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Early Assessment of Innovation in a Health Care Setting

Short title: Early assessment of innovation in health care

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Abstract

Objectives

Early assessment can assist in allocating resources for innovation effectively and produce the most beneficial technology for an institution. The aim of the present study is to identify methods and discuss the analytical approaches applied for the early assessment of innovation in a health care setting.

Method

Knowledge synthesis based on a structured search (using the MEDLINE, Embase, and Cochrane databases) and thematic analysis was conducted. An analytical framework based on the stage of innovation (developmental, introduction, or early diffusion) was applied to assess whether methods vary according to stage. Themes (type of innovation, study, analysis, study design, method, and main target audience) were then decided among the authors. Identified methods and analysis were discussed according to the innovation stage.

Results

A total of 1064 articles matched the search strategy. Overall, 39 articles matched the inclusion criteria. The use of methods has a tendency to change according to the stage of innovation. Stakeholder analysis was a prominent method in the innovation stages, and particularly in the developmental stage, as the introduction and early diffusion stage has more availability of data and may apply more complex methods. Barriers to the identified methods were also discussed as all of the innovation stages suffered from lack of data and substantial uncertainty.

Conclusions

Although this review has identified applicable approaches for early assessment in different innovation stages, research is required regarding the value of the available data and methods and tools to enhance interactions between different parties at different stages of innovation.

Keywords: early assessment; health innovation; organisational innovation; knowledge synthesis; health technology assessment

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Conflict of interest statement

The authors declare no conflicts of interest.

Ethical approval

The authors have nothing to declare. No ethical approval was required for this study.

Objectives

As the importance of innovative technology expands in the health care sector, new practises and organisations are constantly evolving. New technology enables the refinement and personalisation of existing health care practises, which have the potential to prevent grave diseases and save more lives. Although the technological revolution within health care shows great potential, not all technological innovations serve their purposes (1). Documenting the effects of health care innovation is therefore essential to assess prioritizing adequate technology implementation. Unlike the product cycle of pharmaceuticals, where the timeframe from development to implementation can take several years, new technology and organisational innovation in the health care sector moves at a much faster pace (2). The methods for value assessment and priority settings therefore need to be adapted to a faster product cycle with a greater diversity of products.

Over the last few decades, validated methodology such as health technology assessment (HTA) has contributed to sound decision making worldwide. HTA is defined as an interdisciplinary process for synthesizing information regarding medical, social, economic, and ethical issues related to the introduction of new health technology (3). Although HTA methods and approaches have been subject to significant improvements over time, there are several challenges in the field of health technology assessment (4). HTA is deemed a robust method for technology in later phases of national implementation. In its current form, it continues to lack the incentive to promote innovation, include local considerations for decision making at an institutional level, and express the value of dynamic interactions with private businesses. This challenges HTA in showing the whole value chain to promote value-based health care. Hospital-based HTA (HB-HTA) is an approach adapted to inform decision makers at different levels in a hospital setting and ensure acceptability at a local level. This includes processes and methods used to produce HTA reports in and for hospitals (5). Although this assessment and management tool successfully addresses decision making at an institutional level, more research is necessary to identify sustainable innovative ideas and products in the health care system (6). In promoting innovation in the health care sector, research should be dedicated to methods and approaches for early assessment in order to allocate public support effectively and produce the most beneficial technology for society. The international network EuroScan, a collaborative network for information exchange on important emerging new drugs, devices, procedures, programmes, and settings in health care, is currently evaluating the consequences of early technology assessments on the diffusion of new technologies in the health care sector . An article from the network states that early

awareness is increasingly becoming an important component in decision making, implementation, and the spread of new health technology (7).

Although limited, an increasing number of reports on the methods of early assessment can be found in the literature. Many of these studies take an industry perspective, emphasising market entry and reimbursement (9). Both individual studies and review papers broach the subject of early assessment of medical technology (10, 11). Fasterholdt et al. (11) provide an overview of early assessment of medical technology and discuss which models hold the most promise for hospital decision makers. However, early decision support for organisational innovation in a health care setting is less embodied in the literature. A service innovation can consist of both a technology-enabled reorganisation of the health supply or simply an organisational innovation. A mobile application for the registration of blood sugar levels for diabetic patients can change patient pathways and create a new service, which is an example of a technology-enabled service innovation. However, reorganising the health supply such that a health care worker measures blood sugar levels at the patients' homes would also be a service innovation in terms of an organisational innovation. The aim of the present study is to identify methods and discuss the analytical approaches applied to the early assessment of innovation in a health care setting, with a particular focus on technological and organisational innovations. The characteristics of the analytical approaches applied will be discussed according to the stage of innovation.

