



King's Research Portal

Document Version
Peer reviewed version

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Roberts, S. L. E., Healey, A., & Sevdalis, N. (in press). Use of health economic evaluation in the implementation and improvement science fields – A systematic literature review. *Implementation Science*.

Citing this paper

Please note that where the full-text provided on King's Research Portal is the Author Accepted Manuscript or Post-Print version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version for pagination, volume/issue, and date of publication details. And where the final published version is provided on the Research Portal, if citing you are again advised to check the publisher's website for any subsequent corrections.

General rights

Copyright and moral rights for the publications made accessible in the Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the Research Portal

Take down policy

If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

1 Use of health economic evaluation in the implementation and
2 improvement science fields – A systematic literature review

3

4 Authors and affiliations: Sarah Roberts¹, Andy Healey^{1,2}, Nick Sevdalis²

5 1. King's Health Economics, King's College London, UK; 2. Centre for Implementation Science,
6 King's College London, UK

7

8 Corresponding author's details:

9 sarah.l.roberts@kcl.ac.uk; King's Health Economics, Health Service and Population Research

10 Department, Institute of Psychiatry, Psychology and Neuroscience, King's College London, David
11 Goldberg Centre, De Crespigny Park, London SE5 8AF, United Kingdom.

12

13

14

15

16

17

18

19

20

21 Abstract

22 **Background:** Economic evaluation can inform whether strategies designed to improve the quality of
23 health care delivery and the uptake of evidence-based practices represent a cost-effective use of
24 limited resources. We report a systematic review and critical appraisal of the application of health
25 economic methods in improvement/implementation research.

26 **Method:** A systematic literature search identified 1668 papers across the Agris, Embase, Global
27 Health, HMIC, PsycINFO, Social Policy and Practice, MEDLINE and EconLit databases between 2004-
28 16. Abstracts were screened in Rayyan database, and key data extracted into Microsoft Excel.
29 Evidence was critically appraised using the Quality of Health Economic Studies (QHES) framework.

30 **Results:** Thirty studies were included – all health economic studies that included implementation or
31 improvement as a part of the evaluation. Studies were conducted mostly in Europe (62%) or North
32 America (23%) and were largely hospital-based (70%). The field was split between improvement
33 (N=16) and implementation (N=14) studies. The most common intervention evaluated (43%) was
34 staffing reconfiguration, specifically changing from physician-led to nurse-led care delivery. Most
35 studies (N=19) were ex-post economic evaluations carried out empirically – of those, seventeen
36 were Cost Effectiveness Analyses. We found four Cost Utility Analyses that used economic modelling
37 rather than empirical methods. Two Cost-Consequence Analyses were also found. Specific
38 implementation costs considered included costs associated with staff training in new care delivery
39 pathways, the impacts of new processes on patient and carer costs and the costs of developing new
40 care processes/pathways. Over half (55%) of the included studies were rated ‘good’ on QHES. Study
41 quality was boosted through inclusion of appropriate comparators and reporting of incremental
42 analysis (where relevant); and diminished through use of post-hoc sub-group analysis, limited
43 reporting of the handling of uncertainty and justification for choice of discount rates.

44 **Conclusions:** The quantity of published economic evaluations applied to the field of improvement
45 and implementation research remains modest, however quality is overall good. Implementation and

46 improvement scientists should work closely with health economists to consider costs associated
47 with improvement interventions and their associated implementation strategies. We offer a set of
48 concrete recommendations to facilitate this endeavour.

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74 Background

75 Both improving health care and implementation of evidence-based practices are receiving increasing
76 attention within the wider applied health research field. A recent editorial in *Implementation Science*
77 [1] discussed the importance implementation science places on the robustness and validity of health
78 economic evaluations and the benefits gained by properly evaluating both implementation and
79 improvement interventions. We define *improvement* science as the scientific approach to achieving
80 better patient experience and outcomes through changing provider behaviour and organisation,
81 using systematic change methods and strategies [2]. We define *implementation* science as the
82 scientific study of methods to promote the uptake of research findings into routine health care
83 practice or policy [2].

84 This paper presents a review of the application of economic evaluation to evaluative studies of
85 service improvement initiatives and interventions focused on facilitating the implementation of
86 evidence into practice. The aim of economic evaluation is to present evidence on the costs and
87 consequences (in terms of patient outcomes) of quality improvement strategies and methods for
88 increasing the uptake of evidence-based practices compared to the “status quo”. In doing so, it
89 informs whether specific initiatives are (or have been) a worthwhile (or “cost-effective”) use of the
90 limited resources of health systems.

