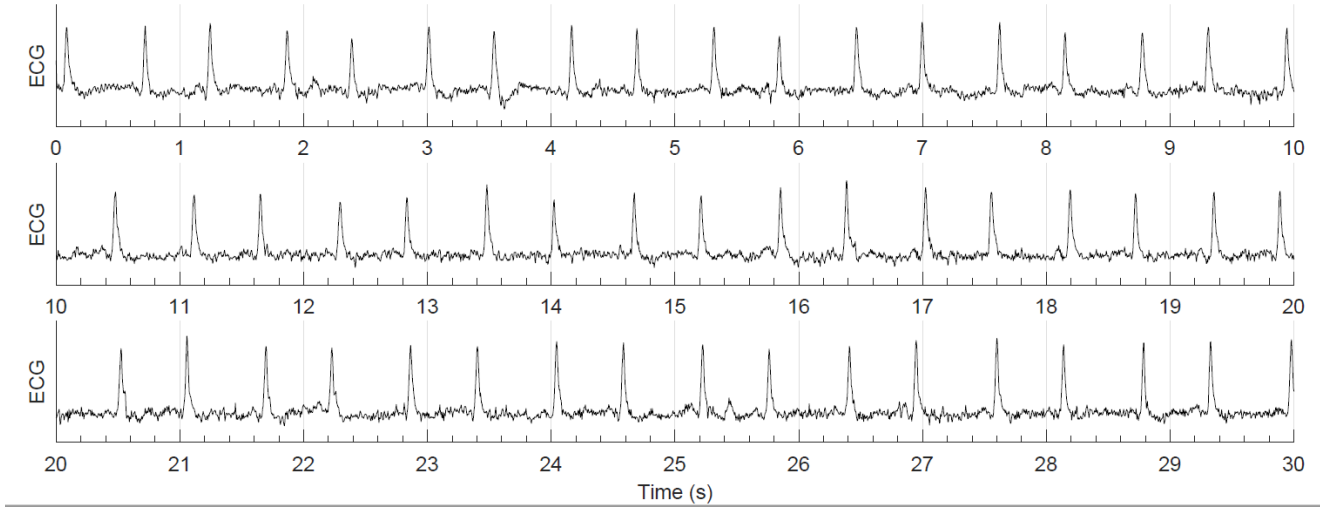
Source: [4]

Screening for AF



Screening for AF

Zenicor EKG-2 handheld ECG device
Source: zenicor.com



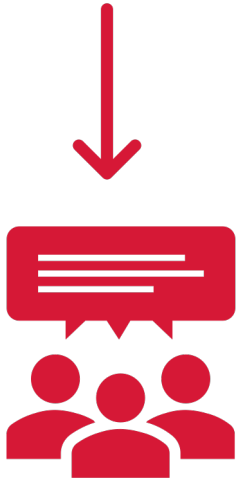
Single-lead 30 second ECG recording

Automated algorithm

High sensitivity

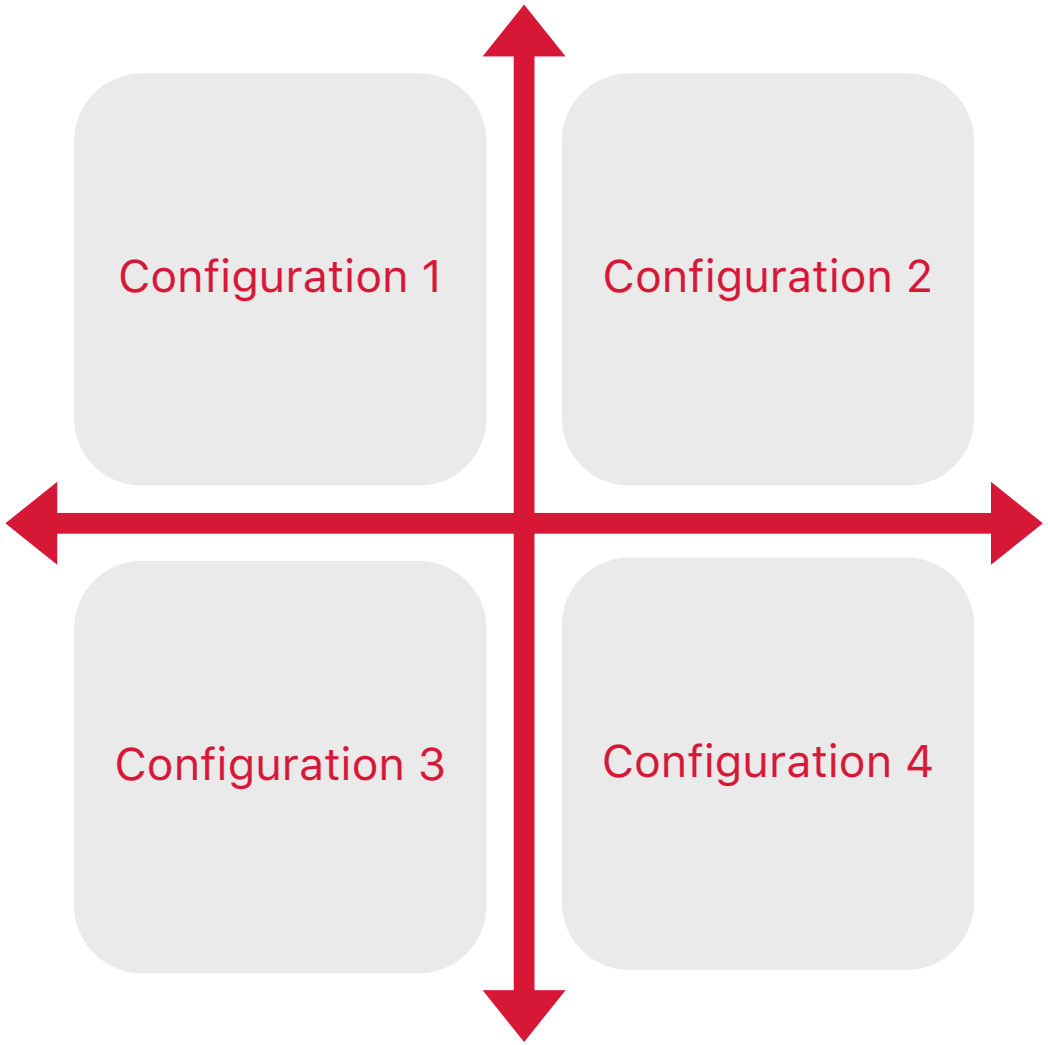
Maximises number of people **correctly** diagnosed with AF