Methods

A knowledge synthesis based on a structured search and thematic analysis was conducted to identify early assessment methods used to evaluate innovation in the health care sector. This review attempts to summarize existing studies on a specific topic to improve understanding and identify research gaps to define future research. The knowledge synthesis also seeks toaddress broader topics, where a diversity of study methodologies and designs exist and synthesize the findings narratively.

Search structure

The review was structured according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (15). The review of the articles was accomplished in two constructive screenings. 1) Articles reporting on the early assessment of innovation in the health sector (articles were excluded if they did not report on assessment in the health care sector, for instance if the evaluation only took place in the industry) and 2) articles reporting on methods or practises for the early assessment of health innovations (articles were excluded

if they did not report on the early assessment of technological or organisational innovation). Detailed inclusion and exclusion criteria are shown in Table 1.

Identifying the research issues

Based on the health technology assessment (HTA) definition of the International Network of Agencies for Health Technology Assessment, “early assessment of medical devices” can be defined as the early examination of the medical, economic, social, and ethical implications of the medical device to determine the potential of incremental value in health care (17). The research aim was to identify methods for the assessment of early assessment of technological and organisational innovation in a health care setting and discuss the analytical approaches applied according to the stage of innovation (development, introduction, and early diffusion).

Identifying relevant studies and study selection

A literature search was conducted 2017 of the major medical reference databases (MEDLINE Ovid and Embase Ovid). Due to the limited amount of literature on this topic, we did not set a limit on the publication date. The protocol, search strategy, and literature search were elaborated and undertaken in collaboration with a librarian with vast experience in knowledge-based synthesis.

The search was accomplished using a combination of controlled vocabulary (medical subject headings and Emtree terms) and text words. The search strategy for MEDLINE was built using the MeSH term "Technology Assessment, Biomedical" and synonyms and near-synonyms thereof combined with the text words "early," "pilot," "novel," or "first-stage" or "first-phase" or "horizon." This search component was then combined with search terms covering various methods and theories using MeSH terms such as "Decision Support Techniques" OR "Cost Benefit Analysis" OR "Risk Assessment" and text word equivalents. The MEDLINE search strategy was translated and adjusted and then conducted in Embase. A similar search with fewer outcomes was conducted in the Cochrane Library using the keywords "Technology Assessment, Biomedical" combined with the text words "early, pilot, novel," resulting in only a few references from the Health Technology Assessment Database. The EuroScan has played an important role in the harmonization process so that effective collaboration, reduction of duplication and the further development of procedures have become possible. Although the search identified literature from the EuroScan network, much of this literature was excluded as it mainly concerns horizon scanning and early alert systems which is not subject of this review.

Table 1 shows the final inclusion and exclusion criteria agreed to by the review team. References from each database search were imported into database-specific folders in EndNote version X7 and duplicates were eliminated. Abstracts were first assessed by LNS using the selection criteria listed in Table 1 and then each of the full-text articles was appraised independently by two reviewers (LNS and KJK). Disagreements were via by discussion or referred to a third author (KK).

Table 1. Inclusion and exclusion criteria

Charting the data and collating, summarising, and reporting the results

The data were initially extracted by LNS and then discussed with KJK. A framework based on the assessed literature was agreed upon and core themes to answer the research issue were identified. When there was a disagreement among the authors as to the appropriate theme, the article was discussed until agreement was achieved. Bibliographic data and study content were collected and analysed using templates developed iteratively with feedback from the other authors (KK and TM).

Data collection: framework and themes

The following categorisation of the data was performed on the included studies.