91 Depending on the service and population context, the methods used in economic evaluations can
92 vary depending on the perspective taken. This can range from a narrow assessment of patient
93 outcomes alongside immediate health care provider cost impacts through to the quantification of
94 costs and consequences affecting other (non-health related) sectors, organisations and wider
95 society. In health programme evaluation, economic evaluations are most frequently carried out “ex-
96 post” or “after the fact”, using empirical methods applied to cost and outcome data extracted from
97 trials or other research designs used to evaluate initiatives being tested in specific populations and
98 settings. Economic evaluations can also be applied “ex-ante” - to inform option appraisal and pre-

99 implementation decision making using available evidence and modelling to simulate the costs and
100 outcomes of alternatives, e.g. in relation to population scale-up or geographical spread of strategies
101 and methods for improvement and evidence uptake.

102 While economic evaluation has become an integral part of health technology assessment, its
103 application within improvement and implementation evaluative research remains relatively limited
104 [1]. In two earlier reviews (Hoomans et al in 2007 [3] and earlier Grimshaw et al in 2004 [4]), the use
105 of economic methods in evaluating the implementation of evidence-based guidelines was examined
106 and the authors found evidence of limited quality and scope for understanding the cost-
107 effectiveness of implementation strategies. It is now over a decade since these reviews were
108 published, hence a fresh evidence review, synthesis and appraisal is required.

109 The aim of this study was to examine what advances have been made in the use of economic
110 analysis within implementation and improvement science research, specifically in relation to the
111 quantity and quality of published economic evidence in this field; and to what extent economic
112 evaluations have considered implementation and improvement as part of a holistic approach to
113 evaluating interventions or programmes within the applied health arena.

114

115 **Methods**

116 *Search strategy*

117 A systematic review methodology was undertaken. A search strategy was developed to capture
118 evidence published after 2003 (the date of most recent-evidence review) and the last searches were
119 performed on 16th March 2016. The searches were performed on the following databases: Agris,
120 Embase, Global Health, HMIC, PsycINFO, Social Policy and Practice, MEDLINE and EconLit. These
121 databases were chosen to attempt to capture the widest range of health improvement, social
122 scientific and health economic studies.

123 The search strategy (Box 1) was designed to capture studies that had a quantitative economic
124 element (i.e. costs and outcomes based on randomised trial data, observational study data or
125 synthesis of the wider empirical evidence base to support economic modelling). The search was
126 conducted to be inclusive of studies whereby behavioural interventions for quality improvement and
127 implementation of evidence into practice were evaluated as well as initiatives around re-design or
128 adjustment to care pathways or reconfiguration of staffing inputs for the purpose of quality
129 improvement-

130 We searched across a wide range of clinical settings, including primary, secondary and tertiary care
131 and public health.

132

133 *Screening*

134 The completed search results were downloaded into Endnote X6 for citation management and
135 deduplication. Screening was done in Rayyan, a web-based literature screening program [6]. Rayyan
136 allows for easy abstract and full text screening of studies, custom inclusion and exclusion criteria, as
137 well as custom tags or labels that can be added to each entry. Studies were initially screened using
138 the inclusion/exclusion criteria outlined in the next section, on title and abstract only (by SLER);
139 studies that were borderline for inclusion were more thoroughly screened by examining their full
140 text. The reference lists of the studies were checked for any related studies that were not picked up
141 by the search.

142

143 *Inclusion and exclusion criteria*

144 Studies were included if they:

- 145 • Were published in the English language
- 146 • Reported on a completed study

147 ○ Study protocols, methodological papers or conference abstracts were excluded
148 (after additional searches had been performed to ensure that full papers had not
149 been subsequently published).

- 150 • Were published after 2003 and before 16th March 2016
- 151 • Were conducted in public health, primary, secondary or tertiary care

152 Further, studies were included if they covered aspects of:

- 153 • Implementation
- 154 • Quality/service improvement
- 155 • Health or clinical service delivery
- 156 • Staff behaviour change
- 157 • Patient behaviour change

158 And they also:

- 159 • Had patient focused outcomes or outcomes as overall service improvement that would
160 improve patient outcomes or care, expressed as quantifiable outcomes
- 161 • Had economic elements, expressed as quantifiable outcomes
- 162 • Reported one of the following health economic methodologies:
 - 163 ○ Cost effectiveness analysis
 - 164 ○ Cost-utility analysis
 - 165 ○ Cost-benefit analysis
 - 166 ○ Cost-consequence analysis
 - 167 ○ Burden of disease

168 The following study designs were included:

- 169 ○ Randomised controlled trials
- 170 ○ Hybrid effectiveness-implementation trials

- 171 ○ Comparative controlled trials without random assignment
- 172 ○ Before and after studies
- 173 ○ Systematic reviews
- 174 ○ Time series study design

175 Studies or papers that did not fall within the above criteria were excluded. No geographical
176 exclusions were applied. Cost-only studies were not included as the aim of this review was to
177 establish the extent that both costs and benefits were being considered as part of a holistic
178 approach to evaluation of implementation and improvement interventions.

179

180 To mitigate for potential selection bias after screening, keyword searching was done in Rayyan for
181 the main keywords within the excluded categories (primarily, those that were deemed to be topic-
182 relevant but not containing economic methods). These were then re-screened by the first author.
183 Studies that included only minimal discussion of costs or costing with no evidence of application of
184 appropriate, standard costing methods (as per the criteria above) were excluded.