High positive predictive value



Minimises **unnecessary** review of normal ECGs

Our aims



Manual review workload

Accurate identification of AF patients

The SAFER Feasibility Study

Dataset

162,515
ECG recordings

2,141 adults

Aged over 65

Methods

Review Process

Cardiolund ECG Parser algorithm

First filter review

Expert reviews

Resolution of discrepancies

Final diagnosis assigned to each participant

Algorithm configurations

Screening algorithm configuration	Pathological recordings			Low quality recordings
	Irregular Sequence	Fast Regular	Other	
Configuration 1	✓	✓	✓	✓
Configuration 2	✓	✓	✓	
Configuration 3	✓	✓		
Configuration 4	✓			

Manual review workload

Number of ECGs reviewed by the first filter which meet the criteria

Number of ECGs reviewed by the expert reviewer which meet the criteria

✖ 2

Findings

Results

Screening algorithm configuration	Number of manual reviews			Number of AF patients identified
	First Filter	Expert	Total	
Configuration 1: All pathological/low quality	20,155	5,005 x2	30,165	54

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Configuration 1: All pathological/low quality	20,155	5,005 x2	30,165	54
Configuration 2: All pathological	15,241	4,570 x2	24,561	54
	- 23%	**- 9%**	**- 18.6%**	

Results

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	First Filter	Expert	Total	
Configuration 1: All pathological/low quality	20,155	5,005 x2	30,165	54
Configuration 2: All pathological	15,241	4,570 x2	24,561	54
Configuration 3: Selected pathological	11,975	3,299 x2	18,573	54
Configuration 4: Only irregular sequences	11,748	3,198 x2	18,144	53

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- 38.4%

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- 40%

Results

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Key Findings

- Configuration 3 most appropriate
  - Manual review for recordings with “Irregular Sequence” and “Fast Regular” classifications
- First filter excluded 70.4-75.2% ECGs prior to expert review
- Useful to have first filter, followed by expert review:
  1. For every first filter review, we save 2 expert reviews
  2. Each expert review likely to be more expensive than first filter review

Limitations

- Assumption that all ECGs sent for manual review were reviewed
- Might have had false negative tests among ECGs that were not sent for review under any algorithm configuration
- Cost differences between first filter and expert reviews

Future Work

- Improve ECG parsing algorithm further to incorporate P wave characteristics
- Creation of training dataset with labelled ECGs
- Prospective studies to verify findings

Conclusions

References

[1] Adderley, N.J.; Ryan, R.; Nirantharakumar, K.; Marshall, T. Prevalence and treatment of atrial fibrillation in UK general practice from 2000 to 2016. *Heart* **2019**, *105*, 27–33, doi:10.1136/heartjnl-2018-312977.

[2] Wolf PA; Abbot RD; Kannel WB Atrial fibrillation as an independent risk facor for stroke: the Framingham study. *Stroke* **1991**, *22*, 983–988.

[3] Perera, K.S.; Vanassche, T.; Bosch, J.; Swaminathan, B.; Mundl, H.; Giruparajah, M.; Barboza, M.A.; O'Donnell, M.J.; Gomez-Schneider, M.; Hankey, G.J.; et al. Global Survey of the Frequency of Atrial Fibrillation–Associated Stroke. *Stroke* **2016**, *47*, 2197–2202, doi:10.1161/STROKEAHA.116.013378.

[4] Lip, G.Y.H.; Nieuwlaat, R.; Pisters, R.; Lane, D.A.; Crijns, H.J.G.M.; Andresen, D.; Camm, A.J.; Davies, W.; Capucci, A.; Olsson, B.; et al. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: The Euro Heart Survey on atrial fibrillation. *Chest* **2010**, *137*, 263–272, doi:10.1378/chest.09-1584.

Thank you!

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