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Scanning the horizon: A systematic literature review of methodologies

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ABSTRACT

Objectives: Society is confronted with the rapid emergence of innovation in science and technology. To manage this, horizon scanning is being adopted globally to identify, assess and prioritise innovations and trends at an early stage of their development. This enables decision-makers to be better informed and prepare for change. The aim of this paper is to systematically identify and evaluate HS methodologies employed in healthcare and elsewhere.

Methods and Results: A systematic literature review was performed using PUBMED and EMBASE, and was supplemented with grey literature searches. The principal methodologies used in horizon scanning were extracted from approximately 100 articles, and were summarised in a literature map. The search revealed many examples of horizon scanning across disciplines. Challenges, such as the need to refine prioritisation criteria, manage uncertainty inherent in the findings, and improve the dissemination of identified issues, have been highlighted.

Conclusion: Horizon scanning, when performed appropriately, is a flexible and reliable tool. When used for the early identification of trends, horizon scanning can inform and influence decision-making, leverage opportunities and address challenges at an international level. Further research to identify the most effective methodologies available would add depth to this landscape and enable the evolution of best practice to most efficiently anticipate novel developments and innovations.

Strengths and limitations of this study

- This systematic review offers an up-to-date perspective on horizon scanning methodologies – incorporating practices from beyond the health field; however, as reviews into horizon scanning in healthcare have been undertaken previously, some duplication of findings was inevitable.(1-5)
- Resource limitations have precluded evaluation of horizon-scanning in all sectors, particularly in the private sector, and consideration of material in languages other than English and Italian.
- The paper may be subject to outcome bias as the papers reported systematic methodological aspects of horizon scanning; therefore, some ad-hoc horizon scanning methods may not be captured.

INTRODUCTION

Across organizations worldwide, the rapid emergence of high impact innovation is a major challenge faced by decision makers.(6) To respond, the identification of future innovations and trends is being undertaken in a comprehensive, systematic and sustainable manner so that policy makers, and other stakeholders, can respond appropriately and enable innovations to reach the market with minimal developmental, legal, regulatory, process or procurement bottle-necks. To catalyse the achievement of this objective, horizon scanning is emerging as a valuable and viable strategy. This is particularly true in the health sector, where the European Medicines Agency (EMA) is seeking to promote the availability of innovative medicines using horizon scanning. This foresight will in turn inform the Agency's Regulatory Science Strategy and the European medicines regulatory network strategy.(7-9)

Horizon scanning has been in use for many years, initially by commercial organisations and later by public bodies; Japan was an early adopter of foresight methodologies in the 1970s.(4, 10) Since then, horizon scanning has been used across diverse sectors to aid financial, policy, process and research planning.(5, 11) There are many definitions of horizon scanning,(12) but most can be captured by its generic characterisation as a systematic examination of information to detect early signs of important developments. The approach generally targets the early lifecycle of technologies – i.e, in an early phase of adoption before their introduction on to the market - but may also scan for broader trends, challenges and opportunities. It provides an early warning of 'signals', rather than a comprehensive study of their impact.

Horizon scanning generally follows a process of signal detection, filtration, prioritisation, assessment and dissemination (Fig 1). Its use is growing across sectors,(13) and this risks the duplication of efforts (both in design and execution) as similar stretches of the horizon are scanned by many.

Fig 1. Common stages of Horizon scanning from the EuroScan network (12).

There have been no recent reviews of horizon scanning methods used in the health sector,(12, 14) or those looking beyond the health sector sectors. As a result, the aim of this literature review is to systematically identify and evaluate HS methodologies employed in healthcare and elsewhere. The overall goal is to broaden and update knowledge on the methodologies used, and through mapping and evaluation, provide a useful guide for the establishment and optimisation of future horizon scanning initiatives. This includes the activities of the EMA's recently established Regulatory Science Observatory, as well as the EU Innovation offices Network and the International Coalition of Medicines Regulatory Authorities (ICMRA).(9)

METHODS

A systematic review of the literature was performed to capture and map the use of horizon scanning activity, and the widespread use of modern IT/web capabilities, with 2008 to 2018 chosen accordingly.(15) Three researchers were involved and a systematic protocol was followed to minimise inter-rater bias; this involved cross validation between two researchers, with diverging opinions then arbitrated by the third. This systematic approach also permitted gaps and inconsistencies in the field to be identified. Data collection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines:(16) the literature was first screened and filtered using inclusion and exclusion criteria; the accepted papers then underwent data extraction and analysis; and, finally, the scanning methodologies were mapped.

Search strategy

Medline and Embase bibliographic databases were searched to identify research papers on the use of horizon scanning, and the methods used for this purpose. Grey literature and bibliographies of the most relevant research papers supplemented this search. The primary search terms and relevant MeSH terms used were: "*horizon scan*" OR "*strategic foresight*" OR "*systematic early dialogue*" OR "*early warning and alert system*". All literature, of which the title or abstract contained any of the keywords above, was flagged.

Inclusion and exclusion criteria

Only articles published in English or Italian from 2008-2018 were included,

In the first round of screening the publication abstracts had to indicate:

(a) either a methodology for horizon scanning or strategic foresight, *or* a discussion, or experience provided, of horizon scanning.

(b) It was also essential for the abstracts to indicate a breadth of horizon scanning of the relevant field level *or* address a methodological aspect which may be generally applicable across different fields.

In the second round, the full texts of the selected articles were then reviewed according to additional inclusion criteria:

(a) the horizon scan or foresight methodology was detailed, *and*

(b) the priority areas included relevant science and/or technology, *and*

(c) a collaborative/international approach was used, *and*

(d) the horizon scanning undertaken spanned a period of between 2 and 15 years.

Alternatively, the paper was required to demonstrate methodological aspect(s) of foresight or horizon scanning of potentially general applicability.

The foresight period of 2-15 years reflected the facts that signals suggesting impact in less than two years obviously concern innovations that are already in late-stage development, while those anticipated to 'mature' in 15-20 years' time are too distant and uncertain to be useful.

The mapping was elaborated using the EuroScan International Information Network method, a scientific association of member organizations and individuals for the exchange of information on important emerging new drugs, devices, procedures, programs, and settings in health care (EuroScan), and novel methodological aspects from the searched literature.(12)

Patient and Public Involvement

The patients and public were not directly involved in the design or conduct of the study.

RESULTS

There were 413 papers identified through the initial database searches and grey literature, of which 252 were removed due to duplication or failing to meet the inclusion criteria. 60 papers were excluded because of language issues or lack of access to full-text. 101 publications were included in this study after reading the full text as indicated (Fig 2).

Fig 1. Literature selection process flowchart (16)

Consistency between the selection of papers by the two researchers, who undertook the screening, was fair (Cohen's unweighted Kappa =0.28).(17) A third researcher therefore screened the excluded literature according to the criteria to ensure that all relevant papers were captured (and resulting in one further publication being selected).

Most of the studies included in this review address horizon scanning as whole, following the process outlined in Figure 1, and of these, many operate in a national context. A few papers also focus on the use of specific methodological aspects such as Delphi techniques (see Table 1). Given the databases interrogated, the most prevalent priority areas identified were environmental issues,(12) gene therapy,(8) oncology(9) and clinical practice. Public sector bodies in the UK, USA, Sweden and Australia published the most on the topic. Internationally, EuroScan was repeatedly referenced for its role in harmonizing horizon scanning methodology, supporting its members and encouraging international collaboration.

Risk of bias was assessed in accordance with the BMJ guidelines and the Cochrane risk of bias tool. Most bias were not applicable to these non-clinical qualitative studies, however the following were:

- A form of publication bias was likely in which only horizon scanning undertaken in organisations with a strong background in publishing academic publications were discovered. It was not possible to correct for this.

- Outcome bias may have occurred as the papers reported systematic methodological aspects of horizon scanning, whereas some horizon scanning may occur in an ad-hoc manner e.g. a signal discovered by word of mouth.

- The competing interests of the authors were not considered beyond the standards of the source journals. This was because it was not thought highly relevant to the reporting of methodologies.

Mapping

The process outlined in the EuroScan Method toolkit was used as a basis and novel methodological aspects found in the literature added.(12) The resulting map is segmented into: signal identification and detection, criteria and methods of filtration and prioritization, assessment, dissemination and updating of information, and overall evaluation of the process. Notable references are given; the full dataset is provided in supplementary data file.

Information sources and signal detection

For more detailed results, please see the supplementary information.

Signals are detected from manifold sources in a horizon scanning exercise; Table 1 summarises the most common origins of information.

Information sources (signal detection)
• Scientific/biomedical literature review • Patents • Input from industry and industry associations • Other observatories • Media • International institutions and forums • Individuals, committees and expert groups • Surveys • Government bodies • Meetings and conferences • Other organisations • Grey literature

Table 1: Information sources used for signal detection in horizon-scanning

Review of the scientific and biomedical literature is perhaps the most common place to identify innovation. Searches can be structured, using systematic and validated strategies, for broad or targeted topic areas;(18-20) a two-step approach, first to survey the field and, second, for a 'deep dive', can be used. Recently issued patents and published patent applications (e.g., the European Patent Office)(21) represent an alternative source of early

signals, particularly of innovations originating in industry (large, medium and small). Systematic and/or *ad hoc* scanning of direct or indirect information about new findings from industry or industry associations(22, 23) (such as investment of venture capital in SMEs) is also useful for monitoring of research pipelines. As are, for example, clinical trials databases(24, 25) and intelligence gathered from research infrastructures and consortia, and from university and research institute technology transfer offices.

Other observatories of potential value include repositories of innovation and trends generated from the horizon scanning outputs of international regulators and the committees and expert groups of governmental bodies, such as OECD and EuroScan(26-28). The media - print, electronic and social - generate substantial topic-specific and commercially-relevant information, available via RSS feeds(13), Twitter, Facebook, etc.(29) Social media also allow suggestions of signals from stakeholders. Workshops can also be useful to bring together diverse experts (chosen on the basis of their area of specialisation, breadth of knowledge, publications and commitment to the process) to discuss areas of novel science and technology and to collaboratively scan the horizon from different points of view.(30) These 'sand-pit' exercises can be supplemented by participants from the scanning organisation itself, appropriate stakeholder groups, external consultants and policy-makers.(31, 32) For sustainable and continuous horizon scanning, it may prove valuable to create a steering committee, think tank or "idea radar" including representatives of the aforementioned participants.(33, 34)

Delphi studies are widely used to pool knowledge and build consensus around emerging issues. There are two or more rounds involved: in the first, participants identify relevant issues, which are then pooled and ranked; the second round sees these issues discussed followed by their re-ranking. This process is iterated until a consensus is reached. Several Delphi variations have been described, from more conventional workshop formats to the use of online tools such as Nvivo (quantitative analysis of text) or Wordle.net (a word cloud

tool).(35) The design of a Delphi study should take into account the sample size and confounding factors, such as the level of conformity in the group.(5, 36, 37)

Surveys, conducted via the web or by mail,(23, 34) enable staff of an organisation, stakeholders and the public to be asked to identify new technologies or trends.(38) These may be most useful when horizon-scanning in well-defined fields.(5) Semi-structured interviews covering a standard set of questions can also be used, with similar outcomes.(19) However, public input was not found to be hugely productive.(38) Likewise, an attempt to establish a Wikipedia community has been largely unsuccessful.(39)

Finally, a number of additional sources have been identified including draft legislation and policy papers from governmental bodies, the proceedings of scientific conferences and symposia, professional and scientific societies, interest groups, think-tanks and research funders (government, charities, venture capital, etc.), the so-called grey literature where global shifts that influence society, the economy and the environment — megatrends —(40) are sometimes foreseen. Google alert queries, Google Trends, Google News Timeline, Google Insight, and blogs were mentioned.(39, 41)

Filtration criteria and methods

For more detailed and explanatory results, please see the supplementary information.

Table 2 presents the criteria and methods commonly used to discard irrelevant signals.

Filtration criteria (discarding irrelevant signals)	**Filtration methods**
• Potential impact • Size of affected population or global relevance • Novelty • Level of innovation • Evidence • Organisational impact • Plausibility • Levels of stakeholder and media interest • Policy priority • Stage of development • Ethical and social issues • Within time-frame of 2-15 years	• Classification criteria • Automated text-mining tools • Individual and group filtration • Peer review • Expert participation

Table 2: Filtration criteria and methods used in horizon-scanning to discard irrelevant signals

Several key criteria concerning a signal's potential impact were used:(20, 34, 42-44) What are the costs, and the cost-utility ratio, of resource consumption; what are the implications in terms of quality of life, burden of disease and patient safety?(44, 45)

The level of evidence is a further important criterion that has been ranked using a simple traffic light system,(46) where green denotes sufficient evidence to support the uptake of the signal, yellow indicates insufficient evidence to support uptake but the evidence may constitute useful information, and red implies unsupportive or insufficient evidence.

In terms of filtration methods, these may be separated into those which tag signals according to the criteria in a binary yes/no fashion, or those which use distinct or graduated categories, e.g., confirmed, likely, potential, unlikely, and questionable.(25) Automated text-mining tools can be used with databases to enable the identification, tagging and categorisation of signals and facilitate clustering and filtering.(5) Individual or group filtration may be performed by organisational staff, who can also undertake, up to point, peer review that ultimately requires the participation of external experts. The latter can also be responsible for weighting signals, according to the criteria, using an evidence framework.(20, 30)

Prioritisation criteria and methods for assessing signals

For more detailed and explanatory results, please see the supplementary information.

The signals which have met the filtration criteria can then be prioritised. The prioritisation criteria which must be met, and the methods used to do so, are collected in Table 3.

Prioritisation criteria (assessing signals)	**Prioritisation methods**
• Potential impact on outcomes • Size make-up of the affected population • Expected variation of impact • Likely time-frame • Evidence of effectiveness • Relevance to strategic and political priorities • Effect on other related policies • Desirability • Factual basis • Requirement of availability of expertise • Novelty	• Qualitative approach • Quantitative or semi-quantitative approaches • Rating and ranking • Best-worst scaling • Risk analysis • Standardisation of signals • Delphi approach • Public consultation • Engagement of experts • Mixed methods

Table 3: Prioritisation criteria and methods used in horizon-scanning to assess signals

Logically, the criteria consider the potential impact on outcomes, a clear example being resource consumption, and the cost of a signal.(34, 42) The size and composition of the

affected population are therefore important factors,(34, 45, 47, 48) as well as the expected variation that may be observed between different subsets.(42, 47) For the signal to be prioritised, the timeframe must be realistic,(11, 34, 49) and there must be a clear, factual indication of true novelty and desirability. In addition to evidence of effectiveness, consideration must be given to the relative added-value over current practice,(34) and whether this sufficient to satisfy strategic and/or political priorities and policies (e.g., reduction in inequality)(42).

With respect to prioritisation methods, a simple qualitative approach uses short summaries of the signals as a basis to prioritise.(50) Quantitative or semi-quantitative approaches are obviously more rigorous and typical (for details of such approaches see supplementary information).

There were several novel Delphi approaches developed, for example, to acquire expert input online in a continuous feedback forum or market place. Here, participants prioritise, or purchase, a limited number of signals which then accrue a "price" that can ultimately be used to prioritise those of greatest value.(33) Controls are possible to counteract the possibility of scoring fatigue.(51)

Finally, it should be emphasised that the engagement of experts for prioritisation must ensure diverse participation from different sectors, geographical regions, disciplines, and demographics.(29, 43, 52) Public consultation is a valuable asset to provide input and involvement from citizens and users in prioritisation, and can be achieved in person, via email or online.(34, 39)

Signal assessment and methods

For more detailed and explanatory results, please see the supplementary information.

The signals which have met the prioritisation criteria are then assessed. The factors assessed, and the methods employed to do so, are in Table 4. (e.g., in terms of resource implications and broad financial perspectives).