185

186 *Data extraction*

187 Screened studies were downloaded from Rayyan and transferred into a template developed in
188 Microsoft Excel 2016 for detailed data extraction. During screening, each included study was tagged
189 in Rayyan with the reasons for inclusion, type of economic evaluation (see Box 2), which economic
190 modelling method used (if applicable), whether improvement or implementation study, the health
191 condition covered, the focus of the reported intervention and health care setting. These were cross-
192 checked for accuracy during the data extraction stage. The next stage of the extraction added the
193 country of the study, perspective of the study (healthcare only or “societal”), and more detailed
194 information about the economic methods. The latter included whether the evaluation included
195 appropriate comparators (e.g. status quo/the standard care practice), patient outcome measures

196 used, whether costs and outcomes were analysed and reported in the form of incremental cost-
197 effectiveness ratios (ICERs) for cost-effectiveness or cost-utility analyses, how uncertainty was
198 handled and what conclusions were made regarding the cost-effectiveness of the interventions
199 under evaluation.

200

201 *Quality appraisal*

202 Each paper's methodological quality was assessed using the 'Quality of Health Economic Studies
203 (QHES) standardised framework [4]. The QHES instrument was designed to more easily tell the
204 difference between high quality and low-quality studies.[5] Each study was scored out of 100 based
205 on 16 criteria, with points allocated for full and partial assessments against each item (see Appendix
206 for the framework and scoring system). As per standard practice using this framework, the studies
207 were deemed to be of good quality if they attained a score of 75/100 or higher [5].

208

209 Results

210 *Studies included*

211 Figure 1 shows the flow of studies through the screening stages of the systematic review.

212 In total, the initial search strategy identified 1668 articles, of which 1566 were excluded, 1525 during
213 the initial screen and 41 following full text screening. Reasons for exclusion were: the study did not
214 include implementation or quality improvement research aspects (575); it did not include economic
215 aspects (447); was not within a health care/public health setting (437); it was in a language other
216 than English (22); it was incomplete (19); or it was not a full refereed publication (e.g. conference
217 abstracts, doctoral theses) (37).

218 Thirty studies were included in the final evidence review and synthesis.

219

220 *Descriptive analysis of the evidence base*

221 Table 1 provides a descriptive overview of the evidence base reported in the thirty reviewed studies.
222 Seventeen of the studies (62%) were European-based (mostly from the UK – 12 studies), six studies
223 (23%) were based in either the US or Canada, four from Australia and one each from Ethiopia, a
224 subset of African countries (Uganda, Kenya and South Africa) and Malaysia. In terms of health care
225 settings, twenty-one studies were hospital based, approximately half in inpatient wards and
226 departments, including cardiology, oncology, rheumatology, gastroenterology, geriatrics,
227 endocrinology, orthopaedics and respiratory medicine, or specifically concerning ward management
228 or discharge protocols.

229 Sixteen of the included studies were identified as “improvement” studies (see Table 1, panel 1a) and
230 fourteen were identified as “implementation” studies (see Table 1, panel 1b). The definitions from
231 Batalden & Davidoff (2007) that are cited in the introduction were used to stratify the studies. The
232 most common focus of the reviewed improvement studies was staff reconfigurations within a
233 clinical area from medical to nursing staff; for implementation studies, the most common focus was
234 on implementation strategies for of new care pathways or novel services.

235 Table 2 summarises the types of intervention evaluated. The most common intervention type,
236 evaluated in thirteen (43%) of the included studies, was staffing reconfiguration for service quality
237 improvement, specifically changing from physician-led to nurse-led delivery of interventions to
238 patients. More broadly, interventions involving general service reorganisation or changes to existing
239 systems of care were the primary focus in ten (33%) of studies reviewed.

240 Nineteen studies were ex-post economic evaluations of which seventeen were CEAs with one CUA
241 [7][12][14][15] [17] [18][20][21][22][23][24][25][26][27][29][30][31][36]. All these evaluations
242 compared a new intervention against current practice. There were also four further CUAs that used
243 economic modelling rather than empirical methods [8] [9] [10][37], and two cost-consequence
244 analyses[16][38]. Three of the included studies were literature reviews [11] [13] [39].

245 Specific implementation costs, such as those associated with training staff in new care delivery
246 pathways, the impacts of new processes on patient and carer costs and the costs of developing the
247 new processes were considered by six of the reviewed studies. Scenario analysis for rollout or scaling
248 up were included in three of the studies, and potential funding sources were considered by one
249 study.

