PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Does use of point of care testing improve cost effectiveness of the NHS Health Checks programme in the primary care setting? A cost minimisation analysis.
AUTHORS	El-Osta, Austen; Woringer, Maria; Pizzo, Elena; Verhoef, Talitha; Dickie, Claire; Ni, Melody; Huddy, Jeremy; Soljak, Michael; Hanna, George; Majeed, Azeem

VERSION 1 - REVIEW

REVIEWER	Paresh Dawda Australian National University, Australia Board Member of ACT Heart Foundation, Australia
REVIEW RETURNED	15-Jan-2017

GENERAL COMMENTS	1. I could not see any reference to ethics approval. 2. There are minor typos (page 1 line 54 range instead of rage; page 3 line 38 is the word practice inadvertently omitted after general; page 4 line 38 change practiced to practices 3. Page 7 paragraph 1 - it would be helpful to see and understand which part of the laboratory pathway contributed to making it 2.5 minutes longer. I'm presuming this data was obtained from the three mock health checks conducted at each practice. Intuitively, I would have thought POCT was longer (assuming HCA/nurse were not undertaking phlebotomy duties). 4. Page 12. The final paragraph on the cost of opportunistic health checks assumes that HCA/nurses perform all such health checks. In such cases would the GP undertaking the consultation and identifying the opportunity also conduct the health check? 5. Page 14 lines 40-42 states that POCT may offer an effective way to increases coverage while prescribing statins to more people identified to be at high CVD risk. I'm not sure the study you have conducted explored this. Who in the general practice is responsible for discussing the risk and making the prescribing decision? This statement assumes that decision is made at the same time as the health check, however, I believe your study goes up the point the CVD risks score is calculated rather than beyond. 6. Page 14 lines 54-56 - Is there a reference for this statement? 7. Whilst I recognise the scope of your study is limited to NHS England you may want to review the Evaluation Report of New Zealand's heart check program (http://www.health.govt.nz/system/files/documents/publications/more-hearts-diabetes-checks-evaluation-aug16.pdf). It acheved high coverage eventually; identified need for blood tests as an impediment to slow uptake further evidenced by consumer feedback (see page 35-36 of report)

REVIEWER	Sebastian Hinde Centre for Health Economics, University of York. United Kingdom
REVIEW RETURNED	28-Feb-2017

GENERAL COMMENTS	Major: - While the question underlying the study is a good one, i.e. does POCT have the potential to both reduce NHS costs and increase the number of patients receiving full Health Checks, the analysis is far too limited in what it attempts. This limitation can be traced to 3 elements. Firstly, while it is described as a cost-benefit analysis it would perhaps be more accurate to describe it as a cost-minimisation analysis, as while the benefits of full attendance at the Health Checks are incorporated, they are not reported in its own right, rather a driver of cost saving. Secondly, despite commenting on the original Department of Health analysis (conducted in 2008 and while largely critiqued is yet to be improved upon) no attempt is made to use their findings on the long term implications of Health Check attendance to comment on the broader cost-effectiveness of a move to POCT. It is one thing to not conduct a full cost-effectiveness analysis, but to fail to incorporate existing results is disappointing. Finally, no consideration is made as to the wider implications of this study, surely there are many crossovers with non-Health Check activity, I feel this is missing from the discussion. Given the ever increasing speed and reducing size of testing machines, this shift to POCT could be argued as almost inevitable. - Why was no attempt made to quantify the level of uncertainty through PSA? Given the lower than planned number of Health Checks that inform the analysis and current lack of effectiveness analysis I would argue PSA is vitally important. - While I have said there are no undeclared CoIs, as funding by Alere is declared, I feel more should be commented on the role of the funder in the study. For example were the POCT equipment used under patent owned by Alere? Was the funding conditional? Did they have any active role in the study design or analysis? Minor: - The abstract presents the analysis as a purely prospective cohort study but given the emphasis on the cost minimisation analysis it might be worth adding something like '…and theoretical mathematical model'. - There is confusion both in the abstract and paper about the difference between methods and results with almost all of the details of the model, assumptions and scenarios appearing in the results section. While I appreciate that several of the model variables are derived from the cohort study almost all of what is reported on pages 5 to 10 are methods. Without any preamble in the current methods section that specific details are reported later in the paper I (as I'm sure other readers might) had all but discounted the paper as lacking in methodological detail. - A better level of proofreading is needed, examples include 'rage' rather than 'range' (p1 ln54) and 'and' rather than 'an' (p7 ln32). - In light of the model being a cost minimisation activity I would advise the use of the phrase 'mathematical modelling' over 'economic modelling' - A reference is needed on p3 ln3-5. - I would move much of the last introductory paragraph to the discussion