Stage of innovation: Based on how Ijzerman et al. (14) distinguished early HTA in different stages, this review divided the innovation process into the following three stages: the developmental stage, the introduction stage, and the early diffusion stage. The developmental stage is when an innovation is in a concept phase and is not yet piloted. The introduction stage is when the innovation is undergoing the first pilot. A pilot study is normally a small test with a few patients in which the innovation is tested. Finally, the early diffusion stage is when the pilot is transferred or extended to other populations or locations.

Type of innovation (technological or organisational innovation)

Type of study (theoretical or empirical)

Study design

Type of analysis: The identified articles were distinguished in strategic, economic, and clinical analysis based on the purpose of the analysis and not on the analytical approach used, as one analytical approach can be used for different purposes.

Methods (qualitative or quantitative)

Main target audience: An attempt was made to identify whether the assessment targeted the following audience groups: decision makers on implementation, patients/users, health care personnel, or innovators.

Results

Literature retrieval

Figure 1 is a flow chart of the literature selection process. In total, the literature search yielded 1064 papers and 373 duplicates that were excluded. Upon reviewing the 691 abstracts, 638 papers were excluded on the basis of the following criteria: not used in the health care sector, not an early assessment of non-invasive technology or organisational innovation, and language not in English, Norwegian, or Danish. After the first exclusion of abstracts, 53 articles were included in full text. Based on relevance, an additional 21 papers were excluded. A total of 32 articles met the inclusion criteria, while a further 7 articles were included based on screening of their reference lists.

Figure 1. Overview of the inclusion process

Table 2 describes the data extracted from the included studies and summarises the analyses of the early assessment models. Twelve studies presented the early assessment of technology that is still in the development stage. Fourteen studies assessed technology in the introduction stage. Thirteen papers were included in the early diffusion stage. Twenty studies presented early assessments of technological innovation, while only seven studies dealt with organisational innovation alone. Twelve studies evaluated both technological innovation and the consequential organisational innovation. Table 2 shows that the included articles consisted of 20 empirical studies and 19 theoretical studies.

The main target audience of the evaluation was based on the authors' interpretation of who is likely to benefit the most from the assessment. A majority of the articles addressed decision makers on implementation as the main target audience of the assessment, equalling 36% of the included studies (14/39). Eleven studies targeted innovators as the main target audience, resulting in 28% of the included studies (11/39). A total of 26% of the studies targeted health care providers as the main audience (10/39). Only 10% of the studies targeted patient/users as the main audience (4/39).

Table 2. Description of the data and data analysis

Analysis of early assessment models identified: Variation in methods depending on stage of innovation

This section describes the type of analyses identified based on the innovation stage, the analytical framework used to guide the study. The methods for early data collection and assessment were categorised as qualitative (n=15), quantitative (n=12), and mixed method

(n=12). The studies were categorised as strategic, economic, or clinical analyses or a combination. This categorisation is based on the purpose of the assessment in terms of outcomes. For example, an analysis was deemed strategic if its core outcome was to determine the acceptance rate of a technology to plan future implementation, or deemed economic if the core outcome was to determine socioeconomic value through a Markov model.

Developmental Stage: A majority of the articles presented a combination of strategic, economic, and clinical analyses (n=6). Two studies were categorised as economic analyses, one as strategic and one as clinical. One study combined strategic and clinical analyses and one combined economic and clinical analyses. The empirical articles used analytical approaches that reflected the amount of data available and the intention of the assessment in each stage. The methods applied in the development stage stressed the need to generate more data. Qualitative simulations based on scenario drafting applied qualitative data from stakeholder insights, expert opinions, focus groups, and scenario drafting can provide insights into the reality of an innovation (18-21). The theoretical studies in the development stage recommended more complex quantitative models such as Markov modelling, Bayesian modelling, and clinical simulations, as well as strategic models such as PEST and SWOT analyses (16, 22-24). Although these analytical approaches are applicable with scarce data, they are more resource intensive than the methods applied by the empirical articles.

Introduction Stage: In this stage, the greater part of the studies focused on strategic analysis (n=4). Two studies consisted of economic analyses, three consisted of clinical analyses, and three consisted of the combination of all three analyses. Two studies had a combination of clinical and strategic analysis. In the empirical studies, this stage was characterised by a mixture of preliminary data collection and estimates. Quantitative and qualitative methods for assessment and data collection such as closed questionnaires, focus groups, and semi-structured interviews were frequently used to both capture the impact for the users and facilitate the innovation process (21, 25-28). Literature reviews also provided insight when a small amount of data was available (29, 30). The theoretical studies highlighted case studies with subsequent economic modelling as an applicable approach to collect and analyse data (31, 32).

