

## LIVERPOOL REVIEWS AND IMPLEMENTATION GROUP (LRiG)

The clinical and cost effectiveness  
of lead-I electrocardiogram (ECG)  
devices for detecting atrial  
fibrillation using single-time point  
testing in primary care [DAP39]

### Addendum 2

This Diagnostics Assessment Report was  
commissioned by the NIHR HTA Programme  
as project number 16/30/05

Addendum 2 completed 11<sup>th</sup> February 2019

Copyright belongs to the Liverpool Reviews  
and Implementation Group



# 1 INTRODUCTION

This document provides the results of incremental base case (Base Case 1 and Base Case 4) and probabilistic sensitivity analyses which incorporate changes to base case assumptions following stakeholder responses to the diagnostics consultation document. An additional scenario investigating the impact on the results of alternative sensitivity and specificity estimates for the RhythmPad GP device is also presented.

The original results from the incremental analysis using Base Case 1 and Base Case 4 (as presented in the EAG Addendum document dated 13th November 2018) are shown in Table 1 and Table 2.

Table 1 Original Base Case 1: Incremental cost effectiveness analysis

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£514,187	447.963			
Kardia Mobile	£515,551	449.249	£1,364	1.286	£1,060
RhythmPad*	£518,436	448.573	£2,885	-0.676	Dominated
Zenikor-ECG	£518,468	449.199	£2,917	-0.050	Dominated
MyDiagnostick	£521,233	449.024	£5,682	-0.225	Dominated
imPulse	£530,745	448.987	£15,194	-0.262	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Table 2 Original Base Case 4: Incremental cost effectiveness analysis

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£516,678	447.895			
Kardia Mobile	£517,315	449.220	£637	1.324	£481
RhythmPad*	£520,142	448.540	£2,828	-0.680	Dominated
Zenikor-ECG	£520,231	449.170	£2,916	-0.050	Dominated
MyDiagnostick	£522,985	448.994	£5,670	-0.226	Dominated
imPulse	£532,507	448.956	£15,192	-0.264	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

## 2 BASE CASE ANALYSES WITH UPDATED DEVICE COSTS

The manufacturers of the MyDiagnostick device and RhythmPadGP device responded to the diagnostics consultation document with updated costs for their devices. These costs were:

- MyDiagnostick
  - device cost of €165 (£144.38 as at 8 February 2019), dependent on bulk ordering of 6000 devices
  - 10 year lifespan
  - monthly cost for cloud use of €6 (£5.25) per device. The manufacturer noted its intention to offer a private cloud service for the NHS for a one-off cost; however, this service is not currently available.
- RhythmPad GP
  - device cost of £399
  - lifespan of 5 years.

Incremental cost effectiveness results for Base Case 1 and Base Case 4 including updated device costs for MyDiagnostick and RhythmPad GP are shown in Table 3 and Table 4. The results of changes made to costs in these two base cases represent the lower and higher bound of base case ICERs per QALY gained, since Base Case 1 returned the highest ICERs per QALY gained and Base Case 4 returned the lowest ICERs per QALY gained in the original analysis.

Table 3 Base Case 1: Incremental cost effectiveness analysis (MyDiagnostick=£144 plus £5.25 cloud storage per month and 10 year lifespan, RhythmPad GP=£399 and 5 year lifespan)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£514,187	447.963			
Kardia Mobile	£515,551	449.249	£1,364	1.286	£1,060
RhythmPad GP*	£517,416	448.573	£1,865	-0.676	Dominated
Zenikor-ECG	£518,468	449.199	£2,917	-0.050	Dominated
MyDiagnostick	£521,220	449.024	£5,669	-0.225	Dominated
imPulse	£530,745	448.987	£15,194	-0.262	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Table 4 Base Case 4: Incremental cost effectiveness analysis (MyDiagnostick=£144 plus £5.25 cloud storage per month and 10 year lifespan, RhythmPad GP=£399 and 5 year lifespan)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£516,678	447.895			
Kardia Mobile	£517,315	449.220	£637	1.324	£481
RhythmPad GP*	£519,122	448.540	£1,807	-0.680	Dominated
Zenikor-ECG	£520,231	449.170	£2,916	-0.050	Dominated
MyDiagnostick	£522,972	448.994	£5,657	-0.226	Dominated
imPulse	£532,507	448.956	£15,192	-0.264	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