250

251 *Quality appraisal*

252 Twenty-two of the papers were included in the QHES economic quality appraisal: as the quality scale
253 is designed to evaluate cost-minimisation, cost-effectiveness and cost-utility studies [5], the
254 literature reviews, meta-analyses or commentaries were excluded for this component. Of the
255 excluded papers, four were systematic reviews and four were papers that did not report on specific
256 studies. The QHES instrument contains 16 dimensions and an outline of the dimensions, the average
257 score and the percentage of the papers reaching the perfect score for each dimension can be found
258 in Table 3. While most of the papers in this study reached the threshold of being 'good' studies, the
259 scores are gained mostly in the same areas in each paper. The average quality score was 76 out of a
260 possible 100 (Figure 2). Thirteen of the studies (62%) attained a 'good' score of over 75. Only one
261 study [36] obtained a 'perfect' score of 100 points. Improvement studies performed overall better
262 than implementation studies on the QHES.

263 The best performing QHES dimensions were the methodological dimensions. Incremental analysis
264 with a relevant comparator (dimension 6) was used in all but one study, and in 81% of studies the
265 data sources for the analysis were from randomised controlled trials, the highest scoring type of
266 evidence in the QHES instrument. The costing element, covered by dimension 9, performed poorly
267 overall. While three quarters of studies gave details of what methodology was used to quantify
268 service inputs (such as use of self-report service use schedules) and the sources and methods used
269 for estimating unit costs, only two gave justification for why they chose that method. By comparison,

270 there was justification for the use of effectiveness measures and study outcomes given in two-thirds
271 of studies.

272 Discount rates were correctly applied and stated when adjusting for timing of costs and benefits in
273 all cases where measured costs and outcomes extended beyond one year.

274 A little over a quarter of the included studies declared the perspective of their analysis and gave a
275 justification for the perspective used. Only a third gave details of how parameter uncertainty was
276 addressed in relation to the study conclusions. Justification for chosen discount rates was not
277 provided in around half the studies that used them. Where sub-group analysis was carried out, this
278 was done post-hoc rather than being pre-planned with a clear a-priori justification for the use of the
279 chosen sub-groups.

280

281 Discussion

282 *Reflections on the evidence*

283 The aim of this review was to critically evaluate the application of economic analysis within
284 implementation and service improvement evaluative research in recent years. The results of
285 evaluating the thirty included papers paint a picture of an area of research that is still developing.

286 The reviewed studies were generally of good quality. However, we found that there were aspects of
287 improvement and implementation that were not adequately covered in many studies. These reflect
288 particularly project costs relating to managerial and clinical time allocated to preparatory work and
289 training and education as well as ongoing costs linked to monitoring care quality and outcomes – all
290 of which are known strategies for successful implementation [40]. Only six out of thirty studies
291 included an explicit assessment of these type of “hidden” costs of improvement and implementation
292 strategies. This risks underestimating the cost impacts of change and could represent a missed
293 opportunity to develop evidence about the likely comparative magnitude and importance of fixed

294 and recurrent costs that are integral to the scale up and spread of improvement- and
295 implementation-focussed initiatives.

296 A further reflection: many of the economic studies picked up in our review were linked to wider
297 studies built around more traditional evaluative research designs, specifically randomised controlled
298 trials. There was no evidence that economic methods have as yet been integrated into more
299 advanced evaluative designs within the fields of improvement and implementation design,
300 particularly “hybrid” designs [41][42] that aim to jointly test clinical effectiveness of the evaluated
301 health intervention on patient outcomes and, simultaneously, effectiveness of implementation
302 strategies in embedding the clinical intervention within an organisation or service. This may reflect
303 the fact that hybrid designs are a more recent methodological development, which requires further
304 integration into traditional health care evaluations.

305 Furthermore, and in relation to the wider role of health economic evaluations within the
306 improvement and implementation science arena we found that all the of the studies included in our
307 review were empirical and ex-post in nature. The studies evaluated costs and outcomes
308 retrospectively using data over a period of time following the introduction of a specific improvement
309 or implementation initiative. This is certainly valuable information for decision makers in making
310 decisions about already applied interventions and in building up an economic evidence base around
311 these interventions. However, it also suggests that economic analysis, and particularly economic
312 modelling, currently at least appears to have a less important role in informing decisions over which
313 options to pursue at earlier stages of implementing change, and in the appraisal of spread and scale
314 up within wider populations. Such earlier phase economic analyses were simply not found in our
315 review. We reflect that either this type of economic analysis is not happening – hence there is a
316 significant gap in the application of economic considerations in improvement and implementation
317 policy decisions; or that such analyses may indeed be undertaken but being be less likely to be
318 reported in academic publications and thus under-represented in our review. We cannot rule out

319 either possibility based on this review. Our collective experience suggests that more nuanced
320 economic analyses than simply consideration of 'costs' should be carried out in early phases of
321 implementation and improvement programme planning; prospective economic modelling offers a
322 way forward for health care improvers and policy makers planning scale up of evidence
323 interventions.