Signal assessment	Assessment methods
• Impact, e.g., resource (financial) implications • Level of innovation • Expected utilisation and diffusion • Risk assessment • Actions required and time to impact • Legal and ethical issues • Barriers to market • Stakeholder perception	• ExpertLens • Driver analysis • Scenario planning • Expert, user and policy-maker participation • Peer review

Table 4: Signal assessment and methods used in horizon-scanning

A key factor to consider in the assessment of any signal, of course, are the resource implications. The expected utilisation and availability of the innovation across different geographical regions is also important(32, 34, 45), as is a detailed risk assessment. A number of practical issues must also be considered, including actions needed to translate the signal into use (such as further research, the development of new processes, and whether complementary technology, for example, is essential to realise the value of the signal), the time and investment required to do so, the need for new or specialised training of personnel involved,(11) the cooperation and acceptance of key stakeholders, any ethical

issues, access to the necessary experts(5) and the intellectual property associated with the signal, and whether legislative or regulatory guideline changes are required. As always, impact on the market must be taken into consideration: is the innovation likely to have a disruptive effect, will it encounter reimbursement barriers, what are the timelines and milestones,(33) etc.? A consensus level of innovation can be sought (e.g., important, moderate, modest)(53).

Insofar as the methods used for signal assessment are concerned, a number of approaches are available (see supplementary information).

Dissemination and evaluation of the results of horizon scanning

For more detailed and explanatory results, please see the supplementary information.

The key elements involved in the disseminating and evaluating the results of horizon scanning are listed in Table 5.

Dissemination	**Evaluation**
• Format • Methods • Audience • Frequency • Updating	• Short, medium and long-term • Process and output audit • Validation and sensitivity • Focus groups • Metrics • Access to database

Table 5: Dissemination and evaluation of the results of horizon-scanning

In terms of dissemination, the assessment of an individual signal can be summarised in a document with the following elements: authors, lay summary, assessment objectives and methods, background and current practice, signal description, impacts and other issues, estimated time to impact, comparator signals (innovations), expert opinion, and declaration of any conflict of interests. It may also be beneficial to include policy recommendations which are linked to decision-making priorities, structures, and individual and cross-cutting policies.(18, 30, 38, 45, 48) Dissemination can be achieved, when a new report is available, via numerous pathways, including email, social media, notification of target groups,(39, 43) public events involving the participation of policymakers,(5, 34) publicly-accessible repositories of data or outputs that are clearly indexed, easily searchable and categorised, for example, by level of evidence and other metrics.(41, 54)

Dissemination of any new report should be made systematically through diverse platforms(43) and shared directly with relevant organisations.(41) The frequency of dissemination depends on circumstances.

A related activity that bridges dissemination and evaluation is the updating of horizon-scanning information. This comprises four essential elements: (a) continually checking and pruning sources based on their usefulness, relevance, and evolution, (b) monitoring and updating changes in signals by periodically refreshing the horizon scan, (c) reassessment of signals when sufficient new data are available or a step-change in technology has occurred, (d) validating annually, for example, the horizon-scanning update by a team of expert researchers, practitioners and journalists.

Evaluation of the results of horizon-scanning can be performed in the short, medium and long-term. A short-term evaluation may involve the following actions: survey of an appropriate audience on the usefulness of horizon-scanning in decision-making; use of metrics (e.g., provided by Google Analytics), such as number of downloads, page views, average session duration, citations in publications and funding applications; reports of

failures; consistency with other horizon scanning methods. In the medium-term, an evaluation would include the responsiveness of the horizon-scanning team to requests; the ability to keep the horizon-scanning content up-to-date; to compare findings with "gold" standards (e.g., EuroScan, The Agency for Healthcare Research and Quality); and to measure sensitivity and associated predictive value. Finally, a long-term evaluation assesses the usage of horizon-scanning information in arriving at decisions; the accuracy of projections; the timeliness with which new technologies were detected; the prioritisation criteria which best signalled the impact of the technology.

A process and output audit represents another approach to evaluation and ensures the completeness of the search record; records of external input; records of expert contact details; clear filing of information used; and a clear statement of the innovation in the briefing. A focus group of users can be employed to review the information input and dissemination and to develop a user-friendly interface through which to access the database.

DISCUSSION

There were a wide variety of sources and methods used to identify new and emerging issues. However, it was common to use scientific literature, individuals, committees and expert groups, the web and Delphi methodologies. That the scientific literature dominates is expected as innovation often begins in an academic environment and because widely-accessible bibliographic databases have powerful search and filtering capabilities. The frequent use of the Delphi methodology may be explained by its ability to 'crowd-source' information and build a consensus amongst participants in a relatively short timeframe. This consensus, particularly expert consensus, adds weight to the conclusions drawn from horizon scanning.

Overall, the majority of the methods used were manual or semi-automated, with relatively few automated aspects. This could be due to the limited availability of software and budget constraints. Complex filtration, prioritisation and assessment criteria are some of the barriers to full automation that may be resolved in the not-too-distant future by the rapidly evolving fields of machine learning and artificial intelligence.

Dissemination of horizon-scanning reports appear to have rarely fed directly and systematically into policymaking. This may simply be a reflection of the unpredictable and political nature of policymaking, as well as a mismatch with the longer time-scale of horizon-scanning. Equally, it is probably fair to say that the information gathered by horizon-scanning lacks, at least to some extent, the conventional measures of credibility and authority required to influence policymaking.(30) New tools and approaches (e.g., via generation of complex scenarios and the clear weighting of evidence)(30, 55) are probably needed to enable horizon-scanning to be considered more seriously by policymakers.

The distance of the horizon scanned was also found to be a tricky balance between the need to assess signals as early as possible to inform decision makers, and the limited information

available at an early stage.(56) There were many different evaluation methods employed, covering different time-spans, reflecting *inter alia* cultural differences, resource limitations and a time-lag between horizon-scanning and its critical evaluation (for example, a high false-positive rate of horizon-scanning implied the need for tighter filtration criteria)(2).

From a public policy standpoint, horizon-scanning has both informative and creative functions, alerting policy makers to emerging issues, and providing new, plausible policy options.(5) This use of horizon-scanning is well established for identification of emerging issues, both positive and negative, in global conservation and biological diversity.(57) In some contrast, however, in the biomedical field, in which this review has concentrated, horizon-scanning is biased towards identification of positive, innovative signals as those with low value inevitably have little impact.(58) Finally, in addition to its institutional value, horizon-scanning can significantly help related stakeholders, such as technology developers or civil society - it can reveal barriers to innovation and allow proactive engagement to reduce these barriers.(59)

Limitations

As systematic reviews into horizon scanning in healthcare have been undertaken previously, some duplication of findings was inevitable;(1-5) however, this review offers an up-to-date and wider perspective, and includes methodologies from beyond the health field. Resource limitations have precluded evaluation of horizon-scanning in other, related sectors, and consideration of material in languages other than English and Italian. Lastly, a fully comprehensive review of all methodologies has not been performed for practical reasons: the inconsistent reporting of the horizon-scanning details and the continually evolving approaches employed. This effort must be viewed as a 'snapshot', therefore, of a rapidly moving target.

Conclusions

To respond to accelerating innovation, horizon-scanning methodology is being adopted both nationally and internationally, particularly in the public sector. The range of methods used, and the limited assessment of their performance, renders recommendation of a single approach premature and explains why combining two or more techniques makes sense for validation and for improving the accuracy of predictions.(4, 5)

Undoubtedly, automation and the development of 'intelligent' horizon-scanning are short-term milestones that will significantly improve the process, enhancing the evidence base, disseminating the acquired outputs efficiently, and facilitating decision-making. Self-evidently, given the need for horizon-scanning across diverse disciplines, involving large numbers of interested stakeholders with related information needs, the process can only benefit from international collaboration. To this end an initiative is already underway within the International Coalition of Medicines Regulatory Authorities in which the EMA is taking an active role)(60, 61). Of course, scanning the horizon for signals is not an endpoint, in and of itself, but rather a window through which current and future opportunities and policies can be linked.(62) It is essential, therefore, that further research be performed to develop, assess and ultimately implement the most efficacious methods of scanning and to ensure their acceptance and uptake by relevant stakeholders.

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Disclaimer

The views expressed in this article are the personal views of the authors and may not be understood or quoted as being made on behalf of or reflecting the position of the agencies or organisations with which the authors are affiliated.

Data sharing

The dataset is available in the supplementary data file or upon request.

Competing interests

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- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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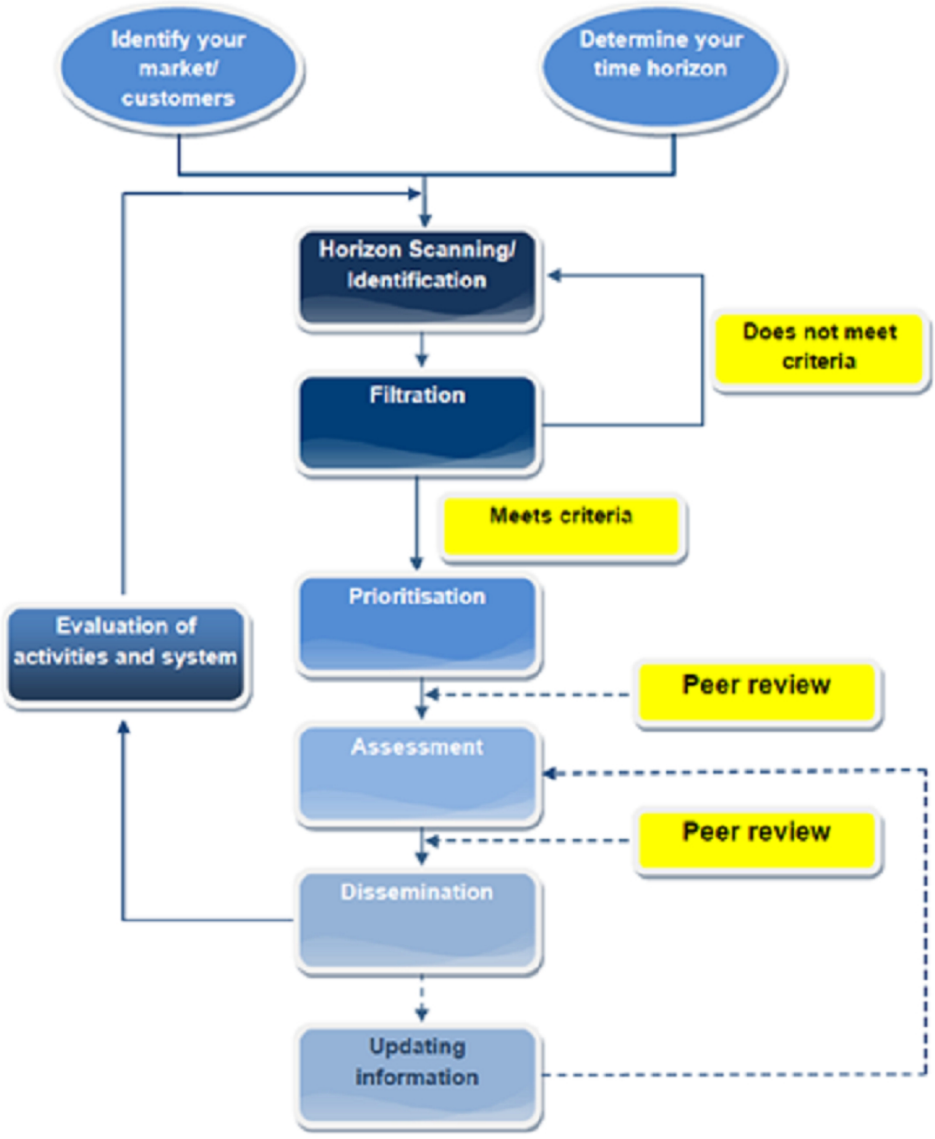

Fig 1. Common stages of Horizon scanning from the EuroScan network (12). This figure is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike4.0 International License (CC BY-NC-SA 4.0)

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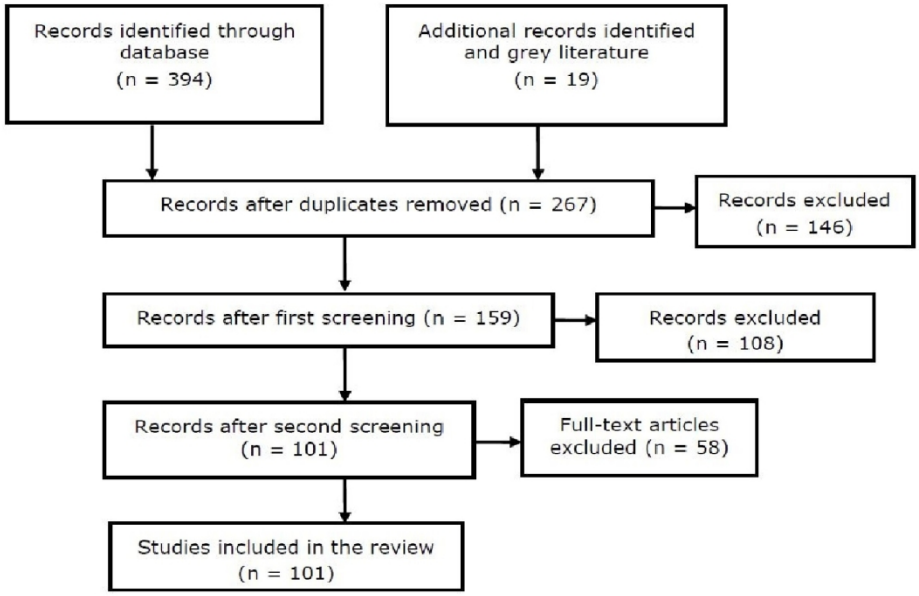


Caption : Fig 2. Literature selection process flowchart (16)

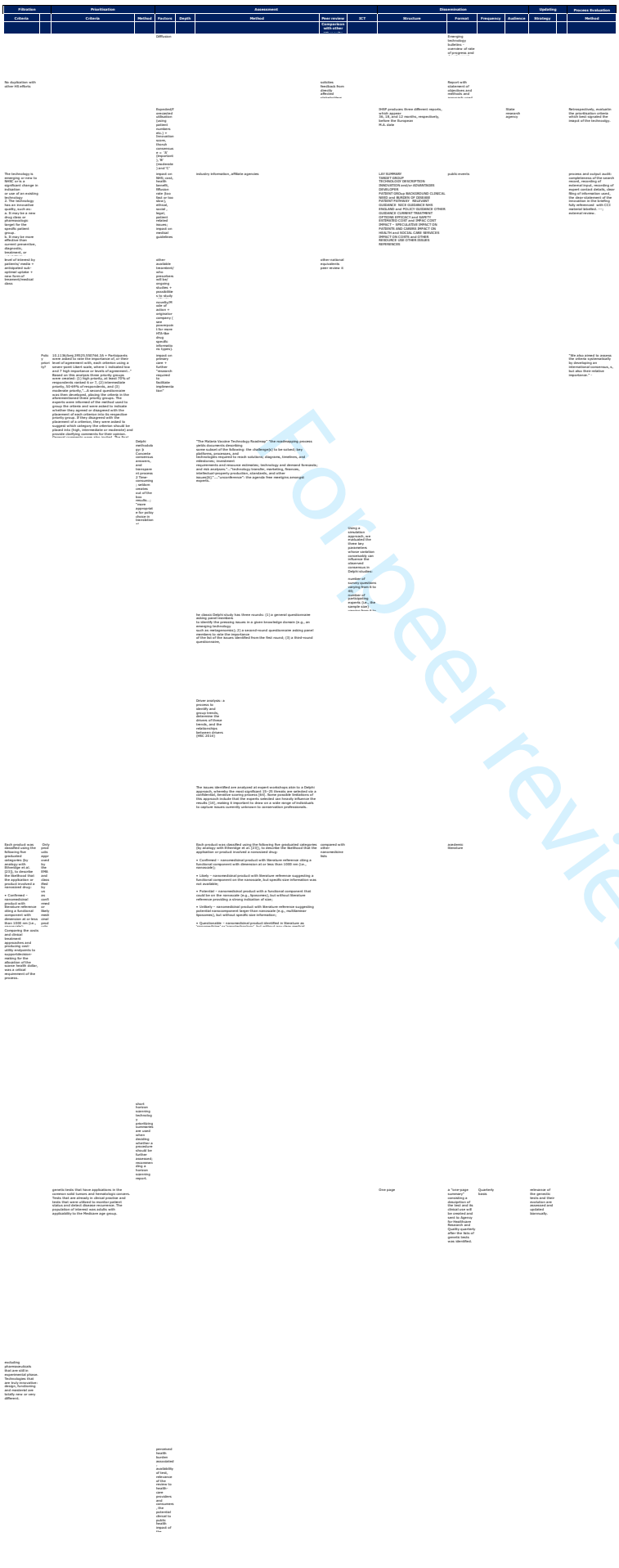
150x102mm (300 x 300 DPI)