	- Table 2 needs direct reference to the sources of each of the parameter values to highlight which is from literature, the study or purely assumption - To what extent can tests conducted in a laboratory be conveyed to patients over the phone? Would this constitute another comparator? - Would a series of tornado plots be a better way of presenting the parameter uncertainty rather than the one way scenarios, this would give the reader a better understanding of how vital your assumptions are. - Is the POCT cost estimate (£950) from a reference or from the manufacturer or purely an assumption? - I am not sure what the sub-section 'Cost of health check assuming all patients respond to invite letter and complete Health Check' adds. Apart from the assumptions being unreasonable would it not fit better as a scenario? The same applies to the 'Cost of opportunistic health checks', this is a relevant discussion point but too assumption heavy to be an analysis.

VERSION 1 – AUTHOR RESPONSE

REVIEWER 1 : Paresh Dawda; Institution and Country: Australian National University, Australia
Competing Interests: Board Member of ACT Heart Foundation, Australia

1- I could not see any reference to ethics approval.
R1-Ethical approval was not sought for this study as it did not involve recruitment of participants or use of patient identifiable data and other qualifying criteria. The HRRA tool (http://hra-decisiontools.org.uk/ethics/) did not indicate a requirement to seek ethical approval. Output saved as PDF and provided as supplement.
We included ethics statement on page 6 of updated manuscript

2- There are minor typos (page 1 line 54 range instead of rage; page 3 line 38 is the word practice inadvertently omitted after general; page 4 line 38 change practiced to practices 3. Page 7 paragraph
R2-The updated manuscript was proof-read by three individuals and errors corrected.

3- it would be helpful to see and understand which part of the laboratory pathway contributed to making it 2.5 minutes longer. I'm presuming this data was obtained from the three mock health checks conducted at each practice. Intuitively, I would have thought POCT was longer (assuming HCA/nurse were not undertaking phlebotomy duties).
R3-The time required to conduct an NHS Health Check up to the point of CVD risk score calculation varied from practice to practice (range = 20-40 min) irrespective of whether they were using POCT. The shortest time recorded was for a simulated patient undertaking an opportunistic Health Check assuming that recent (< 3 month) blood results and blood pressure readings were available on the patient's electronic health record. The following text is now included on page 9, para 2 & 3 of the manuscript:
'The average time required to acquire blood sample was 2.5 minutes longer with cannulated syringe method used in the Laboratory pathway than via pin prick sample used in POCT pathway. Events related to drawing blood sample by cannulated syringe include rolling up patient's sleeve, applying a constriction band, labelling blood vials, disinfecting injection site, inserting cannula, attaching collection vials, drawing of blood sample, removing cannula, applying digital pressure followed by a plaster over the wound, and preparing the vials for dispatch by courier. Accessing a blood sample following finger prick, involved fewer steps including disinfecting injection site, finger pin prick, transferring blood aliquot onto a cassette via capillary to enable measurement with POC device and applying a plaster to wound area. The 5 min time required for the POC device to deliver test results was used to apply the sphygmomanometer enabling further interlocution with the patient to drive the

Health Check.'
Although access to blood sample is more expedient via pin prick method than with a cannulated syringe, we assumed in the base case scenario of the mathematical model that a Health Check with Lab pathway takes 20 minute as opposed to 30 min with POCT (table 1: input parameters). This is because we acknowledge that some patients might have their blood test at hospital main outpatient department or in community health centre (i.e. not at GP practice). In spite of this, the results of the mathematical model still showed that POCT is less costly for the purposes described from NHS perspective.