324

325 ***Quality of the evidence***

326 Comparison between economic studies identified in a previous review carried out by Hoomans et al
327 (covering the immediately preceding period 1998 to 2004) with those identified in this review (2004
328 to 2016) shows evidence of a general improvement in quality over the past two decades, with the
329 caveat that the two reviews used different quality appraisal frameworks. For example, only 42% of
330 studies reviewed by Hoomans et al included evaluation of costs and outcomes against "standard
331 practice/status quo" comparators, compared to 95% of studies in our review. Likewise, costing
332 methodology was only deemed adequate in 11% of cases included in the Hoomans et al review,
333 compared to 76% of the studies in this review. Justification for the outcome measures used was not
334 reported in any of the studies included in Hoomans et al but reported in 68% of studies included
335 here. This is a welcome improvement of applied economics within health care implementation and
336 improvement research. We attribute it at least partly to improvements in reporting economic
337 analyses over time, which would appear to have made an impact on the studies we captured.
338 Additionally, the expanding application of health economic evaluations within the improvement and
339 implementation sphere where high quality study reporting has been a major recent focus has also
340 plausibly contributed to improved reporting. Future evidence reviews will confirm whether this
341 pattern is sustained over time.

342

343 ***Strengths and limitations***

344 This review offers an updated synthesis of an emerging field of economics evaluations of health care
345 intervention evaluations covering both implementation and improvement science studies. The strict
346 inclusion criteria mean that the reviewed evidence is cohesive. The systematic appraisal we carried
347 out also allows us a longitudinal critique of the quality of economic studies in this field. Despite not
348 being able to directly compare the quality assessment from the previous reviews, we would argue
349 that the QHES used here is based on Drummond’s guidelines (used in prior reviews) and is designed
350 to cover the same topics, but offers a simpler, quantifiable format that is easier to apply. [Error! Reference
351 source not found.]

352 This review has some limitations. First, while our search strategy was quite broad, our inclusion
353 criteria were strict, which may have limited the number of studies that we identified and
354 synthesised. We aimed to clearly demarcate the economic analyses carried out within healthcare
355 implementation and improvement interventions research –and to explicitly include papers that
356 included both costs and benefits, and so did not include cost-only studies. We also only considered
357 papers reported in English. Taken together, these criteria are stricter than those applied to prior
358 reviews, which were more inclusive of qualitative outcomes and costing studies.

359

360 ***Implications for implementation and improvement research and future directions***

361 Our review demonstrates an increasing number of health economic evaluations nested within
362 implementation and improvement research studies, which further appear to be improving in
363 methodological quality in recent years. Based on our review we offer the following
364 recommendations and areas for improvement in the continued application of health economic
365 methods to improvement and implementation science evaluative research:

- 366 1. Utilise published guidance on conducting economic evaluation in implementation research
367 and quality improvement projects. Existing implementation frameworks [43] make
368 reference to the need to consider costs as part of an evaluative research strategy, but do not
369 specify how this is to be done. The relationship between implementation outcomes, service
370 outcomes and patient outcomes is central to understanding the benefits and costs and
371 overall cost-effectiveness of an intervention.
- 372 2. Include detailed consideration of the measurement of the resource implications and
373 “hidden” costs relating to wider support activities required to initiate service improvement
374 or to implement evidence into practice (e.g., costs of manualising an intervention; costs of
375 developing and delivering train-the-trainers interventions as implementation strategies and
376 so on).
- 377 3. Ensure that economic methods become fully integrated into the application of more recent
378 methodological advancements in the evaluative design of improvement and implementation
379 strategies, including “hybrid” designs that seeks to jointly test impact on implementation
380 and patient outcomes. This would also provide an opportunity to explore the inter-linkages
381 and relationships between implementation outcomes and economic measures of impact and
382 the cost-effectiveness of improvement and implementation strategies.
- 383 4. While most of the economic studies included in this review were both ex-post and empirical,
384 we would also highlight the value of ex-ante economic evaluation in policy-making contexts.
385 This could be informative either at the early phase of an improvement or implementation
386 project, to guide choices over which options are most likely to yield a cost-effective use of
387 resources (and to rule out those that are likely to be excessively costly compared to
388 expected benefits), or for quantifying the benefits and costs of spread of best practice and
389 delivery at scale.
- 390 5. Finally, we would strongly recommend use of published guidelines and quality assurance
391 frameworks to guide both the design and reporting of economic evaluations. Examples

392 include the QHES framework (used here), the Consolidated Health Economic Reporting
393 Standards (CHEERS) guidance [35] or the Drummond criteria [34].

394

395 **Conclusion**

396 Economic evaluation can inform choices over whether and how resources should be allocated to
397 improve services and for implementing evidence into health care practice. Our systematic review of
398 the recent literature has shown that the quality of economic evidence in the field of improvement
399 and implementation science has improved over time, though there remains scope for continued
400 improvement in key areas and for increased collaboration between health economics and
401 implementation science.

402

403 **Ethics approval and consent to participate:** Not required

404 **Consent for publication:** Not Applicable

405 **Availability of data and material:** Data sharing is not applicable to this article as no datasets were
406 generated or analysed during the current study.

407 **Competing interests:** Sevdalis is the Director of London Safety and Training Solutions Ltd, which
408 provides quality and safety training and advisory services on a consultancy basis to healthcare
409 organisation globally. The other authors have no interests to declare.