Early Diffusion Stage: This stage showed a prevalence of studies including all three analyses (n=6). One study had an economic analysis, three had strategic analyses, one combined strategic and economic analyses, and one combined strategic and clinical analyses. The empirical studies places greater emphasis on quantitative cost-effectiveness models,

implementation and diffusion scenarios, and the logistics associated with the intervention (33, 34). However, among the theoretical studies, the importance of qualitative approaches to data collection such as expert opinion and stakeholder analysis were highlighted (35, 36).
Table 3 is a descriptive table on the identified analytical approaches.

Table 3. Description of analytical approaches

Stakeholder involvement for data generation in early health technology assessment
The developmental stage simulations based on stakeholder analysis and expert interviews were used to understand the effect of innovation on the target population, organisation, and society. In the introduction stage, stakeholder analysis provides additional data to scenarios for simulations on the adaption and development of innovation. In the early diffusion stage, the analytical approaches place greater emphasis on implementation and dissemination scenarios.
An early innovation stage is characterised by a small amount of data and high uncertainty. stakeholder insight was however highlighted to assess the potential benefit of health innovation (23, 31, 35, 37). Harris-Roxas and Harris (31) found that stakeholders' views regarding potential benefits are central for assisting the assessment of an innovation and also for the prioritisation of effects. Such data can potentially ease adoption and diffusion through steering the intervention to achieve value-based innovation (38). This implies that the innovation should be assessed in the context where it will be used in order to disclose how it is adopted and used in the real world. Stakeholders can provide data on the underlying logic of an innovation to help understand changes in outcomes in the target population at an organisational level. Such data can provide valuable information on the potential suitability of the innovation (33). Stakeholder data can be applied in scenario analysis to provide necessary outcome overviews and direct and accelerate the procurement process (39). Through integrating qualitative scenarios from the perspective of stakeholders and experts into a cost-effective model, the potential value of the innovation can be estimated in an early phase (26). Retel et al. (26) developed a framework for the assessment of technology still in development by means of scenario drafting to determine the effects, costs, and cost-effectiveness of possible future diffusion patterns.

Evidence gaps and uncertainty in early economic modelling

Economic modelling of the trade-off between further technological development and the value of investing more research appears largely in the development and introduction stage. The studies containing economic analyses in the early diffusion stage were used to steer the implementation and facilitate proper investments.

It is believed that early economic analysis of an innovation's likely cost-effectiveness can help steer the implementation and restrain resource-inefficient technologies (40). Numerous attempts to fill evidence gaps in early economic models were detected in the literature. Expert elicitations using scenario drafting can provide qualitative and quantitative data to fill the evidence gaps in early health technology assessment (19, 27). Potential economic consequences can be estimated to forecast the effects of health care innovations already at the early research and concept phase to prevent ineffective investments (18, 28, 39). Scenario drafting can also be useful for identifying critical factors that may affect the speed of adoption (41). To account for the dynamic characteristics of an early innovation, future technological development, organisational change, and learning curves should be incorporated into the models (42, 43). Studies have pointed to the use of sensitivity analysis to deal with uncertainty in the interpretation of results and to test the impact of different implementation strategies when the technology is still dynamic (18, 22, 28, 30, 42, 44). Constructive technology assessment that takes into account the learning curve seems to be appropriate in the early assessment of technologies that are still dynamic (23, 26, 45-47). Modelling based on sophisticated mathematic techniques such as Bayesian modelling or Markov modelling can also play an important part in early decision support and provide incentive for data collection prior to implementation. Use of such models in early economic modelling can help determine which efficacy and clinical performance has to be attained for different cost outcomes (23, 40, 43, 48).

Uncertainty is an issue in all decisions; information is valuable because it reduces the expected cost of uncertainty surrounding decisions. Value of information (VOI) analysis recognises the option to postpone the adoption or development of the technology and investing in more research to reduce uncertainty. Waiting may however result in health benefits forgone, and developing before conducting research may also reduce uncertainty (16, 40, 48). Real option analysis (ROA) can be useful for establishing the trade-off between development and research (16, 23, 24, 48).