Included papers and info			Information sources (proactive and passive)																					Time
Title	Full Text Link ("-" if unavailable; or explanation of non-inclusion)	Abstract	Scientific	Pipeline			Patents	Other	Media		International institutions and	Individuals, Committees and expert groups		EU	Draft	Innovation	Organisations					Meeting and	Other grey	
				Clinical trial registers	Research infrastructure	Commercial sources			Commercial	Medical			Survey techniques				Acadamies of science	Interest group profiles.	Think Tanks	Research funders	Venture Capitalist			
Australia and New Zealand Horizon Scanning Network, Australia and New Zealand (ANZHSN, including Adelaide Health Technology Assessment [AHTA])	https://www.effectivehealthcare.ahrq.gov/sites/default/files/pdf/horizon-scan_research-2013.pdf																							
Basque Office for Health Technology Assessment, Basque Country (OSTEBA)	https://www.effectivehealthcare.ahrq.gov/sites/default/files/pdf/horizon-scan_research-2013.pdf												A think-tank/group : " a group of health care professionals, including physicians, nurses, and professionals involved in health management."											
Canadian Agency for Drugs and Technologies in Health, Canada (CADTH)	https://www.cadth.ca/sites/default/files/pdf/ES%20External%20Audience%20Process%20Doc.pdf		targeted literature search																					
Supporting Innovation through Regulation and Science: Ireland	DOI: 10.1159/000481427																							
Italian Horizon Scanning Project, Servizio Farmaceutico Territoriale, Italy (IHSP)																								
National Horizon Scanning Centre, England (NHSC) + (Their research paper: Past speculations of the future: a review of the methods used for forecasting emerging health technologies)																								
Swedish Council on Technology Assessment in Health Care, Sweden (SBU)	https://www.frontiersin.org/articles/10.3389/fphar.2017.00674/pdf										Drug regulators e.g. EMA)													
UK PharmaScan	https://www.ukpharmascan.org.uk/static/about					Systematic input by Pharma (ABPI)																		
Oxford Centre for Monitoring and Diagnosis in Primary Care	https://www.community.healthcare.mic.nihr.ac.uk/about-us/horizon-scanning-1																							
Masum H, Ranck J, Singer PA. Five promising methods for health foresight. Foresight 2010;12:54–66. doi:10.1108/14636681011020182CrossRefGoogle Scholar	https://www.emeraldinsight.com/doi/abs/10.1108/14636681011020182												Enabling experts to collaboratively scan for innovations could act as an "idea radar" to look for emerging trends and out-of-the-box solutions											
Evaluation of nine consensus indices in delphi foresight research and their dependency on delphi survey characteristics: A simulation study and debate on delphi design and interpretation	https://doi.org/10.1371/journal.pone.0135162	The extent of consensus (or the lack thereof) among experts in emerging fields of innovation can serve as antecedents of scientific, societal, investor and stakeholder synergy or conflict. Naturally, how we measure consensus is of great importance to science and technology strategic foresight. The Delphi methodology is a widely used anonymous survey technique to evaluate consensus among a panel of experts. Surprisingly, there is little guidance on how indices of consensus can be influenced by parameters of the Delphi survey itself. We simulated a classic three-round Delphi survey building on the concept of clustered consen-sus/dissensus. We **evaluated three study characteristics that are pertinent for design of Delphi foresight research:** (1) the number of survey questions, (2) the sample size, and (3) the extent to which experts conform to group opinion (the Group Conformity Index) in a Delphi study. Their impacts on the following nine Delphi consensus indices were then examined in 1000 simulations: Clustered Mode, Clustered Pairwise Agreement, Conger's Kappa, De Moivre index, Extremities Version of the Clustered Pairwise Agreement, Fleiss' Kappa, Mode, the Interquartile Range and Pairwise Agreement. The dependency of a consensus index on the Delphi survey characteristics was expressed from 0.000 (no dependency) to 1.000 (full dependency). The number of questions (range: 6 to 40) in a survey did not have a notable impact whereby the dependency values remained below 0.030. The variation in sample											Delphi studies are a cornerstone in deciphering the emerging technology and innovation future(s), helping guide attendant public policies….; nine Delphi consensus indices were then examined											
A Delphi technology foresight study: Mapping social construction of scientific evidence on metagenomics tests for water safety	https://doi.org/10.1371/journal.pone.0129706	Access to clean water is a grand challenge in the 21st century. Water safety testing for pathogens currently depends on surrogate measures such as fecal indicator bacteria (e.g., E. coli). Metagenomics concerns high-throughput, culture-independent, unbiased shotgun sequencing of DNA from environmental samples that might transform water safety by detecting waterborne pathogens directly instead of their surrogates. Yet emerging innovations such as metagenomics are often fiercely contested. Innovations are subject to shaping/construction not only by technology but also social systems/values in which they are embedded, such as experts' attitudes towards new scientific evidence. We conducted a classic three-round Delphi survey, comprised of 107 questions. A multidisciplinary expert panel (n = 24) representing the continuum of discovery scientists and policymakers evaluated the emergence of metagenomics tests. To the best of our knowledge, we report here the first Delphi foresight study of experts' attitudes on (1) the top 10 priority evidentiary criteria for adoption of metagenomics tests for water safety, (2) the specific issues critical to governance of metagenomics innovation trajectory where there is consensus or dissensus among experts, (3) the anticipated time lapse from discovery to practice of metagenomics tests, and (4) the role and timing of public engagement in development of metagenomics tests. The ability of a test to distinguish between harmful and benign waterborne organisms, analytical/clinical											a track record of publications and/or professional scholarly engagements in water safety … Purposive sampling followed by snowball recruitment was used for experts' participation in the study. Fifty-two experts consented to participate in the study. Each expert was assigned a randomly generated code (between 0 and 999) by a study coordinator to safeguard anonymity… "In brief, the above first round responses were analyzed using the NVivo [37] qualitative data analysis software. A word cloud was created using the open access word cloud generator wordle.net.											
Using strategic foresight to assess conservation opportunity	https://doi.org/10.1111/cobi.12404	The nature of conservation challenges can foster a reactive, rather than proactive approach to decision making. Failure to anticipate problems before they escalate results in the need for more costly and time-consuming solutions. Proactive conservation requires forward-looking approaches to decision making that consider possible futures without being overly constrained by the past. Strategic foresight provides a structured process for considering the most desirable future and for mapping the most efficient and effective approaches to promoting that future with tools that facilitate creative thinking. The process involves 6 steps: setting the scope, collecting inputs, analyzing signals, interpreting the information, determining how to act, and implementing the outcomes. Strategic foresight is ideal for seeking, recognizing, and realizing conservation opportunities because it explicitly encourages a broad-minded, forward-looking perspective on an issue. Despite its potential value, the foresight process is rarely used to address conservation issues, and previous attempts have generally failed to influence policy. We present the strategic foresight process as it can be used for proactive conservation planning, describing some of the key tools in the foresight tool kit and how they can be used to identify and exploit different types of conservation opportunities. Scanning is an important tool for collecting and organizing diverse streams of information and can be used to recognize new opportunities and those that could be																						
Strategic foresight: how planning for the unpredictable can improve environmental decision-making	https://doi.org/10.1016/j.tree.	Advanced warning of potential new opportunities and threats related to biodiversity allows decision-makers to act strategically to maximize benefits or minimize costs. Strategic foresight explores possible futures, their consequences for decisions, and the actions that promote more desirable futures. Foresight tools, such as horizon scanning and scenario planning, are increasingly used by governments and business for long-term strategic planning and capacity building. These tools are now being applied in ecology, although generally not as part of a comprehensive foresight strategy. We highlight several ways foresight could play a more significant role in environmental decisions by: monitoring existing problems, highlighting emerging threats, identifying promising new opportunities, testing the resilience of policies, and defining a research agenda.																						
Horizon scan of nanomedicinal products	10.2217/nnm.15.21	Aim: A horizon scan of nanomedicinal product on the market or undergoing clinical investigation by analyzing the current nanomedicinal landscape. Materials & Methods: The horizon scan includes a search of literature, clinical trial registries and the internet. Results: This horizon scan yielded 175 nanomedicinal products. Most products were intended for cancer treatment, followed by infectious diseases. Polymer conjugates, liposomes and protein nanoparticles were the most used structures for nanomedicinal products. Conclusions: This paper provides an overview of nanomedicinal products on the market or undergoing clinical investigation, their application areas and specific properties.	100	identifying nanomedicinal products that are undergoing clinical investigation in humans,..European Clinical Trial Registry https://www.clinicaltrialsregister.eu/ Global Clinical Trial Registry							as well as products already approved by the EMA or the FDA			EMA										excludes applications that are in an earlier phase of the pipeline, such as early animal testing
Trans Tasman Radiation Oncology Group: Development of the Assessment of New Radiation Oncology Technology and Treatments (ANROTAT) Framework	https://onlinelibrary.wiley.com/doi/epdf/10.1111/1754-9485.12255	Introduction The study aim was to develop a generic framework to derive the parameters to populate health-economic models for the rapid evaluation of new techniques and technologies in radiation oncology. Methods A draft framework was developed through horizon scanning for relevant technologies, literature review to identify framework models, and a workshop program with radiation oncology professionals, biostatisticians, health economists and consumers to establish the Framework's structure. It was tested using four clinical protocols, comparing intensity modulated with 3D conformal therapy (post-prostatectomy, anal canal and nasopharynx) and image-guided radiation therapy techniques with off-line review of portal imaging (in the intact prostate). Results The draft generic research framework consisted of five sequential stages, each with a number of components, and was assessed as to its suitability for deriving the evidence needed to populate the decision-analytic models required for the health-economic evaluations. A final Framework was established from this experience for use by future researchers to provide evidence of clinical efficacy and cost-utility for other novel techniques. The four clinical treatment sites tested during the project were considered suitable to use in future evaluations. Conclusions Development of a generic research framework to predict early and long-term clinical outcomes, combined with health-economic data, produced a generally applicable method for the rapid evaluation of new techniques and		prospective clinical data provided by participating sites																				
Horizon scanning for translational genomic research beyond bench to bedside	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4079725/	Purpose:The dizzying pace of genomic discoveries is leading to an increasing number of clinical applications. In this report, we provide a method for horizon scanning and 1 year data on translational research beyond bench to bedside to assess the validity, utility, implementation, and outcomes of such applications.Methods:We compiled cross-sectional results of ongoing horizon scanning of translational genomic research, conducted between 16 May 2012 and 15 May 2013, based on a weekly, systematic query of PubMed. A set of 505 beyond bench to bedside articles were collected and classified, including 312 original research articles; 123 systematic and other reviews; 38 clinical guidelines, policies, and recommendations; and 32 articles describing tools, decision support, and educational materials.Results:Most articles (62%) addressed a specific genomic test or other health application; almost half of these (n = 180) were related to cancer. We estimate that these publications account for 0.5% of reported human genomics and genetics research during the same time.Conclusion:These data provide baseline information to track the evolving knowledge base and gaps in genomic medicine. Continuous horizon scanning of the translational genomics literature is crucial for an evidence-based translation of genomics discoveries into improved health care and disease prevention.Genet Med 16 7, 535-538. © American College of Medical Genetics and Genomics.						online genomic applications in practice and prevention knowledge base.																
ASERNIP-S: International trend setting	https://onlinelibrary-wiley-com.ezproxy.ub.unimaas.nl/doi/epdf/10.1111/j.1445-2197.2008.04679.x	The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) came into being 10 years ago to provide health technology assessments specifically tailored towards new surgical techniques and technologies. It was and remains the only organisation in the world to focus on this area of research. Most funding has been provided by the Australian Government Department of Health, and assessments have helped inform the introduction of new surgical techniques into Australia. ASERNIP-S is a project of the Royal Australasian College of Surgeons. The ASERNIP-S program employs a diverse range of methods including systematic reviews, technology overviews, assessments of new and emerging surgical technologies identified by horizon scanning, and audit. Support and guidance for the program is provided by Fellows of the Royal Australasian College of Surgeons. ASERNIP-S works closely with consumers to produce health technology assessments and audits, as well as consumer information to keep patients fully informed of research. Since its inception, the ASERNIP-S program has developed a strong international profile through the production of over 60 reports on evidence-based surgery, surgical technologies and audit. The work undertaken by ASERNIP-S has evolved from assessments of the safety and efficacy of procedures to include guidance on policies and surgical training programs. ASERNIP-S needs to secure funding so that it can continue to play an integral role in the improvement of quality of care both																						
Update on Horizon Scans of Genetic Tests Currently Available for Clinical Use in Cancers [Internet].	https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0078750/pdf/PubMedHealth_PMH0078750.pdf	The Coverage and Analysis Group at the Centers for Medicare and Medicaid Services (CMS) is interested in an update report of genetic tests for cancer conditions and the accompanying database to serve as a ready reference for their internal discussions in this area as well as the source for decisions on future topics for systematic reviews. CMS requested that the Technology Assessment Program (TAP) of the Agency for Healthcare Research and Quality (AHRQ) conduct an update of genetic tests for cancer conditions that were identified since the 2006 horizon scan report on Genetic Testing for Cancer. AHRQ assigned this project to the Tufts Medical Center Evidence-based Practice Center (Contract Number: HHSA 290 2007 10055 I, Task Order #3, work assignment #3). The main objective of this report is to provide succinct information along with a preliminary estimate on the amount of published literature available on each identified genetic test through grey literature search since 2006. Systematic review of selected tests will be the subject of future focused reviews. The contents in the database and in this report reflect the data of genetic tests that were obtained from manufacturers' Web sites or other commercial Web sites, and should not be construed as definitive clinical evidence or as recommendations for their routine clinical use.						Gene Test Tracker database																
Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain.	http://plymsea.ac.uk/6640/1/GlobalChangeBiodiversity_final%20paper.pdf	Invasive alien species (IAS) are considered one of the greatest threats to biodiversity, particularly through their interactions with other drivers of change. Horizon scanning, the systematic examination of future potential threats and opportunities, leading to prioritization of IAS threats is seen as an essential component of IAS management. Our aim was to consider IAS that were likely to impact on native biodiversity but were not yet established in the wild in Great Britain. To achieve this, we developed an approach which coupled consensus methods (which have previously been used for collaboratively identifying priorities in other contexts) with rapid risk assessment. The process involved two distinct phases: Preliminary consultation with experts within five groups (plants, terrestrial invertebrates, freshwater invertebrates, vertebrates and marine species) to derive ranked lists of potential IAS. Consensus-building across expert groups to compile and rank the entire list of potential IAS. Five hundred and ninety-one species not native to Great Britain were considered. Ninety-three of these species were agreed to constitute at least a medium risk (based on score and consensus) with respect to them arriving, establishing and posing a threat to native biodiversity. The quagga mussel, Dreissena rostriformis bugensis, received maximum scores for risk of arrival, establishment and impact; following discussions the unanimous consensus was to rank it in the top position. A further 29 species were considered to constitute a high risk and were grouped	literature review and risk assessment with dynamic consensus method.																					
Making processes reliable: a validated pubmed search strategy for identifying new or emerging technologies.	https://www-cambridge-org.ezproxy.ub.unimaas.nl/core/services/aop-cambridge-core/content/view/2782FAEFFF1BDEEE737FDA08E4A45268/S0266462312000578a.pdf/making_processes_reliable_a_validated_pubmed_search_strategy_for_identifying_new_or_emerging_technologies.pdf	BACKGROUND AND OBJECTIVES: Horizon scanning systems need to handle a wide range of sources to identify new or emerging health technologies. The objective of this study is to develop a validated Medline bibliographic search strategy (PubMed search engine) to systematically identify new or emerging health technologies. METHODS: The proposed Medline search strategy combines free text terms commonly used in article titles to denote innovation within index terms that make reference to the specific fields of interest. Efficacy was assessed by running the search over a period of 1 year (2009) and analyzing its retrieval performance (number and characteristics). For comparison purposes, all article abstracts published during 2009 in six preselected key research journals and eight high impact surgery journals were scanned. Sensitivity was defined as the proportion of relevant new or emerging technologies published in key journals that would be identified in the search strategy within the first 2 years of publication. RESULTS: The search yielded 6,228 abstracts of potentially new or emerging technologies. Of these, 459 were classified as new or emerging (383 truly new or emerging and 76 new indications). The scanning of 12,061 journal abstracts identified 35 relevant new or emerging technologies. Of these, twenty-nine were located within the Medline search strategy during the first 2 years of publication (sensitivity = 83 percent).						early warning system report published in the EuroScan database																4 to 5 years
Improving the efficiency and relevance of evidence-based recommendations in the era of whole-genome sequencing: an EGAPP methods update.	https://www.nature.com/articles/gim2012106.pdf	To provide an update on recent revisions to Evaluation of Genomic Applications in Practice and Prevention (EGAPP) methods designed to improve efficiency, and an assessment of the implications of whole genome sequencing for evidence-based recommendation development. Improvements to the EGAPP approach include automated searches for horizon scanning, a quantitative ranking process for topic prioritization, and the development of a staged evidence review and evaluation process. The staged process entails (i) triaging tests with minimal evidence of clinical validity, (ii) using and updating existing reviews, (iii) evaluating clinical validity prior to analytic validity or clinical utility, (iv) using decision modeling to assess potential clinical utility when direct evidence is not available. EGAPP experience to date suggests the following approaches will be critical for the development of evidence based recommendations in the whole genome sequencing era: (i) use of triage approaches and frameworks to improve efficiency, (ii) development of evidence thresholds that consider the value of further research, (iii) incorporation of patient preferences, and (iv) engagement of diverse stakeholders. The rapid advances in genomics present a significant challenge to traditional evidence based medicine, but also an opportunity for innovative approaches to recommendation development.											nomination by EGAPP members, stakeholder group, steering committee, external consultants , and POHG staff.											