410 **Funding:** This research is supported by the National Institute for Health Research (NIHR)
411 Collaboration for Leadership in Applied Health Research and Care South London at King's College
412 Hospital NHS Foundation Trust. The authors are members of King's Improvement Science, which is
413 part of the NIHR CLAHRC South London and comprises a specialist team of improvement scientists
414 and senior researchers based at King's College London. Its work is funded by King's Health Partners
415 (Guy's and St Thomas' NHS Foundation Trust, King's College Hospital NHS Foundation Trust, King's

416 College London and South London and Maudsley NHS Foundation Trust), Guy's and St Thomas'
417 Charity, the Maudsley Charity and the Health Foundation. The views expressed are those of the
418 authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

419 **Authors' Contributions:** SLER, AH and NS conceptualised the literature review. SLER performed
420 literature searches, screening and analysis. SLER, AH and NS contributed to the writing of the
421 manuscript.

422 **Acknowledgements:** Not Applicable

423 References

- 424 1. Hoomans T, Severens JL. Economic evaluation of implementation strategies in health care.
425 Implementation Science. 2014;9(1):168
- 426 2. Batalden PB, Davidoff F. What is "quality improvement" and how can it transform healthcare?
427 Quality and Safety in Health Care. 2007;16(1):2.
- 428 3. Hoomans T, Evers SMAA, Ament AJHA, Hübgen MWA, Van Der Weijden T, Grimshaw JM, et al.
429 The Methodological Quality of Economic Evaluations of Guideline Implementation into Clinical
430 Practice: A Systematic Review of Empiric Studies. Value in Health. 2007;10(4):305-16.
- 431 4. Grimshaw JM, Thomas RE, MacLennan G, Fraser C, Ramsay CR, Vale L, et al. Effectiveness
432 and efficiency of guideline dissemination and implementation strategies. International Journal of
433 Technology Assessment in Health Care. 2005;21(1):149-
- 434 5. Ofman JJ, Sullivan SD, Neumann PJ, Chiou C-F, Henning JM, Wade SW, et al. Examining the
435 Value and Quality of Health Economic Analyses: Implications of Utilizing the QHES. Journal of
436 Managed Care Pharmacy. 2003;9(1):53-61
- 437 6. Elmagarmid A, Fedorowicz Z, Hammady H, Ilyas I, Khabsa M, Ouzzani M. Rayyan: a systematic
438 reviews web app for exploring and filtering searches for eligible studies for Cochrane Reviews.
439 InEvidence-informed public health: opportunities and challenges. Abstracts of the 22nd Cochrane
440 Colloquium 2014 Sep 21 (pp. 21-26). John Wiley & Sons Hyderabad, India, India.
- 441 7. Latour CHM, Bosmans JE, van Tulder MW, de Vos R, Huyse FJ, de Jonge P, et al. Cost-
442 effectiveness of a nurse-led case management intervention in general medical outpatients

- 443 compared with usual care: An economic evaluation alongside a randomized controlled trial.
444 Journal of Psychosomatic Research. 2007;62(3):363-70
- 445 8. Burr JM, Mowatt G, Hernández R, Siddiqui MA, Cook J, Lourenco T, Ramsay C, Vale L, Fraser C,
446 Azuara-Blanco A, Deeks J. The clinical effectiveness and cost-effectiveness of screening for open
447 angle glaucoma: a systematic review and economic evaluation. Health technology assessment
448 (Winchester, England). 2007;11(41):1-90.
- 449 9. Burr , J M , Botello-Pinzon , P , Takwoingi , Y , Hernández , R , Vazquez-Montes , M ,
450 Elders , A , Asaoka , R , Banister , K , van der Schoot , J , Fraser , C , King , A , Lemij , H ,
451 Sanders , R , Vernon , S , Tuulonen , A , Kotecha , A , Glasziou , P , Garway-Heath , D ,
452 Crabb , D , Vale , L , Azuara-Blanco , A , Perera , R , Ryan , M , Deeks , J & Cook , J 2012 , '
453 Surveillance for ocular hypertension : an evidence synthesis and economic evaluation '
454 Health Technology Assessment , vol. 16 , no. 29 , pp. 1-272
- 455 10. Robertson C, Arcot Ragupathy SK, Boachie C, Dixon JM, Fraser C, Hernández R, et al. The
456 clinical effectiveness and cost-effectiveness of different surveillance mammography regimens
457 after the treatment for primary breast cancer: systematic reviews registry database analyses and
458 economic evaluation. Health technology assessment (Winchester, England). 2011;15(34):v-322.
- 459 11. Umscheid CA, Williams K, Brennan PJ. Hospital-based comparative effectiveness centers:
460 translating research into practice to improve the quality, safety and value of patient care. Journal
461 of general internal medicine. 2010 Dec 1;25(12):1352-5.
- 462 12. Albers-Heitner CP, Joore MA, Winkens RA, Lagro-Janssen AL, Severens JL, Berghmans LC.
463 Cost-effectiveness of involving nurse specialists for adult patients with urinary incontinence in
464 primary care compared to care-as-usual: An economic evaluation alongside a pragmatic
465 randomized controlled trial. Neurourology and urodynamics. 2012 Apr;31(4):526-34.
- 466 13. Faulkner A, Mills N, Bainton D, Baxter K, Kinnersley P, Peters TJ, Sharp D. A systematic review
467 of the effect of primary care-based service innovations on quality and patterns of referral to
468 specialist secondary care. Br J Gen Pract. 2003 Nov 1;53(496):878-84.
- 469 14. Bauer JC. Nurse practitioners as an underutilized resource for health reform: Evidence-based
470 demonstrations of cost-effectiveness. Journal of the American Academy of Nurse Practitioners.
471 2010 Apr;22(4):228-31.