Clinical efficacy in trials with a small amount of data

Articles containing clinical analyses were primarily found in the developmental stage. Assessing clinical efficacy in early stages can be challenging. Randomised clinical trials

(RCTs) have long been considered the gold standard in assessing clinical outcomes. However, RCTs can have limitations, especially for evaluations of early stage interventions (49). RCTs require a large amount of data and therefore consume time and resources. The difficulty of blinding is also evident in the literature on the assessment of non-invasive technology and organisational innovation. The literature however pointed out some applicable methods. Clinical trial simulations based on prior clinical outcomes can supply information otherwise unavailable in early stages (16, 40, 50, 51). Input data for clinical simulations can also consist of expert opinions or a structured literature search on clinical outcomes (18, 39, 42, 52). Clinical trials performed in a controlled laboratory setting, such as bench studies, were also highlighted in the literature to reduce uncertainty regarding the efficacy of clinical outcomes (22).

User involvement

Involvement of potential users of an innovative technology in the early stages could make assessments more relevant and acceptable (53). Although users or patients should be an important part of a stakeholder analysis, this is not always the case. Stakeholders are all the affected parties of an innovation, for example, an innovator, decision maker at the hospital or municipality, purchase unit, etc. A user is the one who directly uses the innovation. In this review, only 10% (4/39) of the studies targeted patients or users as the main target audience of the analysis. Early analysis and modelling of outcomes from user involvement in early assessment helps prevent failures and can accelerate implementation (20). Gollumud at al. (54) addressed the significance of user and health data collected through mobile devices. Such data allows individuals the opportunity to make informed health decisions and provide researchers and decision makers the opportunity to assess innovative health technology in real time. Smartphone-enabled health technologies provide a novel source of data for qualitative and quantitative analysis purposes.

Discussion

The purpose of this knowledge synthesis was to identify methods for early assessment of innovation in a health care setting and discuss the analytical approaches applied according to the stage of innovation. As illustrated in the Results section, several different methods for the early assessment of innovation were found, and the majority of the articles included a combination of strategic, clinical, and economic analyses with qualitative and quantitative analyses. However, no articles validated the specific methods used for early assessment against a technology assessment completed in later phases with additional data. In the earlier

innovation stages, the methods focus on identifying available data sources, while in later stages various simulation and analysis methods may be used in new ways to increase the impact of the scarce availability of data. However, the involvement of stakeholders was considered a prominent data source in every stage.

Challenges concerning early assessment of health innovations

The present study has identified empirical and theoretical approaches for the early assessment of innovations in a health care setting. Although contributions have been made to the development of new methodology, the choice of method may lead to different outcomes as no universal method was found. Markiewicz et al. (22) argued that there is a lack of evidence on how effective the methods are and that there is a need to develop an agreed-upon method for early assessment. This coincides with Hartz et al.'s (40) perception on the use of early economic data, which is generally no standard tool for public policy decision making. Bridges et al. reported the need for new health financing mechanisms to ensure the implementation of valuable innovation (37). However, it has been argued that evaluation is rarely seen as an integral part of implementation, thus resources are not usually dedicated to evaluation (21).

A further challenge stressed in the literature is the scarce evidence available in an early innovation stage (23, 33, 40). Small data sets lack the power to control for variables that could explain the observed effect and short investigation periods make it difficult to identify changes in outcome. Efforts have been made to deal with uncertainty and lack of data through applying more complex mathematical models. However, Craig et al. (43) argued that these models suffer from the precision required for data input. Such potential sources of data could be challenging to acquire at an early stage. Furthermore, the authors highlighted that these models can be difficult to apply without in-depth knowledge of economic modelling.

Scenario analysis built on expert elicitation has been used to acquire data on potential outcomes in early assessment. However, there are concerns regarding the loss of information that may occur in scenario analysis, as a scenario does not cover all outcomes in a real-world system (26, 38). The same is true for expert elicitation as different approaches are used, which may lead to varying results (28). Different studies included in the present review have also stressed the need for the integration of patient or user perspectives or preferences in early assessment (16, 22, 41). Bartelmes et al. (23) suggested that early assessment of health innovation cannot replace a comprehensive HTA, but rather form a preceding step in a multi-staged HTA process.