Knowledge integration at the center of genomic medicine.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4681509/	Three articles in this issue of Genetics in Medicine describe examples of "knowledge integration," involving methods for generating and synthesizing rapidly emerging information on health-related genomic technologies and engaging stakeholders around the evidence. Knowledge integration, the central process in translating genomic research, involves three closely related, iterative components: knowledge management, knowledge synthesis, and knowledge translation. Knowledge management is the ongoing process of obtaining, organizing, and displaying evolving evidence. For example, horizon scanning and "infoveillance" use emerging technologies to scan databases, registries, publications, and cyberspace for information on genomic applications. Knowledge synthesis is the process of conducting systematic reviews using a priori rules of evidence. For example, methods including meta-analysis, decision analysis, and modeling can be used to combine information from basic, clinical, and population research. Knowledge translation refers to stakeholder engagement and brokering to influence policy, guidelines and recommendations, as well as the research agenda to close knowledge gaps. The ultrarapid production of information requires adequate public and private resources for knowledge integration to support the evidence-based					
Horizon scanning for new genomic tests.	www.nature.com/articles/gim9201128.pdf	PURPOSE: The development of health-related genomic tests is decentralized and dynamic, involving government, academic, and commercial entities. Consequently, it is not easy to determine which tests are in development, currently available, or discontinued. We developed and assessed the usefulness of a systematic approach to identifying new genomic tests on the Internet. METHODS: We devised targeted queries of Web pages, newspaper articles, and blogs (Google Alerts) to identify new genomic tests. We finalized search and review procedures during a pilot phase that ended in March 2010. Queries continue to run daily and are compiled weekly; selected data are indexed in an online database, the Genomic Applications in Practice and Prevention Finder. RESULTS: After the pilot phase, our scan detected approximately two to three new genomic tests per week. Nearly two thirds of all tests (122/188, 65%) were related to cancer; only 6% were related to hereditary disorders. Although 88 (47%) of the tests, including 2 marketed directly to consumers, were commercially available, only 12 (6%) claimed United States Food and Drug Administration licensure. CONCLUSION: Systematic surveillance of the Internet provides information about genomic tests that can be used in combination with other resources to evaluate				Google Alert queries	
Evaluating new surgical techniques in Australia: the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical experience.	https://www-sciencedirect-com.ezproxy.ub.unimaas.nl/science/article/pii/S0039610905001428?_rdoc=1&_fmt=high&_origin=gateway&_docanchor=&md5=b8429449ccfc9c30159a5f9aeaa92ffb	The Australian Safety and Efficacy Register of New Interventiona lProcedures-Surgical (ASERNIP-S) exists primarily to assess new surgical technologies and techniques. It originally conducted systematic literature reviews, but now uses accelerated reviews, horizon scanning for emerging procedures, research and clinical audits,preparation of patient information, assistance with guideline development,and the production of research protocols of new surgical techniques. Future international cooperation and networking among health technology assessment groups will avoid duplication of effort and maximize outputs. Experience has shown that when surgeons lead in assessing new and emerging surgical techniques and technologies, the benefits of an evidence-based approach are realized, and the surgical community accepts the complementary role of evidence-based medicine in the provision of high-quality patient care.					
The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) assesses new surgeries.	www.publish.csiro.au/ah/pdf/AH040143	The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) is a programme of the Royal Australasian College of Surgeons (RACS). We provide assessments of new and emerging surgical techniques, establish and facilitate clinical and research audits or trials, and produce clinical practice guidelines. We use horizon scanning to identify new techniques. ASERNIP-S conducts systematic literature reviews and accelerated systematic literature reviews on the safety and effectiveness of new surgical techniques before they are widely accepted into the health care system. The RACS recently endorsed two new ASERNIP-S systematic reviews and three accelerated systematic reviews.					
Report from the World Health Organization's third Product Development for Vaccines Advisory Committee (PDVAC) meeting, Geneva, 8-10th June 2016	http://dx.doi.org/10.1016/j.vaccine.2016.10.090	The third meeting of WHO's Product Development for Vaccines Advisory Committee (PDVAC) was held in June 2016, with a remit to revisit the pathogen areas for which significant progress has occurred since recommendations from the 2015 meeting, as well as to consider new advances in the development of vaccines against other pathogens. Since the previous meeting, significant progress has been made with regulatory approvals of the first malaria and dengue vaccines, and the first phase III trials of a respiratory syncytial virus (RSV) vaccine candidate has started in the elderly and pregnant women. In addition, PDVAC has also supported vaccine development efforts against important emerging pathogens, including Middle Eastern Coronavirus (MERS CoV) and Zika virus. Trials of HIV and tuberculosis vaccine candidates are steadily progressing towards pivotal data points, and the leading norovirus vaccine candidate has entered a phase IIb efficacy study. WHO's Immunization, Vaccine and Biologicals (IVB) department is actively working in several pathogen areas on the recommendation of PDVAC, as well as continuing horizon scanning for advances in the development of vaccines that may benefit low and middle income countries (LMICs), such as the recent licensure of the enterovirus 71 (EV71) vaccine in China. Following on from discussions with WHO's Strategic Advisory Group of Experts (SAGE) on Immunization, PDVAC will also look beyond licensure and consider data needs for vaccine recommendation and implementation to reduce the delay between vaccine approval and vaccine impact.					
A knowledge base for tracking the impact of genomics on population health	http://dx.doi.org/10.1038/gim.2016.63	Purpose:We created an online knowledge base (the Public Health Genomics Knowledge Base (PHGKB)) to provide systematically curated and updated information that bridges population-based research on genomics with clinical and public health applications.Methods:Weekly horizon scanning of a wide variety of online resources is used to retrieve relevant scientific publications, guidelines, and commentaries. After curation by domain experts, links are deposited into Web-based databases.Results:PHGKB currently consists of nine component databases. Users can search the entire knowledge base or search one or more component databases directly and choose options for customizing the display of their search results.Conclusion:PHGKB offers researchers, policy makers, practitioners, and the general public a way to find information they need to understand the complicated landscape of genomics and population health.		PHGKB searchable database consisting 9 databases: content indexed and grouped into categories that include pactice guidelines, systematic reviews, implementation studies, genetic tests, and family health history, according to the availble evidence.				
Challenges and priorities for modelling livestock health and pathogens in the context of climate change	http://dx.doi.org/10.1016/j.envres.2016.07.033	Climate change has the potential to impair livestock health, with consequences for animal welfare, productivity, greenhouse gas emissions, and human livelihoods and health. Modelling has an important role in assessing the impacts of climate change on livestock systems and the efficacy of potential adaptation strategies, to support decision making for more efficient, resilient and sustainable production. However, a coherent set of challenges and research priorities for modelling livestock health and pathogens under climate change has not previously been available. To identify such challenges and priorities, researchers from across Europe were engaged in a horizon-scanning study, involving workshop and questionnaire based exercises and focussed literature reviews. Eighteen key challenges were identified and grouped into six categories based on subject-specific and capacity building requirements. Across a number of challenges, the need for inventories relating model types to different applications (e.g. the pathogen species, region, scale of focus and purpose to which they can be applied) was identified, in order to identify gaps in capability in relation to the impacts of climate change on animal health. The need for collaboration and learning across disciplines was highlighted in several challenges, e.g. to better understand and model complex ecological interactions between pathogens, vectors, wildlife hosts and livestock in the context of climate change. Collaboration between socio-economic and biophysical disciplines was seen as important for better engagement with stakeholders and for improved modelling of the costs					
Priority questions and horizon scanning for conservation: A comparative study	http://dx.doi.org/10.1371/journal.pone.0145978	Several projects aimed at identifying priority issues for conservation with high relevance to policy have recently been completed in several countries. Two major types of projects have been undertaken, aimed at identifying (i) policy-relevant questions most imperative to conservation and (ii) horizon scanning topics, defined as emerging issues that are expected to have substantial implications for biodiversity conservation and policy in the future. Here, we provide the first overview of the outcomes of biodiversity and conservation-oriented projects recently completed around the world using this framework. We also include the results of the first questions and horizon scanning project completed for a Mediterranean country. Overall, the outcomes of the different projects undertaken (at the global scale, in the UK, US, Canada, Switzerland and in Israel) were strongly correlated in terms of the proportion of questions and/or horizon scanning topics selected when comparing different topic areas. However, some major differences were found across regions. There was large variation among regions in the percentage of proactive (i.e. action and response oriented) versus descriptive (non-response oriented) priority questions and in the emphasis given to sociopolitical issues. Substantial differences were also found when comparing outcomes of priority questions versus horizon scanning projects undertaken for the same region. For example, issues related to climate change, human demography and marine ecosystems received higher priority as horizon scanning topics, while ecosystem services were more emphasized as current priority				public online questionnaire to invite horizon scanning topics.		
Techniques and technologies in radiation oncology: The RANZCR faculty of radiation oncology horizon scan	http://dx.doi.org/10.1002/jmrs.2_166/full	Horizon Scanning is a regular initiative of the Faculty of Radiation Oncology (FRO) at the Royal Australian and New Zealand College of Radiologists (RANZCR). The ongoing horizon scanning project is intended to provide a resource to key stakeholders that are non radiation oncology experts showing the techniques and technologies that are used in radiation therapy treatment and the way that these are used at a facility, regional and national level. This project was initiated in 2011 and was developed with expert clinical input from radiation therapists, radiation oncology medical physicists and radiation oncologists. The horizon scan and associated position paper have undergone regular review and update (in 2012, 2013 and 2015) to ensure that the information contained within is current and reflective of contemporary practice. The dissemination of the horizon scan also allows for opportunities to meet with stakeholders from areas such as government jurisdictions, policy, radiation oncology professions and industry and discuss issues important to the radiation therapy community. The 2015 Horizon Scan was discussed at the Radiation Therapy Industry Roundtable and Radiation Therapy Innovations Summit.					
A Horizon Scan of Global Conservation Issues for 2016	http://dx.doi.org/10.1016/j.tree.2015.11.007	This paper presents the results of our seventh annual horizon scan, in which we aimed to identify issues that could have substantial effects on global biological diversity in the future, but are not currently widely well known or understood within the conservation community. Fifteen issues were identified by a team that included researchers, practitioners, professional horizon scanners, and journalists. The topics include use of managed bees as transporters of biological control agents, artificial superintelligence, electric pulse trawling, testosterone in the aquatic environment, building artificial oceanic islands, and the incorporation of ecological civilization principles into government policies in China.			Identify and invite issues on social media: monitored a range of environmental and technological Twitter account; used Facebook to invite issues.			
A horizon scan of future threats and opportunities for pollinators and pollination	http://dx.doi.org/10.7717/PEERJ.2249	Background. Pollinators, which provide the agriculturally and ecologically essential service of pollination, are under threat at a global scale. Habitat loss and homogenisation, pesticides, parasites and pathogens, invasive species, and climate change have been identified as past and current threats to pollinators. Actions to mitigate these threats, e.g., agri-environment schemes and pesticide-use moratoriums, exist, but have largely been applied post-hoc. However, future sustainability of pollinators and the service they provide requires anticipation of potential threats and opportunities before they occur, enabling timely implementation of policy and practice to prevent, rather than mitigate, further pollinator declines. Methods. Using a horizon scanning approach we identified issues that are likely to impact pollinators, either positively or negatively, over the coming three decades. Results. Our analysis highlights six high priority, and nine secondary issues. High priorities are: (1) corporate control of global agriculture, (2) novel systemic pesticides, (3) novel RNA viruses, (4) the development of new managed pollinators, (5) more frequent heatwaves and drought under climate change, and (6) the potential positive impact of reduced chemical use on pollinators in non-agricultural settings. Discussion. While current pollinator management approaches are largely driven by mitigating past impacts, we present opportunities for pre-emptive practice, legislation, and policy to sustainably manage pollinators for future generations.						3 decades
Looking back on 5 years of horizon scanning in oncology	http://dx.doi.org/10.1017/S0266462316000052	Objectives: The regularly structured adaptation of health technology assessment (HTA) programs is of utmost importance to sustain the relevance of the products for stakeholders and to justify investment of scarce financial resources. This study describes internal adjustments and external measures taken to ensure the Horizon Scanning Programme in Oncology (HSO) is current. Methods: Formal evaluation methods comprising a survey, a download, an environmental analysis, and a Web site questionnaire were used to evaluate user satisfaction. Results: The evaluation showed that users were satisfied with HSO outputs in terms of timeliness, topics selected, and depth of information provided. Discussion of these findings with an expert panel led to changes such as an improved dissemination strategy and the introduction of an additional output, that is, the publication of a league table of emerging oncology drugs. The rather high level of international usage and the environmental analysis highlighted a considerable overlap in topics assessed and, thus, the potential for international collaboration. As a consequence, thirteen reports were jointly published based on eleven calls for collaboration. To further facilitate collaboration and the usability of reports for other agencies, HSO reports will be adjusted according to tools developed at a European level. Conclusions: Evaluation of the impact of HTA programs allows the tailoring of outputs to fit the needs of the target population. However, within a fast developing HTA community, estimates of impact will increasingly be determined by international collaborative efforts. Refined methods and a broader					
CHANGING HEALTH TECHNOLOGY ASSESSMENT PARADIGMS?	http://dx.doi.org/10.1017/S0266462316000386	Objectives: Health technology assessment (HTA) has to innovate to best support changing health system environments and to help provide access to valuable innovation under fiscal constraint. Methods: Issues associated with changing HTA paradigms were identified through scoping and explored through deliberation at a meeting of industry and HTA leaders. Results: Five broad areas of change (engagement, scientific dialogue, research prioritization, adaptive approaches, and real world data) were identified. The meeting focused on two themes derived from these: re-thinking scientific dialogue and multi-stakeholder engagement, and re-thinking value, affordability, and access. Earlier and ongoing engagement to steer the innovation process and help achieve appropriate use across the technology lifecycle was perceived as important but would be resource intensive and would require priority setting. Patients need to be involved throughout, and particularly at the early stages. Further discussion is needed on the type of body best suited to convening the dialogue required. There was agreement that HTA must continue to assess value, but views differed on the role that HTA should play in assessing affordability and on appropriate responses to challenges around affordability. Enhanced horizon scanning could play an important role in preparing for significant future investments. Conclusions: Early and ongoing multi-stakeholder engagement and revisiting approaches to valuing innovation are required. Questions remain as to the most appropriate role for HTA bodies. Changing HTA paradigms extend HTA's traditional remit of being responsive to					
New and emerging technologies for the treatment of inherited retinal diseases: A horizon scanning review	http://dx.doi.org/10.1038/eye.2015.115	The horizon scanning review aimed to identify new and emerging technologies in development that have the potential to slow or stop disease progression and/or reverse sight loss in people with inherited retinal diseases (IRDs). Potential treatments were identified using recognized horizon scanning methods. These included a combination of online searches using predetermined search terms, suggestions from clinical experts and patient and carer focus groups, and contact with commercial developers. Twenty-nine relevant technologies were identified. These included 9 gene therapeutic approaches, 10 medical devices, 5 pharmacological agents, and 5 regenerative and cell therapies. A further 11 technologies were identified in very early phases of development (typically phase I or pre-clinical) and were included in the final report to give a complete picture of developments 'on the horizon'. Clinical experts and patient and carer focus groups provided helpful information and insights, such as the availability of specialised services for patients, the potential impacts of individual technologies on people with IRDs and their families, and helped to identify additional relevant technologies. This engagement ensured that important areas of innovation were not missed. Most of the health technologies identified are still at an early stage of development and it is difficult to estimate when treatments might be available. Further, well designed trials that generate data on efficacy, applicability, acceptability, and costs of the technologies, as well as the long-term impacts for various conditions are required before these can be considered for adoption into	direct contact with commercial developers who are active in the field, further information about the technology was requested from the developers if there is a lack of publicly accessible information.			Patients and cares focus group discussion, their comments are being taken into account.		
Results from a horizon scan on risks associated with transplantation of human organs, tissues and cells: from donor to patient	https://link-springer-com.ezproxy.ub.unimaas.nl/content/pdf/10.1007%2Fs10561-014-9450-0.pdf	The successful transplantation of human materials such as organs, tissues and cells into patients does not only depend on the benefits, but also on the mitigation of risks. To gain insight into recent publications on risks associated with the process of transferring human materials from donor to recipient we performed a horizon scan by reviewing scientific literature and news websites of 2011 on this subject. We found there is ample information on how extended donor criteria, such as donor age, affect the survival rates of organs or patients. Interestingly, gender mismatch does not appear to be a major risk factor in organ rejection. Data on risks of donor tumor transmission was very scarce; however, risk categories for various tumor types have been suggested. In order to avoid rejection, a lot of research is directed towards engineering tissues from a patient's own tissues and cells. Some but not all of these developments have reached the clinic. Developments in the field of stem cell therapy are rapid. However, many hurdles are yet to be overcome before these cells can be applied on a large scale in the clinic. The processes leading to genetic abnormalities in cells differentiated from stem cells need to be identified in order to avoid transplantation of aberrant cells. New insights have been obtained on storage and preservation of human materials, a critical step for success of their clinical use. Likewise, quality management systems have been shown to improve the quality and safety of human materials used for transplantation.					
Preparedness for emerging infectious diseases: Pathways from anticipation to action	https://www-cambridge-org.ezproxy.ub.unimaas.nl/core/services/aop-cambridge-core/content/view/2BF2E95179CE794D9961A03CB5E3F362/S095026881400315Xa.pdf/preparedness_for_emerging_infectious_diseases_pathways_from_anticipation_to_action.pdf	Emerging and re-emerging infectious disease (EID) events can have devastating human, animal and environmental health impacts. The emergence of EIDs has been associated with interconnected economic, social and environmental changes. Understanding these changes is crucial for EID preparedness and subsequent prevention and control of EID events. The aim of this review is to describe tools currently available for identification, prioritization and investigation of EIDs impacting human and animal health, and how these might be integrated into a systematic approach for directing EID preparedness. Environmental scanning, foresight programmes, horizon scanning and surveillance are used to collect and assess information for rapidly responding to EIDs and to anticipate drivers of emergence for mitigating future EID impacts. Prioritization of EIDs-using transparent and repeatable methods-based on disease impacts and the importance of those impacts to decision-makers can then be used for more efficient resource allocation for prevention and control. Risk assessment and simulation modelling methods assess the likelihood of EIDs occurring, define impact and identify mitigation strategies. Each of these tools has a role to play individually; however, we propose integration of these tools into a framework that enhances the development of tactical and strategic plans for emerging risk preparedness.					
Identifying and selecting new procedures for health technology assessment: A decade of nice experience in the United Kingdom	http://dx.doi.org/10.1017/S0266462314000415	Objectives: The aim of this study was to analyze the experience of the National Institute for Health and Care Excellence (NICE) in identifying new procedures entering the United Kingdom (UK) healthcare system, for assessment and publication of recommendations on their use. This system is designed to provide guidance in an area where regulation is lacking worldwide. Methods: Retrospective analysis of all procedures notified to the Interventional Procedures Programme (NICE) between 2002 and 2012. Notifications were analyzed year by year for their source (who notified them), clinical specialties involved, and whether guidance was subsequently published. Results: A total of 1,094 procedures were notified by clinicians (51 percent), and by others, including hospitals (6 percent), horizon scanners (5 percent), patients (4 percent), private health insurers (4 percent), and medical device manufacturers (3 percent). Guidance was published on 44 percent of procedures notified to the program. There was a decrease in the numbers of procedures notified during 2003-2012 (p =.049). There were notifications across all specialties, with the largest numbers in general surgery (125), urology (104), orthopedics (99), interventional radiology (93), cardiology (82), and obstetrics and gynecology (82). Conclusions: The open NICE Web portal allows anyone to notify new procedures, aiming to maximize the opportunity of identifying all those procedures entering clinical practice. This has resulted in identification of large numbers of procedures from across the whole range of medical specialties. The fact that similar proportions of procedures notified from					
The role of health technology assessment bodies in shaping drug development	http://dx.doi.org/10.2147/DDDT.S49935	The use of health technology assessment (HTA) to inform policy-making is established in most developed countries. Compared to licensing agencies, HTA agencies have different interests and, therefore, different evidence requirements. Criteria for coverage or reimbursement decisions on pharmaceutical compounds vary; however, it is common to include, as part of the HTA, a comparative effectiveness evaluation. This type of clinical data might go beyond that required for market authorization, thus creating an additional evidence gap between the regulatory and the reimbursement submission. The relevance of submissions to HTA agencies is consistently increasing in a pharmaceutical company's perspective, as market prospects are strongly influenced by third-party payers' coverage. In this study, we aim to describe current HTA activities with a potential impact throughout the drug development process of pharmaceuticals, with a comparative emphasis on the systems in place in Italy and in the UK. Based on an extensive literature and website review, we identified three major classes of HTA activities, beyond mainstream HTA, with the potential to influence the drug development program: 1) horizon scanning and early HTA; 2) bipartite and tripartite early dialogue between manufacturers, regulators, and HTA assessors; and 3) managed market entry agreements. From early stages of clinical research up to postauthorization studies, there is a trend toward increased collaboration between parties, anticipation of market access evidence collection, and postmarketing risk-sharing. Heterogeneity of HTA practices increases the						notification of new drugs at NICE, 20 months before the market authorization.
A horizon scan for species conservation by zoos and aquariums	http://dx.doi.org/10.1002/zoo.21153	We conducted the first horizon scan for zoos and aquariums to identify the 10 most important emerging issues for species conservation. This involved input from more than 100 experts from both the wider conservation community and the world zoo and aquarium community. Some of the issues are globally important: diseases, zoonoses, and biosecurity issues; new (communication) technologies; global water shortage and food insecurity; developing economies and markets for wildlife consumption; changes in wildlife population dynamics; and political instability and conflicts. Other issues are more specific to zoos and aquariums: need for extractive reserves; space shortage in zoos and aquariums; need for metapopulation management; and demand for caring of more species in zoos and aquariums. We also identified some broad approaches to these issues. Addressing the emerging issues identified in our horizon scan will further increase the contribution of the world zoo and aquarium community to global biodiversity conservation.					