It is assumed that the updated cost for the MyDiagnostick device represents a lower bound of the range of costs for the device, given that it requires bulk ordering. Table 5 and

Table 6 show the results of the Base Case 1 and Base Case 4 scenarios including the original device cost for MyDiagnostick (£450) over a 5 year lifespan and the updated cost of cloud storage, plus the revised costs for the RhythmPad GP device.

Table 5 Base Case 1: Incremental cost effectiveness analysis (MyDiagnostick=£450 plus £5.25 cloud storage per month and 5 year lifespan, RhythmPad GP=£399 and 5 year lifespan)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£514,187	447.963			
Kardia Mobile	£515,551	449.249	£1,364	1.286	£1,060
RhythmPad GP*	£517,416	448.573	£1,865	-0.676	Dominated
Zenikor-ECG	£518,468	449.199	£2,917	-0.050	Dominated
MyDiagnostick	£521,296	449.024	£5,745	-0.225	Dominated
imPulse	£530,745	448.987	£15,194	-0.262	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Table 6 Base Case 4: Incremental cost effectiveness analysis (MyDiagnostick=£450 plus £5.25 cloud storage per month and 5 year lifespan, RhythmPad GP=£399 and 5 year lifespan)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£516,678	447.895			
Kardia Mobile	£517,315	449.220	£637	1.324	£481
RhythmPad GP*	£519,122	448.540	£1,807	-0.680	Dominated
Zenikor-ECG	£520,231	449.170	£2,916	-0.050	Dominated
MyDiagnostick	£523,048	448.994	£5,733	-0.226	Dominated
imPulse	£532,507	448.956	£15,192	-0.264	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Applying updated costs associated with purchasing and using the MyDiagnostick device decreases incremental costs by £13 at the lower bound of the device cost estimate and increases incremental cost by £63 at the higher bound in both Base Case 1 and Base Case 4. Applying updated costs associated with purchasing and using the RhythmPad GP device decreases incremental costs associated by £1,020 in both Base Case 1 and Base Case 4. Both devices are dominated by the Kardia Mobile device in the updated incremental analysis. The order of the incremental analysis is not affected by applying updated costs for these two devices.

### 3 BASE CASE ANALYSES WITH UPDATED ESTIMATES OF ANTICOAGULANT USE

In their response to the diagnostics consultation document, the Academic Health Science Networks (AHSNs) requested that the data used in the model that were derived from the NHS Quality and Outcomes Framework (QOF) to estimate anticoagulant use be updated with 2017/18 figures. Data from 2016/17 and 2017/18 QOF sources are shown in Table 7.

Table 7 Quality and Outcomes Framework data used in the economic model

Parameter	2016/17	2017/18	Source or calculation
Proportion of AF patients with CHA2DS2-VASc $\geq 2$	82.4%	82.9%	AF007 Denominator plus exceptions/AF Prevalence Register
Proportion of AF patients with CHA2DS2-VASc $\geq 2$ treated with OACs	81.2%	84.0%	AF007 Patients receiving intervention

Source: NHS Quality and Outcomes Framework<sup>1,2</sup>

Incremental cost effectiveness results for Base Case 1 and 4 including updated QOF data are shown in Table 8 and

Table 9. These results use the original costs and lifespans for the MyDiagnostick (£450 over 5 years, no charge for cloud storage) and RhythmPad GP (£1,100 over 1 year) devices.