Strengths and limitations

This knowledge synthesis may not have identified all published studies on the early assessment of health innovation, in particular the grey literature. Despite attempts to adjust the search strategy to several different terms previously used in the literature to describe similar methodologies, other terms may also exist. Although three comprehensive health databases were included in the search (MEDLINE, Embase, and Cochrane), searching other databases may have included additional published studies. Our search included only studies in English, Norwegian, and Danish, although only English terms were used in the search. Furthermore, no consultations from stakeholders or experts were included in this review. Finally, although the method was systematically followed by the reviewers, each reviewer subjectively included studies based on the study criteria. The classification and interpretation of the results were also subject to reviewer bias.

Further research

Although this knowledge synthesis has identified several different methods applied in early assessment, no single method can be highlighted as prominent relative to the robustness of the results or the frequency of use. More research is therefore needed to systematically validate the methods suggested in this review with the aim of finding a standardised recommendation for methodology concerning early health technology assessment. An empirical test of the precision of the early assessment method needs to done in practise. Research should be dedicated to enhance the precision of methods that deal with lack of data and uncertainty. Such research may imply combining existing methods to address risks from more perspectives or/and profit from the elevated availability of data sources in an increasingly digitalised world. This was also emphasised by Ijzerman et al. in a recent study of early HTA where observational studies and big data were highlighted as data sources that would allow more detailed analysis in early HTA (55).

Conclusions

Existing health technology assessment is considered a robust method to support decisions in later phases when the technology is well tested in clinical environments and a large amount of data is collected. Research on altering and adopting these methods to earlier phases of decision making is emerging in the literature. This knowledge synthesis has shown that the use of methods hass a tendency to change according to the stage of innovation. Stakeholder analysis was highlighted in this review as a prominent method of collecting data in the three innovation stages. This applies particularly in the earliest stage of innovation, the developmental stage, as the introduction an early diffusion stage involves greater availability of data and the use of more complex methods and models. Barriers to the identified methods

have also been discussed as all of the innovation stages suffer from lack of data and much uncertainty. Early assessment may address clinical value and risk but due to short investigation periods, it is challenging to obtain concluding evidence. Although user or patient involvement in the early phases of innovation is recommended in the literature, there is a shortage of studies in this review that effectively involves them. More research is required to promote innovation and dynamic interaction between health institutions and industry through the use of HTA. In early assessment in particular and research on the value of available data, methods, and tools to enhance the interactions between different parties in varying stages of innovation is needed.

Figure Legends

Figure 1 Overview of the inclusion process

Table 1 Inclusion and exclusion criteria

Table 2 Description of the data and data analysis

Table 3 Description of analytical approaches

Appendix

Appendix

Search Strategy Medline:

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1 exp Technology Assessment, Biomedical/ and (early* or first-stage or first-phase or horizon or pilot).tw,kf. (538)

2 ((early assessment or early stage assessment or early phase assessment) adj5 (biomedical or medical or health) adj5 (technology or service* or app? or application* or device* or tool*)).tw,kf. (6)

3 (Constructive Technology Assessment* and (early or pilot or forecast*)).tw,kf. (5)

4 ((Early or novel or pilot*) adj5 (hta or health technolog* or technology assess* or technology evaluat* or Health innovation*)).tw,kf. (132)

5 or/1-4 (629)

6 probability/ or bayes theorem/ or markov chains/ (85568)

7 Cost-Benefit Analysis/ (69191)

8 exp models, economic/ (12343)

9 exp Models, Theoretical/ (1498481)

10 exp models, statistical/ (333067)