4- Page 12. The final paragraph on the cost of opportunistic health checks assumes that HCA/nurses perform all such health checks. In such cases would the GP undertaking the consultation and identifying the opportunity also conduct the health check?
R4-GPs do not routinely conduct an NHS Health Check during a consultation with patients due to limited consultation time (circa 10 minutes)
The main model was based on HCA or nurse salary costs. The modelling was based on commonly observed Base Case Scenario (HCA-led Health Check with a DNR rate of 90.2% in both pathways, DNA rate of 10.6% in the POCT and the first step of laboratory pathway and then DNA rate of 5% in the following steps for the laboratory pathway; LAB fasting glucose measurement as opposed to HbA1c).

5- Page 14 lines 40-42 states that POCT may offer an effective way to increases coverage while prescribing statins to more people identified to be at high CVD risk. I'm not sure the study you have conducted explored this. Who in the general practice is responsible for discussing the risk and making the prescribing decision? This statement assumes that decision is made at the same time as the health check, however, I believe your study goes up the point the CVD risks score is calculated rather than beyond.
R5-Low statin prescribing to people at increased CVD risk and variation in statin prescribing among general practices highlights the need for better follow-up of patients. We propose that because CDV risk score is available immediately following a Health Check with POCT, it could potentially expedite the timely prescription of statins to patients identified to be at high CVD risk during a routine or follow-up appointment with GP or prescribing clinician. It is assumed that patients who complete Health Check in one sitting using POCT and are found to be at risk of CVD may be offered statins sooner by virtue of having their CVD risk score available to their prescribing clinician/GP during a routine or scheduled follow-up appointment immediately. Conversely, CVD risk score of patient will not be available to GP/prescribing clinician in the case that the patient has commenced the Health Check but is still waiting for blood results or calculation of CVD risk using online algorithm (this may take up to one weeks as CDV risk score calculation using online algorithm is usually conducted by HCA or Nurse and not by GP during routine consultation time). This could potentially delay timely prescription/offer of statins for these patients who see their GP soon after initiating Heath Check. We would be happy to exclude this statement if this is your preference, but in view of our rationale above, we reworded the statement in the manuscript on (Page 15, para 4) to read: 'Because CDV risk score is available immediately following a Health Check with POCT, it could potentially expedite the timely prescription of statins to patients identified to be at high CVD risk during a routine or follow-up appointment with GP or prescribing clinician'

6- Page 14 lines 54-56 - Is there a reference for this statement [Unless the cost of the tests (including equipment, consumables and time) were fully reimbursed, the practice would lose money from employing the use of POCT].
R6-We included appropriate reference for this. Huddy et al., 2016 (reference number 18 in updated manuscript) suggest that the primary barrier [for the widespread adoption CRP POCT to support ABX prescribing] at present is the absence of a UK funding and reimbursement model for the test. Several funding models were proposed during their study, each with their own incentives for reimbursement,

but they report that there is a risk that inappropriate schemes may lead to overuse or underuse of the test potentially leading to an overall reduction in cost-effectiveness.In the case of extant reimbursement models to support use of POCT for NHS Health Checks, GP practices are eligible to claim payment from PHE Local Area Team for every complete Health Check conducted, or they might otherwise not conduct a Health Check as it is not mandatory. Practices that conduct Health Checks are therefore incentivised to support the programme with payments (anecdotal evidence from our engagement with pan London practices suggest this payment varies between £19-£35 depending on locality, and payment is scalable based on number of Health Checks conducted). Income from this funding stream could be used to offset actual resource costs linked to conducting the Health Check (i.e. nurse time, consumables etc., and/or cartridge costs and other relevant costs if using POCT). However, practices that do not offer Health Checks do not 'lose' any money per se- they simply don't claim a tariff for an activity they did not complete. Therefore, (apart from offering Health Checks for patient benefit) it could be argued that some practices conduct Health Checks to attract additional income, or that they may choose not offer a non-mandatory service (e.g. Health Check) if they cannot recoup payment. General practices in England are under great workload pressures, with many practices struggling to remain solvent in the current financial climate. This has led to the creation of large and federated GP Practice models. Unless the cost of non-mandatory activity is recouped (from NHSE, CCG or Local Enhanced Scheme for example) the practice will be out of pocket for supporting this activity. This was our rationale for making this statement.