Table 8 Base Case 1: Incremental cost effectiveness analysis (QOF 2017/18 data)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£517,575	448.317			
Kardia Mobile	£519,149	449.627	£1,574	1.310	£1,201
Zenikor-ECG	£522,161	449.582	£3,013	-0.046	Dominated
RhythmPad GP*	£522,243	449.007	£3,094	-0.620	Dominated
MyDiagnostick	£525,084	449.421	£5,936	-0.206	Dominated
imPulse	£534,954	449.387	£15,805	-0.240	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Table 9 Base Case 4: Incremental cost effectiveness analysis (QOF 2017/18 data)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£520,068	448.249			
Kardia Mobile	£520,909	449.598	£841	1.349	£623
Zenikor-ECG	£523,920	449.552	£3,012	-0.046	Dominated
RhythmPad GP*	£523,943	448.974	£3,035	-0.625	Dominated
MyDiagnostick	£526,832	449.391	£5,923	-0.208	Dominated
imPulse	£536,712	449.356	£15,803	-0.242	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Applying updated estimates for the proportion of patients treated with anticoagulants increases costs and QALYs for each of the devices in the analysis. The ICER per QALY gained for the Kardia Mobile device increases by £141 in both Base Case 1 and Base Case 4. All other devices remain dominated by the Kardia Mobile device. However, the order of the incremental analysis is affected by applying updated estimates for anticoagulant use as the

total cost of using the RhythmPad GP device becomes marginally greater than the total cost of using the Zenicor-ECG device in this scenario.

## 4 BASE CASE ANALYSES WITH UPDATED DEVICE COSTS AND ESTIMATES OF ANTICOAGULANT USE

Table 10 and

Table 11 show the incremental cost effectiveness results for Base Case 1 (updated Base Case 1) and Base Case 4 (updated Base Case 4) when the updated costs for MyDiagnostick and RhythmPad GP, and updated estimates of anticoagulant use from the QOF 2017/18 are applied in combination.

Table 10 Updated Base Case 1: Incremental cost effectiveness analysis (including updated device costs and QOF 2017/18 data)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£517,575	448.317			
Kardia Mobile	£519,149	449.627	£1,574	1.310	£1,201
RhythmPad GP*	£521,222	449.007	£2,074	-0.620	Dominated
Zenicor-ECG	£522,161	449.582	£3,013	-0.046	Dominated
MyDiagnostick	£525,072	449.421	£5,923	-0.206	Dominated
imPulse	£534,954	449.387	£15,805	-0.240	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Table 11 Updated Base Case 4: Incremental cost effectiveness analysis (including updated device costs and QOF 2017/18 data)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£520,068	448.249			
Kardia Mobile	£520,909	449.598	£841	1.349	£623
RhythmPad GP*	£522,923	448.974	£2,014	-0.625	Dominated
Zenicor-ECG	£523,920	449.552	£3,012	-0.046	Dominated
MyDiagnostick	£526,820	449.391	£5,911	-0.208	Dominated
imPulse	£536,712	449.356	£15,803	-0.242	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Applying updated device costs for MyDiagnostick and RhythmPad GP in combination with updated estimates of the proportion of patients treated with anticoagulants results in a small increase in the ICER per QALY gained for the Kardia Mobile device, in line with the effect of applying the updated estimates for anticoagulant use in isolation. All devices remain

dominated by the Kardia Mobile device and the order of the incremental analyses are unchanged from the original Base Case 1 and Base Case 4 analyses.

## 5 PROBABILISTIC SENSITIVITY ANALYSES

Pairwise and incremental cost effectiveness results from the probabilistic sensitivity analysis (PSA) for the updated Base Case 1 scenario including updated device costs and estimates of anticoagulant use are shown in Table 12 and

Table 13. The cost effectiveness acceptability curve (CEAC) for all devices in the updated Base Case 1 is shown in Figure 1.