Strategic foresight: how planning for the unpredictable can improve environmental decision-making	http://dx.doi.org/10.1016/j.tree.2014.07.005	Advanced warning of potential new opportunities and threats related to biodiversity allows decision-makers to act strategically to maximize benefits or minimize costs. Strategic foresight explores possible futures, their consequences for decisions, and the actions that promote more desirable futures. Foresight tools, such as horizon scanning and scenario planning, are increasingly used by governments and business for long-term strategic planning and capacity building. These tools are now being applied in ecology, although generally not as part of a comprehensive foresight strategy. We highlight several ways foresight could play a more significant role in environmental decisions by: monitoring existing problems, highlighting emerging threats, identifying promising new opportunities, testing the resilience of policies, and defining a research agenda.					
Evolutionary rescue in a changing world	http://dx.doi.org/10.1016/j.tree.2014.06.005	Evolutionary rescue occurs when adaptive evolutionary change restores positive growth to declining populations and prevents extinction. Here we outline the diagnostic features of evolutionary rescue and distinguish this phenomenon from demographic and genetic rescue. We then synthesize the rapidly accumulating theoretical and experimental studies of evolutionary rescue, highlighting the demographic, genetic, and extrinsic factors that affect the probability of rescue. By doing so, we clarify the factors to target through management and conservation. Additionally, we identify several putative cases of evolutionary rescue in nature, but conclude that compelling evidence remains elusive. We conclude with a horizon scan of where the field might develop, highlighting areas of potential application, and suggest areas where experimental evaluation will help to evaluate theoretical predictions.					
Identifying the science and technology dimensions of emerging public policy issues through horizon scanning	http://dx.doi.org/10.1371/journal.pone.0096480	Public policy requires public support, which in turn implies a need to enable the public not just to understand policy but also to be engaged in its development. Where complex science and technology issues are involved in policy making, this takes time, so it is important to identify emerging issues of this type and prepare engagement plans. In our horizon scanning exercise, we used a modified Delphi technique [1]. A wide group of people with interests in the science and policy interface (drawn from policy makers, policy adviser, practitioners, the private sector and academics) elicited a long list of emergent policy issues in which science and technology would feature strongly and which would also necessitate public engagement as policies are developed. This was then refined to a short list of top priorities for policy makers. Thirty issues were identified within broad areas of business and technology; energy and environment; government, politics and education; health, healthcare, population and aging; information, communication, infrastructure and transport; and public safety and national security. © 2014 Parker et al.					
Prioritizing genomic applications for action by level of evidence: A horizon-scanning method	http://dx.doi.org/10.1038/clpt.2013.226	As evidence accumulates on the use of genomic tests and other health-related applications of genomic technologies, decision makers may increasingly seek support in identifying which applications have sufficiently robust evidence to suggest they might be considered for action. As an interim working process to provide such support, we developed a horizon-scanning method that assigns genomic applications to tiers defined by availability of synthesized evidence. We illustrate an application of the method to pharmacogenomics tests.					
A horizon-prioritizing method can identify gaps among genomic application guidelines	http://dx.doi.org/10.1038/clpt.2014.16	In light of the increasing need by decision makers for a method of evaluating genomic applications based on the weight of evidence for their efficacy, several agencies have developed systems of classification. Here I review the horizon-scanning method for prioritizing genomics applications as described by Dotson et al. in this issue of CPT. Using the examples of the authors' Tier 1/Green classification for KRAS and Tier 2/Yellow for TPMT, I discuss differences between the guidelines issued by the Clinical Pharmacogenetics Implementation Consortium (CPIC) and those by the National Comprehensive Cancer Network (NCCN). Additionally, I offer suggestions regarding classification of the Tier 3/Red genomics applications and the reproducibility of the data-curating algorithm of the horizon-scanning method.					
DEVELOPING A PRIORITIZED LIST OF INNOVATIVE TECHNOLOGIES: THE SPANISH EXPERIENCE	https://www-cambridge-org.ezproxy.ub.unimaas.nl/core/services/aop-cambridge-core/content/view/C07504E0D911FAE07763865479FEC880/S0266462314000774a.pdf/developing_a_prioritized_list_of_innovative_technologies_the_spanish_experience.pdf	Objectives: Selecting technologies for formal assessment poses a great challenge to health technology assessment agencies. This study aims to contribute to the creation of a reference framework for the identification, filtering, and prioritization of new and emerging technologies which could be demanded in clinical practice within the next 1-2 years. Methods: Technologies were identified using a prevalidated systematic Medline strategy. They were classified by medical specialty and then sent to selected professionals belonging to the medical units or areas responsible for their application, until there was a minimum of three participants per health care setting. A self-administered questionnaire was drawn up and health professionals were asked to: (1) assess the degree of innovation of the technologies, and (11) score their foreseeable clinical impact on the basis of predefined prioritization criteria (n = 4). Intra-rater reliability was analyzed using the intraclass correlation coefficient (ICC). Results: The Medline search yielded 246 potentially relevant technologies. When analyzed by health care area or unit, sixty-eight were deemed to be high-impact innovative technologies (median score >6), with ICCs ranging from 0.03 to 0.83. The final list resulting from the aggregate analysis comprised fifty-one technologies. Conclusions: This study constitutes an innovative contribution to horizon scanning, providing a systematic and reproducible basis for the identification and selection of relevant new and emerging technologies based on the views and values of health professionals involved in their use. In our opinion, the current proposal could be helpful and					
Eu pharmaceutical expenditure forecast	http://dx.doi.org/10.1016/j.jval.2013.03.1302	OBJECTIVES: With constant incentives for health care payers to contain their pharmaceutical budgets forecasting has become critically important. Some countries even developed pharmaceutical horizon scanning units. The objective of this project was to build a model to assess net effect of the entrance of new patented medicinal products versus medicinal products going off-patent, with a forecast horizon until 2016, on seven selected EU Member States' pharmaceutical budgets: France, the UK, Germany, Poland, Portugal, Greece and Hungary. This model should take into account the ageing population, as well as current and future country-specific pricing, reimbursement and market access policies. (performed for the EU Commission -http://ec.europa.eu/health/healthcare /key-documents/index-en.htm) METHODS: A model was developed for generics and biosimilars for each country. This model estimated a separate and combined effect of the direct and indirect impact of patent cliff. A model was also developed for new entrants, which estimated the sales development and risk of development failure. New entrants were reviewed individually to assess their clinical potential and translate into commercial potential. Forecast was performed according to three perspectives (health care public payer, society and manufacturer), several types of distribution chain (retail, hospital, combined retail and hospital). Probabilistic and deterministic sensitivity analyses were carried out. RESULTS: All countries would experience drug budget reduction except Poland (€+41 million). Savings are expected to be the highest in the UK (€-9367 million), France (€-5589	several databases were cross-checked to identify the range of products that would go off-patent and those that would enter the market between 2012 and 2016.			Pharmaceutical pricing and reimbursement policies related to brand, generic, and biosimilar products were gathered for each country from publicly available sources, from local experts and companies.	5 years forcasting period: good compromise between the uncertainties related to any forecasting exercise and the need to inform deicions for better planning.
Horizon scanning for emergence of new viruses: From constructing complex scenarios to online games	http://dx.doi.org/10.1111/j.1865-1682.2012.01356.x	Summary: Horizon scanning techniques can be developed to identify novel routes and sources for the emergence of viruses in the medium to long term. Central to horizon scanning is prediction of the complex scenarios through which viruses could emerge before they occur. One approach involves 'spidergrams' in which complex scenarios are generated by combining factors randomly selected from different categories of events. Spidergrams provide a framework for how different factors could interact, irrespective of the virus, and also enable testing of combinations not previously considered but which would be 'tested' in nature by a virus. The emergence of viruses through new routes is often related to changes, for example, in environmental and social factors, and the Internet will undoubtedly be used to identify long-term trends for consideration. In addition, online games may provide horizon scanners with suggestions for new routes and strategies that could be used by emerging viruses. © 2012 Crown copyright Reproduced with the permission of the Controller of Her Majesty's Stationery Office and Animal Health and Veterinary Laboratories Agency.			feasability of generating spidergrams through online databases and more importantly spotting the more meaningful pathways, welcoming the help of lateral thinkers from extremely diverse backgrounds. Perhaps generate compex scenarios by the horizon scanners.		
The headroom method of early economic evaluation of medical devices: A useful tool for device developers?		OBJECTIVES: Consideration of the value presented to the health service by a new medical device, whilst crucial for late-stage reimbursement decisions, is often neglected by developers early on due to lack of data. The headroom method has been proposed as a way to integrate economic evaluation into early go/no-go decisions. By estimating the maximum reimbursable price (MRP) for a new device idea and comparing this with forecasted developer's costs, R & D resources can be channelled toward innovations for which future returns appear feasible. The aim of this study was to evaluate the method by applying it retrospectively to a large and diverse set of case studies, and comparing predicted 'headroom' with actual market success, within the UK setting. METHODS: The method was applied systematically to twenty devices/diagnostics invented in the past, retrieved from the UK national horizon scanning centre (NHSC)'s 2000-2009 database; literature searches were date restricted to mimic the information available at the 'concept stage' of development. Each case study was followed up to observe the product's actual market success or failure compared with the estimated 'headroom' and the development decision this would have engendered, in order to explore the method's predictive value. RESULTS: Headroom correlated with subsequent market success in 85% of cases. Headroom is most easily elicited where the change proposition of the innovation is straightforward (e.g. direct replacement technologies); diagnostic equipment posed particular difficulties. When the numerical headroom assessments were considered alongside unquantifiable					
Horizon scanning in radiation oncology in Australia: Considerations and future trends	http://dx.doi.org/10.1111/j.1754-9485.2012.02424.x	Purpose: A horizon scan is a tool to inform stakeholders about impending developments in a given field and the potential impact on practice. This is particularly relevant in a field such as radiation oncology that is heavily reliant on technology. Although horizon scans for individual technologies in radiation oncology have been undertaken in Australia, there was a need for a horizon scan on the wider radiation oncology environment in Australia. This work outlines two horizon scans that have been undertaken as part of the 'Assessment of New Radiation Oncology Technology and Treatments' (ANROTAT) Project. Methods and materials: As part of the brief of the ANROTAT project, the Trans Tasman Radiation Oncology Group (TROG Cancer Research) was contracted to conduct and prepare two horizon scan reports on 'New Radiation Oncology Technology and Treatments' (NROTAT). TROG commissioned an external consultant (HealthConsult Pty Ltd) to undertake the initial horizon scan report, and the subsequent periodic horizon scan report was undertaken by TROG with the support of subject matter experts. Results: A horizon scan on NROTAT was reported in April 2010, with a subsequent periodic Horizon Scan Report undertaken in October 2011. The reports identified NROTAT available in Australia and overseas, adoption of new technologies, work practice and reimbursement. Emerging technologies likely to have a significant impact on the clinical practice, outcomes, workforce and training include advances in Image Guided Radiation Therapy (IGRT), Magnetic Resonance Imaging (MRI) guided technology, Adaptive Radiation therapy (ART) and Stereotactic					
The 'Assessment of New Radiation Oncology Technology and Treatments' (ANROTAT) project: Update on progress	http://dx.doi.org/10.1111/j.1754-9485.2012.02424.x	Purpose: The Trans Tasman Radiation Oncology Group (TROG) is undertaking the 'Assessment of New Radiation Oncology Technology and Treatments' (ANROTAT) Project that has a goal to design a generic research framework for the rapid evaluation of new radiation oncology technologies and treatments in the Australian environment. A number of associated project activities include horizon scanning, development of data variables for a national radiation oncology register and submission of applications to the Medical Services Advisory Committee (MSAC) for Intensity Modulated Radiation Therapy (IMRT) and Image Guided Radiation Therapy (IGRT). Methods and materials: The framework is being piloted in four tumour site specific studies to collect evidence on the safety, clinical efficacy dosimetric surrogate endpoints and cost effectiveness of IMRT and IGRT. A study protocol (TROG Research Project (TRP)11.A) has been developed. Decision analytic models have been designed for each study. Results: Two horizon scans have been produced, pre-assessment documentation has been submitted for MSAC applications for IMRT and IGRT, and the ANROTAT Radiation Oncology Register Pilot (TRP11.B) to test the feasibility of national data collection has been developed. Accrual for TRP11.A will conclude in February 2012. Data has been collected from twenty Australian radiation oncology departments and analysis of these data is in progress. Accrual for TRP11.B will conclude in March 2012. Conclusion: The ANROTAT project will conclude in June 2012 when a final report will be produced and provided to the Australian Government Department of Health		retrospective and prospective patient cases were utilised to gather data from 20 Australian Radiatin Oncology Departments.			