- 472 15. Brunenberg DE, van Steyn MJ, Sluimer JC, Bekebrede LL, Bulstra SK, Joore MA. Joint recovery
473 programme versus usual care: an economic evaluation of a clinical pathway for joint replacement
474 surgery. *Medical care*. 2005 Oct 1;1018-26.
- 475 16. Dawes HA, Docherty T, Traynor I, Gilmore DH, Jardine AG, Knill-Jones R. Specialist nurse
476 supported discharge in gynaecology: A randomised comparison and economic evaluation.
477 *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2007 Feb 1;130(2):262-
478 70.
- 479 17. Furze G, Cox H, Morton V, Chuang LH, Lewin RJ, Nelson P, Carty R, Norris H, Patel N, Elton P.
480 Randomized controlled trial of a lay-facilitated angina management programme. *Journal of*
481 *advanced nursing*. 2012 Oct;68(10):2267-79.
- 482 18. Judd WR, Stephens DM, Kennedy CA. Clinical and economic impact of a quality improvement
483 initiative to enhance early recognition and treatment of sepsis. *Annals of Pharmacotherapy*. 2014
484 Oct;48(10):1269-75.
- 485 19. Kifle YA, Nigatu TH. Cost-effectiveness analysis of clinical specialist outreach as compared to
486 referral system in Ethiopia: an economic evaluation. *Cost Effectiveness and Resource Allocation*.
487 2010;8(1):13.
- 488 20. Kilpatrick K, Kaasalainen S, Donald F, Reid K, Carter N, Bryant-Lukosius D, Martin-Misener R,
489 Harbman P, Marshall DA, Charbonneau-Smith R, DiCenso A. The effectiveness and cost-
490 effectiveness of clinical nurse specialists in outpatient roles: a systematic review. *Journal of*
491 *evaluation in clinical practice*. 2014 Dec;20(6):1106-23.
- 492 21. Maloney S, Haas R, Keating JL, Molloy E, Jolly B, Sims J, Morgan P, Haines T. Breakeven, cost
493 benefit, cost effectiveness, and willingness to pay for web-based versus face-to-face education
494 delivery for health professionals. *Journal of medical Internet research*. 2012;14(2):e47.
- 495 22. Mortimer D, French SD, McKenzie JE, Denise AO, Green SE. Economic evaluation of active
496 implementation versus guideline dissemination for evidence-based care of acute low-back pain in
497 a general practice setting. *PloS one*. 2013 Oct 11;8(10):e75647.
- 498 23. Purshouse RC, Brennan A, Rafia R, Latimer NR, Archer RJ, Angus CR, Preston LR, Meier PS.
499 Modelling the cost-effectiveness of alcohol screening and brief interventions in primary care in
500 England. *Alcohol and alcoholism*. 2012 Sep 25;48(2):180-8.