Table 12 Updated Base Case 1: PSA results, pairwise cost effectiveness analysis

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£525,905	454.99426			
Kardia Mobile	£527,542	456.28692	£1,636	1.2927	£1,266
Zenikor	£530,589	456.24273	£4,684	1.2485	£3,752
RhythmPad GP*	£529,599	455.6849	£3,693	0.6906	£5,348
MyDiagnostick	£533,545	456.08804	£7,640	1.0938	£6,985
ImPulse	£543,647	456.05452	£17,742	1.0603	£16,734

ICER=incremental cost effectiveness ratio; PSA=probability sensitivity analysis; QALY=quality adjusted life year

\*Algorithm interpretation

Table 13 Updated Base Case 1: PSA results, incremental cost effectiveness analysis

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
Standard pathway	£525,905	454.99426			
Kardia Mobile	£527,542	456.28692	£1,636	1.2927	£1,266
RhythmPad GP*	£529,599	455.68490	£2,057	-0.6020	Dominated
Zenikor	£530,589	456.24273	£3,048	-0.0442	Dominated
MyDiagnostick	£533,545	456.08804	£6,004	-0.1989	Dominated
ImPulse	£543,647	456.05452	£16,106	-0.2324	Dominated

ICER=incremental cost effectiveness ratio; PSA=probability sensitivity analysis; QALY=quality adjusted life year