Using best-worst scaling in horizon scanning for hepatocellular carcinoma technologies	http://dx.doi.org/10.1017/S026646231200027X	Objectives: There is a growing need for efficient procedures for identification of emerging technologies by horizon scanning systems. We demonstrate the value of best-worst scaling (BWS) in exploring clinicians- views on emerging technologies that will impact outcomes in hepatocellular carcinoma (HCC) in the next 5 to 10 years. Methods: Clinicians in Asia, Europe, and the United States were surveyed and their views about eleven emerging technologies relevant to HCC were explored using BWS (case 1). This involved systematically presenting respondents with subsets of five technologies and asking them to identify those that will have the most and least impact on HCC within 5 to 10 years. Statistical analysis was based on sequential best-worst and analyzed using conditional logistic regression. Results: A total of 120 clinicians uniformly distributed across ten countries completed the survey (37 percent response rate). Respondents were predominately hepatologist (41 percent) who focused on HCC (65 percent) and had national influence in this field (39 percent). Respondents viewed molecular targeted therapy (p <.001) and early detection of HCC (p <.001) as having most potential, while improved surgical techniques (p <.001) and biopsy free HCC diagnostics (p <.001) were viewed upon negatively. Conclusions: We demonstrate that BWS could be an important research tool to facilitate horizon scanning and HTA more broadly. Our research demonstrates the value of including clinicians- preferences as a source of data in horizon scanning, but such methods could be used to incorporate the opinions of a broad array of stakeholders,					
Analyzing 10 years of early awareness and alert activity in the United Kingdom	http://dx.doi.org/10.1017/S026646231200030X	Objectives: The aim of this study was to assess the accuracy of the English National Horizon Scanning Centre (NHSC) in identifying and filtering pharmaceutical developments using end user and international collaborator databases of emerging technologies as proxies for new drugs of likely significance to health services and/or patients. Methods: We used the NHSC information system and the list of National Institute for Health and Clinical Excellence (NICE) technology appraisals to estimate the false positive rate for NHSC identification, filtration, and reporting. We assessed the sensitivity of NHSC identification and filtration of pharmaceuticals for NICE technology appraisals from 1999 to the end of December 2010, and for pharmaceuticals entered into the EuroScan International Network database. Results: We estimate that overall NHSC identification, filtration and reporting had a positive predictive value of 0.39 (95 percent CI, 0.36 to 0.43) and a false positive rate of 60 percent. Using NICE appraisals and EuroScan's database as proxies for pharmaceuticals of significance, we estimate the NHSC sensitivity over the 10-year period at 0.92 (95 percent CI, 0.89 to 0.95) and 0.89 (95 percent CI, 0.82 to 0.96) respectively. Conclusions: Our results suggest that the NHSC has performed well in terms of sensitivity over the past decade, but that the false positive rate of 60 percent may indicate that the filtration criteria for pharmaceuticals could be tightened for increased efficiency. Future evaluations of EAA systems should include an element of external review and explore the level of accuracy acceptable to funders and					
Implementing a national early awareness and alert system for new and emerging health technologies in italy: The COTE project	http://dx.doi.org/10.1017/S0266462312000384	Objectives: The aim of this study was to establish a national Early Awareness and Alert (EAA) system for the identification and assessment of new and emerging health technologies in Italy. Methods: In 2008, Agenas, a public body supporting Regions and the Ministry of Health (MoH) in health services research, started a project named COTE (Observatory of New and Emerging Health Technologies) with the ultimate aim of implementing a national EAA system. The COTE project involved all stakeholders (MoH, Regions, Industry, Universities, technical government bodies, and Scientific Societies), in defining the key characteristics and methods of the EAA system. Agreement with stakeholders was reached using three separate workshops. Results: During the workshops, participants shared and agreed methods for identification of new and emerging health technologies, prioritization, and assessment. The structure of the Horizon Scanning (HS) reports was discussed and defined. The main channels for dissemination of outputs were identified as the EuroScan database, and the stakeholders- Web portals. During the final workshop, Agenas presented the first three HS reports produced at national level and proposed the establishment of a permanent national EAA system. Conclusions: The COTE Project created the basis for a permanent national EAA system in Italy. An infrastructure to enable the stakeholders network to grow was created, methods to submit new and emerging health technologies for possible evaluation were established, methods for assessment of the technologies selected were defined, and the stakeholders involvement was					
Innovation and the burden of disease: Retrospective observational study of new and emerging health technologies reported by the EuroScan network from 2000 to 2009	http://dx.doi.org/10.1016/j.jval.2011.11.034	Objectives: Medical innovation in developed countries has been linked to burden of disease, with more innovation in areas representing greater investment return. This study used horizon scanning or early awareness and alert activity as a novel measure of innovation to determine whether new and emerging health technologies reported by international horizon scanning agencies reflected diseases constituting the greatest burden. Methods: This was a retrospective observational study of the 20 member agencies of EuroScan (the International Information Network on New and Emerging Health Technologies), representing 17 developed countries. Burden of disease was defined as disability-adjusted life-years, taken from the 2004 World Health Organization Global Burden of Disease estimates. This analysis focused on 102 specific diseases within 21 broader groups. Horizon scanning output was measured as the number of technologies reported by EuroScan member agencies between 2000 and 2009. Results: At best there was a weak association between innovation and burden of disease. An apparent high-level association was dependent on just three high-prevalence disease groups: malignant neoplasms, neuropsychiatric conditions, and cardiovascular disease. Disaggregating broader groups into specific diseases further weakened the association. Innovation is disproportionately strong in cancer and nonischemic heart disease and disproportionately weak in mental health. Conclusions: Innovations reported by early awareness and alert systems do not always reflect conditions accounting for the highest morbidity and					
Making predictive ecology more relevant to policy makers and practitioners	http://dx.doi.org/10.1098/rstb.2011.0181	One of the aims of ecology is to aid policy makers and practitioners through the development of testable predictions of relevance to society. Here, we argue that this capacity can be improved in three ways. Firstly, by thinking more clearly about the priority issues using a range of methods including horizon scanning, identifying policy gaps, identifying priority questions and using evidence-based conservation to identify knowledge gaps. Secondly, by linking ecological models with models of other systems, such as economic and social models. Thirdly, by considering alternative approaches to generate and model data that use, for example, discrete or categorical states to model ecological systems. We particularly highlight thatmodels are essential for making predictions.However, a key to the limitation in their use is the degree to which ecologists are able to communicate results to policy makers in a clear, useful and timely fashion.			identify the 100 ecological questions of greatest interest to UK policy makers.		
Scanning the horizon-Development and implementation of an early awareness system for anticancer drugs in Austria	https://ac-els-cdn-com.ezproxy.ub.unimaas.nl/S0168851011002430/1-s2.0-S0168851011002430-main.pdf?_tid=63eaa010-4a88-4913-947c-979aa73fec4b&acdnat=1527672105_fe1f8a2c535f59cf859a3409a607cf7f	Background: Due to increasing expenditures for cancer therapies, an instrument was needed in Austria to facilitate the evidence-based use of new anticancer drugs and to pre-estimate their financial implications. Objectives: To describe and analyse the development and implementation of a Horizon Scanning System (HSS) in Austria that allows for the evaluation of new anticancer drugs before their routine introduction into clinical practice in order to inform decision-makers. Methods: Common stages involved in HSSs were identified by a literature review and in cooperation with experts. A first concept for an HSS in Oncology was developed and piloted, and further adjustments were made after several feedback rounds with experts in oncology. Results: To specifically tailor the five common stages of HSSs to the needs of our HSS, a continually evolving process was required. Now, 21 information sources are regularly scanned, the information is retrieved and extracted in a standardised format, and only anticancer drugs in phase III are included and prioritised by a team of eight experts. Since the HSS in Oncology was implemented as a standard practice, 19 assessments on novel cancer therapies with likely therapeutic and/or financial impacts have been published. Conclusions: The successful implementation of an HSS necessitates a repetitive cycle of adjustments in order to meet the objectives set by the individual HSS. © 2011 Elsevier Ireland Ltd.					around EMA liscensing.
Identification of innovation in public health	http://dx.doi.org/10.1093/pubmed/fdq045	Background The National Horizon Scanning Centre provides national policy-makers in England with forewarning about emerging and new health technologies. This includes public health interventions (PHIs) but identification of these interventions is not always easy.Objectives The aim of this study was to explore the meaning and define innovation in public health. Methods We used a quasi-Delphi method with questionnaire 1 sent to 106 public health and horizon scanning professionals and decision-makers in June 2008. Questionnaire 2 was developed based on answers to questionnaire 1 and sent to all respondents. Result sA definition of innovative PHIs was developed: 'Innovative PHIs are generally new and different to established interventions. They should be equitable, applicable to all in a population, cost-effective and may address health determinants in the non-health sector of society. A good evidence base is ideal, but sometimes it may be necessary to consider PHIs lacking evidence'. Sources suggested for identifying innovative PHIs were similar to those used for other types of health technologies. Conclusion Our findings should help early awareness and alert systems distinguish innovative from non-innovative PHIs, although its application in practice needs trialling. © 2010 The Author Published by Oxford University Press on behalf of Faculty of Public Health. All rights reserved.			Qualitative data from the first questionnaire were analyzed and similar data categorized and discretely grouped. Descriptive statistics were calculated from quantitative data collected during Likert-scale scoring.		
The true role of horizon scanning in Australia: Who it informs and why	http://dx.doi.org/10.1017/S0266462310001212						likely to emerge in the Australian healkth scene within3 years.
Reply to the letter by Mundy, Hiller, and Merlin on the true role	http://dx.doi.org/10.1017/S0						
Forecasting drug utilization and expenditure in a metropolitan health region.		BACKGROUND: New pharmacological therapies are challenging the healthcare systems, and there is an increasing need to assess their therapeutic value in relation to existing alternatives as well as their potential budget impact. Consequently, new models to introduce drugs in healthcare are urgently needed. In the metropolitan health region of Stockholm, Sweden, a model has been developed including early warning (horizon scanning), forecasting of drug utilization and expenditure, critical drug evaluation as well as structured programs for the introduction and follow-up of new drugs. The aim of this paper is to present the forecasting model and the predicted growth in all therapeutic areas in 2010 and 2011. METHODS: Linear regression analysis was applied to aggregate sales data on hospital sales and dispensed drugs in ambulatory care, including both reimbursed expenditure and patient co-payment. The linear regression was applied on each pharmacological group based on four observations 2006-2009, and the crude predictions estimated for the coming two years 2010-2011. The crude predictions were then adjusted for factors likely to increase or decrease future utilization and expenditure, such as patent expiries, new drugs to be launched or new guidelines from national bodies or the regional Drug and Therapeutics Committee. The assessment included a close collaboration with clinical, clinical pharmacological and pharmaceutical experts from the regional Drug and Therapeutics Committee. RESULTS: The annual increase in total expenditure for prescription and hospital drugs was predicted to be 2.0% in 2010 and 4.0% in					
Issues facing the Australian health technology assessment review of medical technology funding		• The Australian Health Technology Assessment Review has the potential to have a major effect on the availability of new medical technology and the listing of associated medical procedures on the Medicare Benefits Schedule. Despite this, only about 15% of submissions to the Review came from "medical associations". • Pharmaceutical and medical technologies are inherently different, and there are a number of difficulties associated with evaluating medical technology using the same process and evidence levels as those used for pharmaceuticals. • The current sequential and lengthy processing of new medical technology and procedures is delaying access to beneficial medical technology and could be substantially reduced. • There is currently no effective funding process for medical technology classified as capital equipment or consumables and disposables. This has created a perverse incentive in favour of using funded implantable prostheses based on access to funding rather than superior clinical effectiveness. • The existing horizon scanning process could be better used to not only identify all potentially cost-effective new and emerging medical technology and procedures as early as possible, but also to identify gaps in the evidence.					