7- Whilst I recognise the scope of your study is limited to NHS England you may want to review the Evaluation Report of New Zealand's heart check program . It achieved high coverage eventually; identified need for blood tests as an impediment to slow uptake further evidenced by consumer feedback (see page 35-36 of report)
R7-Thank you for suggesting we review the findings of this report. We were also interested to read that there were some case studies involving the use of POCT in bid to improve uptake (Page 36, para 3 of Evaluation Report of New Zealand's heart check program sates that "Another work-around trialled in some case study sites was the use of 'point-of-care' capillary blood testing – a system that participants reported to be effective but extremely expensive and so its use was limited to exceptional circumstances"…
In light of this, we included the following paragraph on Page 14, Para 3 of the manuscript:
'A recent evaluation of New Zealand's Heart Check Programme (NZHCP) showed that whereas the coverage rate was initially poor, the programme eventually met its national target coverage rate of 90% following a series of patient engagement initiatives coupled to effective use of IT. The evaluation identified the need for blood tests as an impediment to slow uptake initially, and case studies employing the use of POCT to support NZHCP were deemed effective. However, use of POCT in NZHCP was considered too expensive from the perspective of the provider, although it is unknown whether this conclusion resulted from a cost minimisation analysis.

REVIEWER 2 : Sebastian Hinde; Institution and Country: Centre for Health Economics, University of York, United Kingdom Competing Interests: None declared

1- While the question underlying the study is a good one, i.e. does POCT have the potential to both reduce NHS costs and increase the number of patients receiving full Health Checks, the analysis is far too limited in what it attempts. This limitation can be traced to 3 elements. Firstly, while it is described as a cost-benefit analysis it would perhaps be more accurate to describe it as a cost-minimisation analysis, as while the benefits of full attendance at the Health Checks are incorporated, they are not reported in its own right, rather a driver of cost saving. Secondly, despite commenting on the original Department of Health analysis (conducted in 2008 and while largely critiqued is yet to be improved upon) no attempt is made to use their findings on the long-term implications of Health Check attendance to comment on the broader cost-effectiveness of a move to POCT. It is one thing to

not conduct a full cost-effectiveness analysis, but to fail to incorporate existing results is disappointing. Finally, no consideration is made as to the wider implications of this study, surely there are many crossovers with non-Health Check activity, I feel this is missing from the discussion. Given the ever-increasing speed and reducing size of testing machines, this shift to POCT could be argued as almost inevitable.
R1-Thank you for pointing this out. We updated the manuscript to specify that this is a cost minimisation analysis, employing a micro-costing approach.
We agree that the rapid developments of POC testing may make use of POC tests much more common in primary care (e.g. for the management of infections). Our group has carried out a separate evaluation of the NHS Health Check programme. The Results were published in CMAJ (refernce includedc. The revised manuscript now includes a discussion on how POCT could help reduce missed opportunities to complete an NHS Health Check by enabling CVD risk score presentation in one sitting in the primary care setting (page 14, last para & page 15 1st para). We suggested that future large scale public health screening programmes should ideally consider a disruptive commissioning model that includes reimbursement and other incentives to affect the large scale adoption of suitable multi-array POCT devices in a bid to reduce costs from NHS perspective, whilst also supporting the needs of GP practices in the new setting. We also discussed wider implication of findings
We included a discussion about the wider impactions of this study (Pages 16 & 17), proposing that advances in technology and miniaturisation could result in more affordable POC devices with added functionality (for example, with the ability to conduct an array of tests to serve different clinic needs and as a decision support tool). Competitive behaviour between POC device manufacturers could also lead to lower unit and POCT consumables costs, making POC more affordable. We also highlighted that the use of POCT to support delivery of NHS Health Checks in one sitting may also be more convenient from the patient's perspective as this diminishes the need for subsequent visits. Use of POCT may also be preferred by patients who are needle phobic and avert to having a blood test via a cannulated syringe.