\*Algorithm interpretation



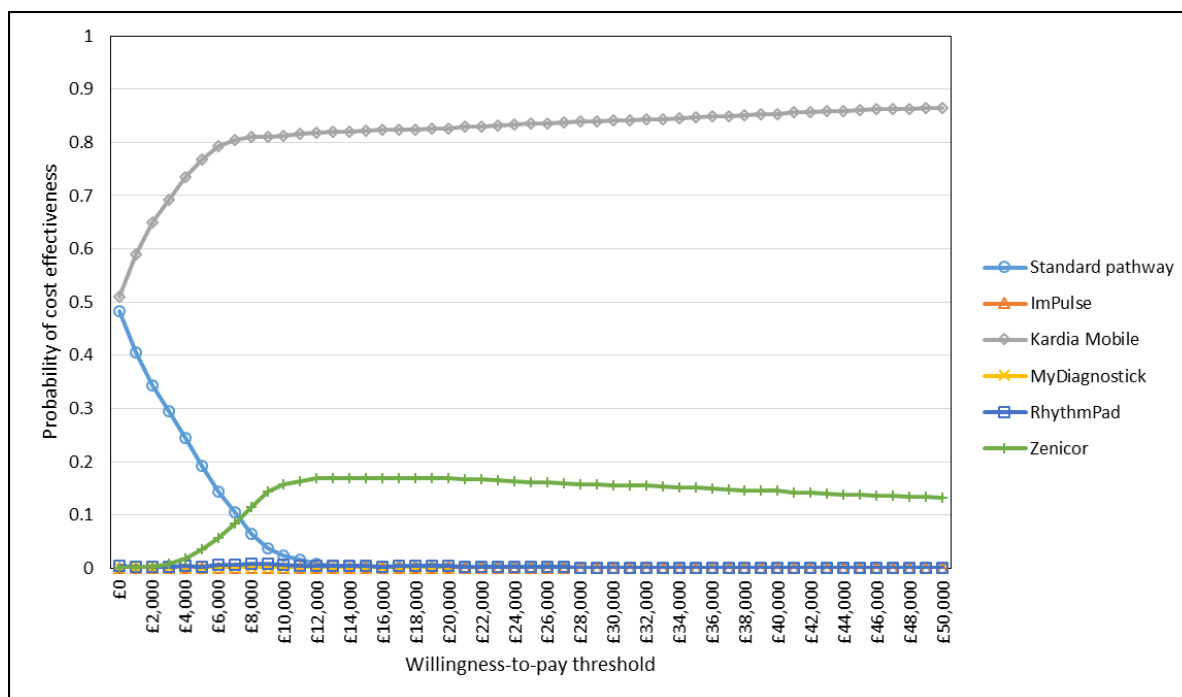


Figure 1 CEAC updated Base Case 1

The pairwise results from the PSA for the updated Base Case 1 scenario indicate that all devices included in this assessment were cost effective in at least 50% of iterations with a willingness to pay (WTP) threshold of around £17,000 per QALY. When all devices were considered together, just under 83% of iterations showed that Kardia Mobile would be the most cost effective option at a WTP threshold of £20,000 per QALY. Zenicor-ECG was the most cost effective option in around 17% of iterations at a WTP threshold of £20,000 per QALY. The results of the PSA when all devices are taken together indicate that the probability of cost effectiveness for the Zenicor-ECG device decreases at WTP thresholds greater than £20,000 per QALY. This is because, in the pairwise analysis, the Zenicor-ECG device reaches 99.9% probability of cost effectiveness at a WTP threshold of around £19,000 per QALY whereas the Kardia Mobile device does not reach this level in the pairwise analysis until a WTP threshold of nearly £50,000 per QALY. The interaction of the increasing probability of cost effectiveness for the Kardia Mobile device and the static probability for the Zenicor-ECG device results in a decreasing probability of cost effectiveness for the Zenicor-ECG device after around £20,000 per QALY.

## 6 SCENARIO: ALTERNATIVE SENSITIVITY AND SPECIFICITY ESTIMATES FOR RHYTHMPAD GP

The manufacturer of the RhythmPad GP device submitted three new documents as part of its response to the diagnostics consultation document:

- An unpublished trial paper manuscript
- An abstract book
- A Clinical Trials History document

These studies were assessed independently by two reviewers for inclusion using the eligibility criteria as in the original report. The new evidence was found not to meet the inclusion criteria. Reasons and rationale for exclusion of the new evidence is detailed below.

### 6.1 *Unpublished trial paper*

[REDACTED]

### 6.2 *Abstract book*

The abstract book includes an abstract with the results of the unpublished trial paper. As mentioned above, the results presented were for RhythmPad GP operated in a six-lead mode only and therefore this abstract was excluded.

### 6.3 *Clinical Trials History document*

This document includes details of three studies that were conducted during the development of the RhythmPad GP device.

[REDACTED]

[REDACTED] The second study was published as a conference abstract and included in the original EAG report. The EAG acknowledges in the report that the results presented are not for the current algorithm of RhythmPad GP. However this was the only available and suitable data for RhythmPad GP operated in a lead-I ECG mode that was available at the time of assessment.

[REDACTED]

[REDACTED]

[REDACTED]

Table 14 Alternative sensitivity and specificity estimates for RhythmPad GP

Parameter	Original model	Scenario
Sensitivity	67%	█
Specificity	97%	█

Source: Cardiocity<sup>3</sup>

Table 15 Scenario: Incremental cost effectiveness analysis using alternative sensitivity and specificity estimates for RhythmPad GP (using updated Base Case 1)

Strategy	Costs	QALYs	Incremental Costs	Incremental QALYs	ICER/ QALY gained
RhythmPad GP*	█	█			
Standard pathway	£517,575	448.317	█	█	Dominated
Kardia Mobile	£519,149	449.627	█	█	Dominated
Zenikor-ECG	£522,161	449.582	█	█	Dominated
MyDiagnostick	£525,072	449.421	█	█	Dominated
imPulse	£534,954	449.387	█	█	Dominated

ICER=incremental cost effectiveness ratio; QALY=quality adjusted life year

\*Algorithm interpretation

Applying the alternative sensitivity and specificity estimates for the RhythmPad GP device results in the RhythmPad GP device dominating (generating lower total costs and higher total QALYs) the standard pathway and all other devices in the analysis.

## 7 REFERENCES

1. NHS Digital. QOF 2016-17: Prevalence, achievements and exceptions at regional and national level. 2017; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/quality-and-outcomes-framework-qof-2016-17>. Accessed 08/02/2019.
2. NHS Digital. QOF 2017-18: Prevalence, achievements and exceptions at regional and national level. 2018; Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2017-18>. Accessed 08/02/2019.
3. Cardiocity Ltd. Clinical Trials History Document (unpublished).