Evaluation criteria to assess the value of identification sources for horizon scanning	http://dx.doi.org/10.1017/S026646231000036X	Objectives: The English National Horizon Scanning Centre routinely scans thirty-five sources to identify new and emerging health technologies. The aim of the study was to develop and apply evaluation criteria and scores to assess the value of sources, and to identify a cutoff score below which sources would be recommended for removal from routine horizon scanning. Criteria to evaluate each source scanned could result in a more efficient approach in the selection process. Methods: Evaluation criteria were developed following a review of the literature and discussions with horizon analysts. Proposed criteria were piloted on a random selection of six sources, and then applied to all thirty-five sources. The criteria were assessed using the Analytic Hierarchy Process. Results: Eight criteria were identified as being most relevant for assessing the value of scanning sources. The three most important (primary) criteria were coverage (approximate percentage of relevant information), quality (reliable, accurate, objective), and efficiency (estimated time to identify one potentially significant health technology or other relevant information). Seven sources fell beneath the cutoff score and were recommended for removal from routine scanning. Conclusions: The criteria were considered useful in the assessment of current sources, and have the potential to be used to assess new ones. These criteria may be useful for other horizon scanning centers to pilot and validate. Copyright © Cambridge University Press 2010.							
The role of surgeons in identifying emerging technologies for health technology assessment		Background: Health technology assessment (HTA) is a tool intended to help policymakers decide which technologies to fund. However, given the proliferation of new technologies, it is not possible to undertake an HTA of each one before it becomes funded. Consequently, "horizon-scanning" processes have been developed to identify emerging technologies that are likely to have a substantial impact on clinical practice. Although the importance of physicians in the adoption of new technologies is well recognized, their role in horizon scanning in Canada has been limited. The purpose of this project was to pilot an approach to engage physicians, specifically surgeons, in provincial horizon-scanning activities. Methods: We invited 18 surgeons from Alberta's 2 medical schools to a horizonscanning workshop to solicit their views on emerging technologies expected to impact surgical practice within the next 5 years and/or the importance of different attributes or characteristics of new technologies. Results: Surgeons, regardless of specialty, identified developments designed to enhance existing minimally invasive surgical techniques, such as endoscopic, robotic and image-guided surgery. Several nonsurgical areas, including molecular genetics and nanotechnology, were also identified. Of the 13 technology attributes discussed, safety or risk, effectiveness and feasibility were rated as most important. Lastly, participating surgeons expressed an interest in becoming further involved in local HTA initiatives. Conclusion: Surgeons, as adopters and users of health technologies, represent an important and accessible information source for identifying emerging technologies for HTA. A more formal, ongoing relationship							
Information service on new and emerging health technologies: Identification and prioritization processes for a European Unionwide newsletter	http://dx.doi.org/10.1017/S0266462309990687	Objectives: EUnetHTA WP 7 (Strand B) aimed to promote sharing information on new and emerging technologies. The task was to develop a prototype of a newsletter and pilot the processes of production. Methods: The EuroScan database served as information source on pertinent technologies. To prioritize, a set of criteria for scoring the potential impact and for selecting the technologies for articles was applied and a pilot newsletter was produced. Results: Being objective and transparent about the content of a newsletter required a method for prioritizing health technologies. Using significance criteria, members of the prioritization panel selected twelve technologies for articles of different length and depth. Potential recipients, surveyed on relevance, content, timeliness, and readability responded mostly positive, but requested more information on cost effectiveness and criticized timeliness. Conclusions: Dissemination of an EU-wide newsletter would be feasible, but time-consuming. Although a newsletter appears to fulfill a need for information on emerging and new health technologies, it is not considered the right tool to avoid duplication of effort in the present international constellation of horizon scanning for new health technologies. Other options will be pursued as part of future collaborative actions, for example, a core set of early awareness information, or an on-demand electronic information system. © 2009 Cambridge University Press.							
The need for environmental horizon scanning	http://dx.doi.org/10.1016/j.tree.2009.04.008	Policymakers and practitioners in most fields, including conservation and the environment, often make decisions based on insufficient evidence. One reason for this is that issues appear unexpectedly, when with hindsight, many of them were foreseeable. A solution to the problem of being insufficiently prepared is routine horizon scanning, which we describe as the systematic search for potential threats and opportunities that are currently poorly recognized. Researchers can then decide which issues might be most worthwhile to study. Practitioners can also use horizon scanning to ensure timely policy development and research procurement. Here, we suggest that horizon scanning is an underused tool that should become a standard element of environmental and conservation practice. We make recommendations for its incorporation into research, policy and practice. We argue that, as an ecological and conservation community, we are failing to provide timely advice owing to a weakness in identifying forthcoming issues. We outline possible horizon-scanning methods, and also make recommendations as to how horizon scanning could have a more central role in environmental and conservation practice. © 2009 Elsevier Ltd. All rights reserved.				interviews: one to one questioning to identify issues and explore important driving forces and areas of uncertainty; issue tree: breaks down key question into a mutually exclusive and completely exhaustive set of sub-questions.			
The Italian Horizon Scanning Project	http://dx.doi.org/10.1007/s00228-009-0666-z	HSP aims to collect, organize and evaluate information on emerging medicines and medical devices with medicated coating. IHSP is currently 100% publicly funded, and the main customers are policy makers (e.g. the Italian Ministry of Health and Local Health Authority(s) in the Veneto Region). The main IHSP infrastructures include a Scientific Secretariat and a Database team (one pharmacists, one administrative, one part-time IT person) and a Scientific Committee (IHSP-SC) of 13 nationally and internationally recognized experts in drug evaluation. Clinicians with expertise in different medical and surgical fields are also involved in issuing a critical clinical assessment (New Product Information Report- NPIR) for prioritized drugs.							the report issued 36 months before the potential market authorization date provides information on the mechanism of action of an emerging drug, phase II trials, which are then often available, and the
Horizon scanning of new and emerging medical technology in Australia: Its relevance to medical services advisory committee health technology assessments and public funding	http://dx.doi.org/10.1017/S0266462309990031								
Global trends in cardiology and cardiothoracic surgery - An opportunity or a threat?		IHSP is supported by a technological infrastructure for data collection, check, monitoring and analysis. The database is available, by a restricted access (http://horizon.cineca.it/). Currently, 2655 emerging drugs are in the IHSP							
Early identification systems for emerging foodborne hazards	http://dx.doi.org/10.1016/j.fct.2007.12.021	This paper provides a non-exhausting overview of early warning systems for emerging foodborne hazards that are operating in the various places in the world. Special attention is given to endpoint-focussed early warning systems (i.e. ECDC, ISIS and GPHIN) and hazard-focussed early warning systems (i.e. FVO, RASFF and OIE) and their merit to successfully identify a food safety problem in an early stage is discussed. Besides these early warning systems which are based on monitoring of either disease symptoms or hazards, also early warning systems and/or activities that intend to predict the occurrence of a food safety hazard in its very beginning of development or before that are described. Examples are trend analysis, horizon scanning, early warning systems for mycotoxins in maize and/or wheat and information exchange networks (e.g. OIE and GIEWS). Furthermore, recent initiatives that aim to develop predictive early warning systems based on the holistic principle are discussed. The assumption of the researchers applying this principle is that developments outside the food production chain that are either directly or indirectly related to the development of a particular food safety hazard may also provide valuable information to predict the development of this hazard.							
Modelling downstream effects in the presence of technological change	http://dx.doi.org/10.2165/0019053-200826120-00003								
Emerging health technologies: Informing and supporting health policy early	http://dx.doi.org/10.1016/j.healthpol.2008.01.002	Objectives: All western healthcare systems are confronted with a rising number of new health technologies. To support decision-making processes with sound information about new health technologies, some countries have established "Horizon Scanning Systems (HSS)". This paper gives an overview of processes and practices of HSS. Method: The paper is based on a literature review (Medline and Embase) and on unpublished information gathered from HSS-agencies. Results: The 13 current HSS have been collaborating in the EuroScan network since 1999. EuroScan has agreed on a common terminology, classification and understanding of their activities. All their activities consist of 5 sequenced main components: identification and filtering, prioritization, early assessment, dissemination and monitoring the assessed technologies. Although there is a common understanding with regard to function and processes there are some differences in the scope of the national/regional HSS. Conclusion: 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. Because of the common understanding there is a certain stability and integration across the functions of HSS. Nonetheless there are some obvious "blank spots" susceptible to subjectivity, such as an implicit prioritization process. © 2008 Elsevier Ireland Ltd. All rights reserved.							
Invasion Science: A Horizon Scan of Emerging Challenges and Opportunities.	https://ac.els-cdn.com/S016953471630218X/1-s2.0-S016953471630218X-main.pdf?_tid=0feb2f64-526b-475d-bd7f-54367ac30b47&acdnat=1527757273_0fea9e57d393fe858f44187f0f343e0d	We present the results of our eighth annual horizon scan of emerging issues likely to affect global biological diversity, the environment, and conservation efforts in the future. The potential effects of these novel issues might not yet be fully recognized or understood by the global conservation community, and the issues can be regarded as both opportunities and risks. A diverse international team with collective expertise in horizon scanning, science communication, and conservation research, practice, and policy reviewed 100 potential issues and identified 15 that qualified as emerging, with potential substantial global effects. These issues include new developments in energy storage and fuel production, sand extraction, potential solutions to combat coral bleaching and invasive marine species, and blockchain technology.							
A 2017 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity.		BACKGROUND: The contemporary environment is a complex of interactions between physical, biological, socio-economic systems with major impacts on public health. However, gaps in our understanding of the causes, extent and distribution of these effects remain. The public health community in Sandwell West Midlands has collaborated to successfully develop, pilot and establish the first Environmental Public Health Tracking (EPHT) programme in Europe to address this 'environmental health gap' through systematically linking data on environmental hazards, exposures and diseases. METHODS: Existing networks of environmental, health and regulatory agencies developed a suite of innovative methods to routinely share, integrate and analyse data on hazards, exposures and health outcomes to inform interventions. RESULTS: Effective data sharing and horizon scanning systems have been established, novel statistical methods piloted, plausible associations framed and tested, and targeted interventions informed by local concerns applied. These have influenced changes in public health practice. CONCLUSION: EPHT is a powerful tool for identifying and addressing the key environmental public health impacts at a local level. Sandwell's experience demonstrates that it can be established and operated at virtually no cost. The transfer of National Health Service epidemiological skills to local authorities in 2013 provides an opportunity to expand the programme to fully exploit its							
Environmental Public Health Tracking: a cost-effective system for characterizing the sources, distribution and public health impacts of environmental hazards.		Poor communication between academic researchers and wildlife managers limits conservation progress and innovation. As a result, input from overlapping fields, such as animal behaviour, is underused in conservation management despite its demonstrated utility as a conservation tool and countless papers advocating its use. Communication and collaboration across these two disciplines are unlikely to improve without clearly identified management needs and demonstrable impacts of behavioural-based conservation management. To facilitate this process, a team of wildlife managers and animal behaviour researchers conducted a research prioritisation exercise, identifying 50 key questions that have great potential to resolve critical conservation and management problems. The resulting agenda highlights the diversity and extent of advances that both fields could achieve through collaboration.							
Research Priorities from Animal Behaviour for Maximising Conservation Progress.		Objective This paper discusses the potential for horizon scanning to identify low-value, inappropriate clinical practices that deliver minimal benefit to patients and represent a considerable financial burden on the health system.Methods Platelet-rich plasma (PRP) was identified by routine horizon scanning as a potentially innovative treatment alternative for osteoarthritis of the knee. A rapid, non-systematic assessment of the evidence pertaining to the safety and effectiveness of PRP compared with nonsteroidal anti-inflammatory drugs (NSAIDs) for the treatment of osteoarthritis of the knee was conducted.Results The evidence base supporting the use of PRP for the treatment of osteoarthritis was poor. No comparative studies were identified that compared the use of PRP to NSAIDs, the current treatment option for osteoarthritis of the knee in Australia. Despite the lack of effectiveness evidence, the use of PRP injections was rapidly increasing in the private sector using an inappropriate Medicare Benefits Schedule item number.Conclusions This assessment highlights the potential of using established horizon scanning methodologies to identify targets for full or partial disinvestment of ineffective, inefficient or harmful clinical practices.What is known about the topic? PRP is rapidly diffusing in the private health system in Australia, however the use of a Medicare Benefits Schedule item number meant that this practice was being subsidised by the public reimbursement							
Platelet-rich plasma: a case study for the identification of disinvestment opportunities using horizon scanning.		The national effort to use genomic knowledge to save lives is gaining momentum, as illustrated by the inclusion of genomics in key public health initiatives, including Healthy People 2020, and the recent launch of the precision medicine initiative. The Office of Public Health Genomics (OPHG) at the Centers for Disease Control and Prevention (CDC) partners with state public health departments and others to advance the translation of genome-based discoveries into disease prevention and population health. To do this, OPHG has adopted an "identify, inform, and integrate" model: identify evidence-based genomic applications ready for implementation, inform stakeholders about these applications, and integrate these applications into public health at the local, state, and national level. This paper addresses current and future work at OPHG for integrating genomics into public health programs.							
Genomics in Public Health: Perspective from the Office of Public Health Genomics at the Centers for Disease Control and Prevention (CDC).		OBJECTIVES: The EuroScan International Network is a global network of publicly funded early awareness and alert (EAA) systems for health technologies. We describe the EuroScan member agency systems and methods, and highlight the potential for increased collaboration. METHODS: EuroScan members completed postal questionnaires supplemented with telephone interviews in 2012 to elicit additional information and check equivalence of responses. Information was updated between March and May 2013. RESULTS: Fifteen of the seventeen member agencies responded. The principal purpose of agencies is to inform decisions on coverage or reimbursement of health services and decisions on undertaking secondary research. The main users of information are national governments; health professionals; health services purchasers, commissioners, and decision makers; and healthcare providers. Most EuroScan agencies are small with almost half having fewer than two whole time equivalent staff. Ten agencies use both active and passive identification approaches, four use only active approaches. Most start identification in the experimental or investigational stages of the technology life cycle. All agencies assessed technologies when they are between the investigational and established,							
EUROSCAN INTERNATIONAL NETWORK MEMBER AGENCIES: THEIR STRUCTURE, PROCESSES, AND OUTPUTS.		The Centers for Medicare & Medicaid Services (CMS) has asked the Agency for Healthcare Research & Quality (AHRQ) and the Tufts-NEMC EPC to perform a horizon scan of gene-based tests in cancer that are currently in clinical use, are being promoted for clinical use, or are being developed for clinical use. CMS has expressed the need for the deliverable to be a ready reference tool to inform discussions in this area.							
Genetic Tests for Cancer		The Coverage and Analysis Group at the Centers for Medicare & Medicaid Services (CMS) requested from The Technology Assessment Program (TAP) at the Agency for Healthcare Research and Quality (AHRQ) a horizon scan to summarize the available scientific evidence on the quality of laboratory-developed ("home brew" or "in-house") molecular tests, which are currently not actively regulated by the U.S. Food and Drug Administration (FDA). CMS has concerns about the quality of laboratory-developed tests and the validation currently being performed on these tests. AHRQ assigned this report to the following Evidence-based Practice Center (EPC): ECRI EPC (Contract Number: 290 2007 10063 I). To help CMS to address its concerns, this horizon scan is intended to: 1) identify types of laboratory-developed molecular tests (LDMTs) currently available for conditions relevant to the Medicare over-65-year-old population, 2) identify the methodologies and the processes that have been developed for the assessment of analytical and clinical performance of molecular tests, 3) summarize the role of Federal agencies in regulating LDMTs, and 4) identify the quality standards that have been developed for molecular tests by regulatory bodies, the industry, and the medical community.						he AMP is a not-for-profit scientific society founded in 19955, that is dedicated to the advancement, practice, and science of clinical molecular laboratory medicine and translational research.	
Quality, Regulation and Clinical Utility of Laboratory-developed Molecular Tests	https://www.ncbi.nlm.nih.gov/pubmed/25834872	Over the past decade, research efforts such as the Human Genome Project and the International Haplotype Map (HapMap) project, coupled with concomitant advances in genomic technologies and bioinformatics, have contributed to an explosive growth in the field of human genomics. These developments have resulted in cheaper and more efficient genomic technologies, and they, along with other innovations in medical diagnostics and therapeutics, will soon play a substantial role in everyday clinical practice. Genetic tests can be used for a variety of purposes including screening, diagnosis, disease monitoring, risk stratification, and therapeutic management. In addition, genetic tests can be helpful in predicting outcomes and can be used as clinical decisionmaking tools. As new assays become available for clinical use, it is crucial for patients, clinicians, and payers to be well informed as to the breadth of genetic testing available and the appropriate contexts in which they should be used. To that end, the Coverage and Analysis Group at the Centers for Medicare and Medicaid Services (CMS) requested the Technology Assessment Program (TAP) at the Agency for Healthcare Research and Quality (AHRQ) map the landscape of genetic tests available for non-cancer diseases/conditions. AHRQ assigned this project to the Tufts Medical Center Evidence-based Practice Center (Contract Number: HHSA 290 2007 10055		We conducted focused searches of grey literature sources, including online genetic databases, registries, and laboratories, to identify new genetic tests that are currently in clinical use. One definition of grey literature is, "that which is produced on all levels of government, academics, business and industry in print	EuroScan International Network member agencies were asked to complete a questionnaire about their EAA system				Universities
Update on Mapping the Landscape of Genetic Tests for Non-Cancer Diseases/Conditions	https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR433/RAND_RR433.pdf	Public Health England (PHE) commissioned RAND Europe to undertake a horizon scanning study exploring the future of public health and related scientific services. This work was intended to help inform thinking at the strategic level within PHE, firstly in relation to the wider vision of the Agency (which was only established in April 2013) and, secondly, in relation to the proposals for the creation of an integrated public health science hub. The study is based on a literature review, a brief Delphi exercise using the ExpertLens platform and key informant interviews with a range of PHE staff and external experts. It focuses on the different future public health science needs and the extent to which an integrated science hub could serve PHE as it evolves over the next twenty years. Thus, the study considers PHE's future remit and objectives in order that decisions about an integrated and co-located science hub be made in context and with reference to expert perceptions about the future.	"Following a broad search of relevant literature and drawing on the initial interviews, the study team identified several bodies of literature that were particularly relevant .... With public health england with PHE, we clustered these issues around key domains and focussed our literature review efforts on so-				An interview protocol (see Appendix B) guided interviews, which usually lasted between 30 and 45 minutes. The protocol gave us the		
The Future of Public Health: A Horizon Scan.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3972886/	The opportunity to reflect broadly on the accomplishments, prospects, and reach of a field may present itself relatively infrequently. Each biennial meeting of the International Biogeography Society showcases ideas solicited and developed largely during the preceding year, by individuals or teams from across the breadth of the discipline. Here, we highlight challenges, developments, and opportunities in biogeography from that biennial synthesis. We note the realized and potential impact of rapid data accumulation in several fields, a renaissance for inter-disciplinary research, the importance of recognizing the evolution-ecology continuum across spatial and temporal scales and at different taxonomic, phylogenetic and functional levels, and re-exploration of classical assumptions and hypotheses using new tools. However, advances are taxonomically and geographically biased, and key theoretical frameworks await tools to handle, or strategies to simplify, the biological complexity seen in empirical systems. Current threats to biodiversity require unprecedented integration of knowledge and development of predictive capacity that may enable biogeography to unite its descriptive and hypothetico-deductive branches and establish a greater role within and outside academia.							
An horizon scan of biogeography									