2- Why was no attempt made to quantify the level of uncertainty through PSA? Given the lower than planned number of Health Checks that inform the analysis and current lack of effectiveness analysis I would argue PSA is vitally important.
R2-As this was not a complete economic evaluation, we decided not to conduct a PSA in the first instance. However, in light of your recommendations we conducted a PSA and included the findings in the paper. A probabilistic sensitivity analysis was performed to obtain 95% credible intervals around the main results. This was done by carrying out 1000 simulations using uniform distributions for each parameter. The input parameters for sensitivity analysis are shown in Table 1, whereas base case scenario showing total expected cost (TEC), number of completed Health Checks and costs per completed Health Check per 100 invites (including 95% credible intervals from PSA) are included in Table 2. We also included a tornado diagram (Figure 2) showing the 10 parameters with the largest influence on the difference in cost per 100 invites.

3- While I have said there are no undeclared CoIs, as funding by Alere is declared, I feel more should be commented on the role of the funder in the study. For example were the POCT equipment used under patent owned by Alere? Was the funding conditional? Did they have any active role in the study design or analysis?
R3-The PHE Local Area Team in the Triborough region (i.e. Hammersmith & Fulham CCG, Westminster/Central London CCG and Kensington & Chelsea CCG- all using TTP SystmOne) were keen to improve uptake of NHS Health Checks in locality due to low coverage. To this end, they bought POCT devices (from Alere), consumables and also contracted with Medvivo 'Pod' system to enable practices to conduct Health Checks in one sitting. They reasoned that this will improve uptake because a Health Check could be completed in one sitting. Alere subsequently became interested in determining if this model (i.e. POCR pathway) could deliver a cost saving from NHS perspective.

Unconditional funding for this work was provided by Alere International Limited in the form of a Medical Education Grant. The Funder did not have a role in study design or analysis. This is now reflected in the Funding Statement on Page 16 of updated manuscript.

4- The abstract presents the analysis as a purely prospective cohort study but given the emphasis on the cost minimisation analysis it might be worth adding something like '…and theoretical mathematical model'.
R4-We updated the abstract to reflect this. We now state 'Design: Observational study and theoretical mathematical model with micro-costing approach'

5- There is confusion both in the abstract and paper about the difference between methods and results with almost all of the details of the model, assumptions and scenarios appearing in the results section. While I appreciate that several of the model variables are derived from the cohort study almost all of what is reported on pages 5 to 10 are methods. Without any preamble in the current methods section that specific details are reported later in the paper I (as I'm sure other readers might) had all but discounted the paper as lacking in methodological details.
R5-Thank you for highlighting this. We revised the manuscript and included relevant text from Results section to Methods- which are now more explicit.

6- A better level of proofreading is needed, examples include 'rage' rather than 'range' (p1 ln54) and 'and' rather than 'an' (p7 ln32).
Corrections were made.
R6- The updated manuscript is now free of typos following review/proofreading by 3 individuals.

7- In light of the model being a cost minimisation activity I would advise the use of the phrase 'mathematical modelling' over 'economic modelling'
R7-This was actioned. The updated manuscript specifies that our study employed the use of a mathematical model with a micro-costing approach.

8- A reference is needed on p3 ln3-5.
R8- Reference added.

9- I would move much of the last introductory paragraph to the discussion.
R9-Much of the last introductory paragraph was moved to discussion.

10- Table 2 needs direct reference to the sources of each of the parameter values to highlight which is from literature, the study or purely assumption
R10-Input Parameters are now shown in Table on page 11 of updated manuscript. We added an additional column to include direct reference to the sources of each of the parameter values used in the analysis.