11 exp decision support techniques/ (68214)
12 exp Risk Assessment/ (214137)
13 exp Uncertainty/ (8842)
14 exp Computer Simulation/ (188970)
15 exp Biomedical Research/ec, mt [Economics, Methods] (31077)
16 (analysis adj3 (cost* or conjoint or Choice or probabalistic)).tw,kf. (25064)
17 analytic* hierarch* process*.tw,kf. (588)
18 (Bayesian adj2 (techniq* or method* or analy*)).tw,kf. (9767)
19 (bench study or bench studies or bench marking).tw,kf. (357)
20 choice-based.tw,kf. (473)
21 clinical trial*.tw,kf. (292412)
22 Conjoint analys*.tw,kf. (560)
23 (decision adj3 (support or modeling or analysis)).tw,kf. (20513)
24 (delphi adj3 (method* or technique*)).tw,kf. (3399)
25 discrete-choice experiment*.tw,kf. (949)
26 early cost-effectiveness.mp. (10)
27 Early Model*.tw,kf. (231)
28 evidence synthesis*.tw,kf. (2409)
29 expected value of perfect information.tw,kf. (143)
30 expected value of sample information.tw,kf. (44)
31 expert panel*.tw,kf. (6906)
32 focus group*.tw,kf. (32514)
33 headroom.tw,kf. (45)
34 health economic modeling.tw,kf. (37)
35 health impact assessment*.tw,kf. (693)
36 horizon scanning.tw,kf. (122)
37 (interview* or focus group* or user* feedback*).tw,kf. (300735)
38 literature review.tw,kf. (64400)
39 (Markov adj3 model*).tw,kf. (10270)
40 multi-criteria decision.tw,kf. (413)
41 Multi-Parameter Evidence Synthesis.tw,kf. (9)
42 payback from research*.tw,kf. (9)
43 preference methods.tw,kf. (55)
44 preliminary market Research.tw,kf. (0)

45 real options analysis.tw,kf. (12)
46 (road-mapping* or multi-path*).tw,kf. (403)
47 return on investment*.tw,kf. (1308)
48 qualitative weighting.tw,kf. (4)
49 Technology profiling.tw,kf. (4)
50 usability test.tw,kf. (94)
51 or/5-50 (2513368)
52 5 and 51 (629)
53 remove duplicates from 52 (623)
54 limit 53 to (danish or english or norwegian or swedish) (583)

Embase and Cochrane:

1 exp biomedical technology assessment/ and (early* or first-stage or first-phase or horizon or pilot).tw,kw. (652)
2 ((early assessment or early stage assessment or early phase assessment) adj5 (biomedical or medical or health or (technology or service* or app? or application* or device* or tool*))).tw,kw. (155)
3 (Constructive Technology Assessment* and (early or pilot or forecast*)).tw,kw. (6)
4 ((Early or novel or pilot*) adj5 (hta or health technolog* or technology assess* or technology evaluat* or Health innovation*)).tw,kw. (206)
5 or/1-4 (967)
6 device economics.fs. (2083)
7 device economics/ (27)
8 exp statistical model/ (160603)
9 exp theoretical model/ (86905)
10 exp economic evaluation/ (267601)
11 decision support system/ (20371)
12 risk assessment/ (423249)
13 uncertainty/ (15179)
14 computer simulation/ (103025)
15 exp medical research/ (395534)
16 (analysis adj3 (cost* or conjoint or Choice or probabalistic)).tw,kw. (39868)
17 analytic* hierarch* process*.tw,kw. (902)
18 exp Bayes theorem/ or probability/ or methodology/ or statistical analysis/ (2085324)

19 exp markov chain/ or exp hidden Markov model/ or (Markov* adj2 model*).tw,kw. (15171)

20 (Bayesian adj2 (techniq* or method* or analy* or theorem*)).tw,kw. (10995)

21 (bench study or bench studies or bench marking).tw,kw. (567)

22 (choice based or choicebased or discrete choic* or clinical trial* or conjoint analys* or early model*).tw,kw. (409683)

23 (delphi adj3 (method* or technique*)).tw,kw. (4469)

24 (early cost or early economic).tw,kw. (85)

25 expected value of.tw,kw. (2506)

26 (expert panel* or expert elicit* or focus group* or user* feedback* or interview).tw,kw. (190958)

27 (headroom or health economic model* or health impact or horizon scan*).tw,kw. (8217)

28 (literature review* or multi-criteria decsision* or multi parameter evidence*).tw,kw. (85332)

29 (payback from research or return on investment).tw,kw. (1645)

30 (preliminary market research or real options analysis or road-mapping or multi-path).tw,kw. (197)

31 (preference methods or qualitative weighting or technolog profiling or usability test*).tw. (1040)

32 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 (3863687)

33 5 and 32 (474)

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