- 501 24. Rachev BT. The economics of health service transformation: A business model for care
502 coordination for chronic condition patients in the UK and US. *Clinical Governance: An*
503 *International Journal*. 2015 Jul 6;20(3):113-22.
- 504 25. Tappenden P, Campbell F, Rawdin A, Wong R, Kalita N. The clinical effectiveness and cost-
505 effectiveness of home-based, nurse-led health promotion for older people: a systematic review.
506 *Health technology assessment (Winchester, England)*. 2012;16(20):1.
- 507 26. Tappenden P, Chilcott J, Brennan A, Squires H, Glynne-Jones R, Tappenden J. Using whole
508 disease modeling to inform resource allocation decisions: economic evaluation of a clinical
509 guideline for colorectal cancer using a single model. *Value in Health*. 2013 Jun 1;16(4):542-53.
- 510 27. Vestergaard AS, Ehlers LH. A health economic evaluation of stroke prevention in atrial fibrillation:
511 guideline adherence versus the observed treatment strategy prior to 2012 in Denmark.
512 *Pharmacoeconomics*. 2015 Sep 1;33(9):967-79.
- 513 28. Walsh B, Steiner A, Pickering RM, Ward-Basu J. Economic evaluation of nurse led intermediate
514 care versus standard care for post-acute medical patients: cost minimisation analysis of data from
515 a randomised controlled trial. *bmj*. 2005 Mar 24;330(7493):699.
- 516 29. Williams KS, Assassa RP, Cooper NJ, Turner DA, Shaw C, Abrams KR, Mayne C, Jagger C,
517 Matthews R, Clarke M, McGrother CW. Clinical and cost-effectiveness of a new nurse-led
518 continence service: a randomised controlled trial. *Br J Gen Pract*. 2005 Sep 1;55(518):696-703.
- 519 30. Williams J, Russell I, Durai D, Cheung WY, Farrin A, Bloor K, Coulton S, Richardson G. What are
520 the clinical outcome and cost-effectiveness of endoscopy undertaken by nurses when compared
521 with doctors? A Multi-Institution Nurse Endoscopy Trial (MINuET). *Health Technology*
522 *Assessment*. 2006;10(40):1-93.
- 523 31. Yarbrough PM, Kukhareva PV, Spivak ES, Hopkins C, Kawamoto K. Evidence-based care
524 pathway for cellulitis improves process, clinical, and cost outcomes. *Journal of hospital medicine*.
525 2015 Dec;10(12):780-6.
- 526 32. Yarbrough PM, Kukhareva PV, Spivak ES, Hopkins C, Kawamoto K. Evidence-based care
527 pathway for cellulitis improves process, clinical, and cost outcomes. *Journal of hospital medicine*.
528 2015 Dec;10(12):780-6.
- 529 33. Øvretveit J, Gustafson D. Evaluation of quality improvement programmes. *BMJ Quality & Safety*.
530 2002 Sep 1;11(3):270-5.

- 531 34. Drummond MF, Jefferson TO. Guidelines for authors and peer reviewers of economic
532 submissions to the BMJ. *Bmj*. 1996 Aug 3;313(7052):275-83.
- 533 35. Husereau D, Drummond M, Petrou S, Carswell C, Moher D, Greenberg D, Augustovski F, Briggs
534 AH, Mauskopf J, Loder E. Consolidated health economic evaluation reporting standards
535 (CHEERS) statement. *Cost Effectiveness and Resource Allocation*. 2013 Dec;11(1):6.
- 536 36. Afzali HH, Gray J, Beilby J, Holton C, Karnon J. A model-based economic evaluation of improved
537 primary care management of patients with type 2 diabetes in Australia. *Applied health economics
538 and health policy*. 2013 Dec 1;11(6):661-70.
- 539 37. Hernández RA, Jenkinson D, Vale L, Cuthbertson BH. Economic evaluation of nurse-led intensive
540 care follow-up programmes compared with standard care: the PRaCTICaL trial. *The European
541 Journal of Health Economics*. 2014 Apr 1;15(3):243-52.
- 542 38. Karnon J, Partington A, Horsfall M, Chew D. Variation in clinical practice: a priority setting
543 approach to the staged funding of quality improvement. *Applied health economics and health
544 policy*. 2016 Feb 1;14(1):21-7.
- 545 39. Mdege ND, Chindove S, Ali S. The effectiveness and cost implications of task-shifting in the
546 delivery of antiretroviral therapy to HIV-infected patients: a systematic review. *Health policy and
547 planning*. 2012 Jun 26;28(3):223-36.
- 548 40. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, Proctor EK,
549 Kirchner JE. A refined compilation of implementation strategies: results from the Expert
550 Recommendations for Implementing Change (ERIC) project. *Implementation Science*. 2015
551 Dec;10(1):21.
- 552 41. Curran GM, Bauer M, Mittman B, Pyne JM, Stetler C. Effectiveness-implementation hybrid
553 designs: combining elements of clinical effectiveness and implementation research to enhance
554 public health impact. *Medical care*. 2012 Mar;50(3):217.
- 555 42. Brown CH, Curran G, Palinkas LA, Aarons GA, Wells KB, Jones L, Collins LM, Duan N, Mittman
556 BS, Wallace A, Tabak RG. An overview of research and evaluation designs for dissemination and
557 implementation. *Annual review of public health*. 2017 Mar 20;38:1-22.
- 558 43. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, Griffey R, Hensley M.
559 Outcomes for implementation research: conceptual distinctions, measurement challenges, and

560 research agenda. Administration and Policy in Mental Health and Mental Health Services
561 Research. 2011 Mar 1;38(2):65-76.

562

563 **Box 1: Search strategy for the systematic review**

564 **Box 2: Types of economic analysis included in the review**

565 **Figure 1: Consort Diagram**

566 **Figure 2: Quality appraisal of economic evidence – Distribution of QHES instrument scores**

567

568 **Table 1: Summary of included studies and quality appraisal - panel 1a improvement studies; panel**
569 **1b implementation studies**

570 **Table 2 – Focus of improvement/implementation intervention included in the reviewed evidence**

571 **Table 3: Summary of implementation costs and scenarios included**

572 **Table 4: Summary of QHES instrument dimension scores**