11- To what extent can tests conducted in a laboratory be conveyed to patients over the phone? Would this constitute another comparator?
R11-Whereas it is possible for blood test results to be conveyed over the phone, CVD risk score calculation via online algorithm and subsequent presentation of CVD risk score to the patient is usually communicated to the patient. A such we did not include a scenario to calculate costs for communicating CVD risk score to the patient over the phone as a comparator.

12 -Would a series of tornado plots be a better way of presenting the parameter uncertainty rather than the one-way scenarios, this would give the reader a better understanding of how vital your assumptions are.
R12-Thank you for suggesting this. We included a tornado diagram (Figure 2) showing the 10

parameters with the largest influence on the difference in cost per 100 invites

13- Is the POCT cost estimate (£950) from a reference or from the manufacturer or purely an assumption?
R13-At the time of the commencement of this study, the indicative cost of the POCT devices used by the practices recruited for this study was £950. The cost for POCT devices from other device manufacturers (i.e. Roche) with similar and/or added functionality ranged from £950-£1,500. This reasonable price range was used in the mathematical model. Although the cost of POCT devices has decreased in the last few years (for example, the same POC device by Alere now costs circa £600), the range used is still applicable as modern devices with added functionality cost around £1000, with the larger, multi-array devices benchtop devices in upwards of £1,500.

14- I am not sure what the sub-section 'Cost of health check assuming all patients respond to invite letter and complete Health Check' adds. Apart from the assumptions being unreasonable would it not fit better as a scenario? The same applies to the 'Cost of opportunistic health checks', this is a relevant discussion point but too assumption heavy to be an analysis.
R14-We conducted this analysis to determine the extent to which costs of blood results (whether via phlebotomy or at point of care) and cost of consumables affected the findings. This analysis showed that the only scenario where Laboratory pathway is less costly than POCT pathway is when an opportunistic Health Check is based on recent (<3 month) blood results are available on patient's EHR.
We included reference to a study which showed that about a quarter of NHS Health Checks result from 'opportunistic' recruitment (i.e. eligible patient is identified in situ during routine appointment with GP or nurse, and they enter the pathway to have a Health check wither via POCT or Laboratory pathway etc.,). However, it is unknown what proportion of these patients identified in situ actually complete a Health Check 'on the spot'. Our analysis of costs related to an opportunistic Health Check provides the costs for a meaningful and increasingly likely scenario. We included these results for completeness because as more and more practices are federating, the likelihood of GP practices offering opportunistic Health Checks (although currently assumed to be small) will likely increase.

VERSION 2 – REVIEW

REVIEWER	Paresh Dawda Australian National University and University of Canberra
REVIEW RETURNED	19-Apr-2017

GENERAL COMMENTS	Authors have satisfactorily addressed previous comments

REVIEWER	Sebastian Hinde Centre for Health Economics, University of York, United Kingdom
REVIEW RETURNED	03-Apr-2017

GENERAL COMMENTS	I would like to thank the authors for providing such through and thoughtful responses to my review comments. I am happy that they have all been answered to a sufficient standard for publication. My one, very small, additional comment would be to better reflect the findings on the PSA in the emphasis placed on the reporting of the results. While I fully accept the informative distributions are not representative of real data, being informed by a uniform distribution based on theorised maximum and minimum values, the authors should reflect that the result suggests the POCT may not be cost saving given the level of prevailing uncertainty. As a result, rather

	than statements such as 'significantly less costly' and 'POCT...is less costly', I would advise, for example, 'would be expected to be less costly', as you have not demonstrated the statistical significance of the cost saving beyond reasonable doubt. Otherwise I congratulate the authors on a greatly improved paper.

VERSION 2 – AUTHOR RESPONSE

We updated the manuscript to address the recommendation of Prof. Sebastian Hind.

We are pleased that you have recommended publication of our findings in BMJ Open, and we look forward to your favourable reply.