Full Mapping

The process outlined in the EuroScan Method toolkit was used as a basis and novel methodological aspects found in the literature added (9). The resulting map is segmented into: signal identification and detection, criteria and methods of filtration and prioritization, assessment, dissemination and updating of information, and overall evaluation of the process. Notable references are given; the full dataset is provided in S1 Appendix.

Information sources and signal detection

Signals are detected from manifold sources in a horizon scanning exercise; Table 1 summarises the most common origins of information.

Information sources (signal detection)

- Scientific/biomedical literature review
- Patents
- Input from industry and industry associations
- Other observatories
- Media
- International institutions and forums
- Individuals, committees and expert groups
- Surveys
- Government bodies
- Meetings and conferences
- Other organisations
- Grey literature

Table 1: Information sources used for signal detection in horizon-scanning

Review of the scientific and biomedical literature is perhaps the most common place to identify innovation and novel methodologies emerging (primarily) from academic research laboratories. Searches can be structured, using systematic and validated strategies, for broad or targeted topic areas (17-19); a two-step approach, first to survey the field and, second, for a 'deep dive', can be used. Recently issued patents and published patent applications (e.g., the European Patent Office (20)) represent an alternative source of early signals, particularly of innovations originating in industry (large, medium and small). Systematic and/or *ad hoc* scanning of direct or indirect information about new findings from industry or industry associations (21, 22) (such as investment of venture capital in SMEs) is also useful for monitoring of research pipelines. As are, for example, clinical trials databases (23, 24) and intelligence gathered from research infrastructures and consortia, and from university and research institute technology transfer offices.

Other observatories of potential value include repositories of innovation and trends generated from the horizon scanning outputs of international regulators and the committees and expert groups of governmental bodies, such as OECD and EuroScan (25-27). The media - print, electronic and social - generate substantial topic-specific and commercially-relevant information, available via RSS feeds (10), Twitter, Facebook, etc. (28). They also allow suggestions of signals from stakeholders. Workshops can also be useful to bring together diverse experts (chosen on the basis of their area of specialisation, breadth of knowledge, publications and commitment to the process) to discuss areas of novel science and technology and to collaboratively scan the horizon from different points of view (29). These 'sand-pit' exercises can be supplemented by participants from the scanning organisation itself, appropriate stakeholder groups, external consultants and policy-makers (30, 31). For sustainable and continuous horizon scanning, it may prove valuable to create a steering committee, think tank or "idea radar" including representatives of the aforementioned participants (32, 33).

Delphi studies are widely used to pool knowledge and build consensus around emerging issues. There are two or more rounds involved: in the first, participants identify relevant issues, which are then pooled and ranked; the second round sees these issues discussed followed by their re-ranking. This process is iterated until a consensus is reached. Several Delphi variations have been described, from more conventional workshop formats to the use of online tools such as Nvivo (quantitative analysis of text) or Wordle.net (a word cloud tool) (34). The design of a Delphi study should take into account the sample size and confounding factors, such as the level of conformity in the group (7, 35, 36).

Surveys, conducted via the web or by mail (22, 33), enable staff of an organisation, stakeholders and the public to be asked to identify new technologies or trends (37). These have proved most useful when horizon-scanning in well-defined fields (7). Semi-structured interviews covering a standard set of questions can also be used, with similar outcomes (18). However, public input was not found to be hugely productive (38).

Likewise, an attempt to establish a Wikipedia community has been largely unsuccessful (38).

Finally, a number of additional sources have been identified including draft legislation and policy papers from governmental bodies, the proceedings of scientific conferences and symposia, professional and scientific societies, interest groups, think-tanks and research funders (government, charities, venture capital, etc.), the so-called grey literature where global shifts that influence society, the economy and the environment — megatrends — (39) are sometimes foreseen. Google alert queries, Google Trends, Google News Timeline, Google Insight, and blogs were mentioned (38, 40).

Filtration criteria and methods

Table 2 presents the criteria and methods commonly used to discard irrelevant signals.

Filtration criteria (discarding irrelevant signals)	Filtration methods
• Potential impact • Size of affected population or global relevance • Novelty • Level of innovation • Evidence • Organisational impact • Plausibility • Levels of stakeholder and media interest • Policy priority • Stage of development • Ethical and social issues • Within time-frame of 2-15 years	• Classification criteria • Automated text-mining tools • Individual and group filtration • Peer review • Expert participation

Table 2: Filtration criteria and methods used in horizon-scanning to discard irrelevant signals

Several key criteria concerning a signal's potential impact were used (19, 33, 41-43): What are the costs, and the cost-utility ratio, of resource consumption; what are the implications in terms of quality of life, burden of disease and patient safety (43, 44)?

Next, to pursue the signal, it was asked what is the size of the affected population, and is this an issue of global relevance (45)? Is the signal truly novel, for which a legislative basis does not exist (8)? What is the level of the innovation based on factors such as design, function and materials? For example, is this a new drug class or a novel treatment paradigm?

The level of evidence is a further important criterion that has been ranked using a simple traffic light system (46), where green denotes sufficient evidence to support the uptake of the signal, yellow indicates insufficient evidence to support uptake but the evidence may constitute useful information, and red implies unsupportive or insufficient evidence.

Additional criteria include (a) potential organisational impact: is this a technology that will require service reorganisation (33, 44), for example?; (b) plausibility – is uptake feasible?; (c) the level of interest of relevant stakeholders; (d) policy priority; (e) stage of development (e.g., clinical trials initiated?) (22, 42); (f) ethical and social issues; and (g) time-frame within the horizon-scanning period.

In terms of filtration methods, these may be separated into those which tag signals according to the criteria in a binary yes/no fashion, or those which use distinct or graduated categories, e.g., confirmed, likely, potential, unlikely, and questionable (24). Automated text-mining tools can be used with databases to enable the identification, tagging and categorisation of signals and facilitate clustering and filtering (7). Individual or group filtration may be performed by organisational staff, who can also undertake, up to point, peer review that ultimately requires the participation of external experts. The latter can also be responsible for weighting signals, according to the criteria, using an evidence framework (19, 29).

Prioritisation criteria and methods for assessing signals

The signals which have med the filtration criteria can then be prioritised. The prioritisation criteria which must be met, and the methods used to do so, are collected in Table 3.

Prioritisation criteria (assessing signals)	**Prioritisation methods**

• Potential impact on outcomes • Size make-up of the affected population • Expected variation of impact • Likely time-frame • Evidence of effectiveness • Relevance to strategic and political priorities • Effect on other related policies • Desirability • Factual basis • Requirement of availability of expertise • Novelty	• Qualitative approach • Quantitative or semi-quantitative approaches • Rating and ranking • Best-worst scaling • Risk analysis • Standardisation of signals • Delphi approach • Public consultation • Engagement of experts • Mixed methods

Table 3: Prioritisation criteria and methods used in horizon-scanning to assess signals

Logically, the criteria consider the potential impact on outcomes, a clear example being resource consumption, and the cost of a signal (33, 41). The size and composition of the affected population are therefore important factors (33, 44, 47, 48), as well as the expected variation that may be observed between different subsets (41, 47). For the signal to be prioritised, the timeframe must be realistic (8, 33, 49), and there must be a clear, factual indication of true novelty and desirability. In addition to evidence of effectiveness, consideration must be given to the relative added-value over current practice (33), and whether this sufficient to satisfy strategic and/or political priorities and policies (e.g., reduction in inequality (41)).

With respect to prioritisation methods, a simple qualitative approach uses short summaries of the signals as a basis to prioritise (50). Quantitative or semi-quantitative approaches are obviously more rigorous and typical. A straightforward rating and ranking can be undertaken using readily available online statistical tools; for example, according to median scores (28, 37), or by rating signals as gold, silver or bronze (51), or by application of a 7-point Likert scale. Prioritisation groupings (e.g., high, medium, low) can be extracted from the rankings and reliability of the results can be assessed using the intra-class correlation coefficient (19).

Another technique, best-worst scaling allows the views of experts to be ranked, via calculation of best-worst scores, square root estimates and conditional Logistic Regression (52). Risk prioritization, risk analysis, and multi-criteria decision analysis are further, more quantitative methods. The latter, for example, assigns objective weightings to different aspects of probability, impact, and other criteria, which can be used separately in rating signals (53). These ratings can then be used to rank and re-rank the signals in an iterative and discursive process taking into account and trading off weightings based on stakeholder preferences (as identified, for example, in symposia or workshops) (54).

Signal scores from different raters can be standardised via the Z-statistic and agreement (or divergence) between the resulting values can be assessed using Kendall's coefficient of concordance (W), a non-parametric statistic that has values from 0 (no agreement) to 1 (complete agreement) (55).

A Delphi approach has been developed to acquire expert input online in a continuous feedback forum or market place. Participants prioritise, or purchase, a limited number of signals which then accrue a "price" that can ultimately be used to prioritise those of greatest value (32). Controls are possible to counteract the possibility of scoring fatigue (56).

Clustering and Likert-scale scoring has been used as a mixed qualitative and quantitative method (57). Wordle.net has also been applied to the prioritisation of signals based on the frequency with which they appear in cloud-based searches.

Finally, it should be emphasised that the engagement of experts for prioritisation must ensure diverse participation from different sectors, geographical regions, disciplines, and demographics (28, 42, 53). Public consultation is a valuable asset to provide input and involvement from citizens and users in prioritisation, and can be achieved in person, via email or online (33, 38).

Signal assessment and methods

The signals which have met the prioritisation criteria are then assessed. The factors assessed, and the methods employed to do so, are in Table 4. (e.g., in terms of resource implications and broad financial perspectives).

Signal assessment	**Assessment methods**

• Impact, e.g., resource (financial) implications • Level of innovation • Expected utilisation and diffusion • Risk assessment • Actions required and time to impact • Legal and ethical issues • Barriers to market • Stakeholder perception	• ExpertLens • Driver analysis • Scenario planning • Expert, user and policy-maker participation • Peer review

Table 4: Signal assessment and methods used in horizon-scanning

A key factor to consider in the assessment of any signal, of course, are the resource implications. The expected utilisation and availability of the innovation across different geographical regions is also important (31, 33, 44), as is a detailed risk assessment. A number of practical issues must also be considered, including actions needed to translate the signal into use (such as further research, the development of new processes, and whether complementary technology, for example, is essential to realise the value of the signal), the time and investment required to do so, the need for new or specialised training of personnel involved (8), the cooperation and acceptance of key stakeholders, any ethical issues, access to the necessary experts (7) and the intellectual property associated with the signal, and whether legislative or regulatory guideline changes are required. As always, impact on the market must be taken into consideration: is the innovation likely to have a disruptive effect, will it encounter reimbursement barriers, what are the timelines and milestones (32), etc.? A consensus level of innovation can be sought (e.g., important, moderate, modest (58)).

Insofar as the methods used for signal assessment are concerned, a number of approaches are available. ExpertLens (Rand Corporation), for example, is an iterative,

online system that permits a large group of people with different levels of expertise in different areas to independently, or collaboratively, identify, rate, prioritise, review and revise their opinions on important issues (59). Driver analysis is a process to identify and group trends, to determine the drivers of these trends, and to characterise the relationship between the drivers (60, 61). Multiple linear regression is used to find the probable links between causes and effects and other tools, such as spidergrams, can generate new perspectives (57). Scenario planning involves the creation of scenarios (e.g., best and worst cases) to assess the impact of signals (33). The headroom method can be applied to the determination of the maximum value of an emerging innovation (56). Methods should ensure the use of discounting and sensitivity analysis (62). Leveraging the participation of experts, users and policy-makers is an additional and valuable method by which to reach consensus about the value of a particular signal (e.g., via face-to-face workshops, remotely, or online (33)). A typical approach might involve a working group of experts that provides oversight and rotates responsibility for assessment (44) using, perhaps, tools such as ExpertLens, Delphi, the Nominal Group Technique and crowdsourcing (36). With respect to users of the potential innovation, their views are recognised as important: patients' assessment of impact on quality of life being an example (38). Finally, peer review and the early and ongoing involvement of experts with policymakers and stakeholders (7) can clearly facilitate both the communication and comparison against other horizon-scanning results (37, 44) and the translation of the signals into actions (7).

Dissemination and evaluation of the results of horizon scanning

The key elements involved in the disseminating and evaluating the results of horizon scanning are listed in Table 5.

Dissemination	Evaluation

• Format • Methods • Audience • Frequency • Updating	• Short, medium and long-term • Process and output audit • Validation and sensitivity • Focus groups • Metrics • Access to database

Table 5: Dissemination and evaluation of the results of horizon-scanning

In terms of dissemination, the assessment of an individual signal can be summarised in a document with the following elements: authors, lay summary, assessment objectives and methods, background and current practice, signal description, impacts and other issues, estimated time to impact, comparator signals (innovations), expert opinion, and declaration of any conflict of interests. It may also be beneficial to include policy recommendations which are linked to decision-making priorities, structures, and individual and cross-cutting policies (17, 29, 37, 44, 48). Dissemination can be achieved, when a new report is available, via numerous pathways, including email, social media, notification of target groups (38, 42), public events involving the participation of policymakers (7, 33), publicly-accessible repositories of data or outputs that are clearly indexed, easily searchable and categorised, for example, by level of evidence and other metrics (40, 63).

The audience for dissemination is self-evident: internal staff and management; local and/or central government; institutions, agencies and relevant committees (42, 48, 58); research funding bodies (64); practitioners and (e.g.) healthcare system managers (37, 42); industry and other stakeholders (65). Dissemination of any new report should be made systematically through diverse platforms (42) and shared directly with relevant organisations (40). The frequency of dissemination depends on circumstances and examples available include on a quarterly basis (48) or the release of up to 1 to 3 reports per quarter (42); alternatively, information may be released at set time-points,

such as those corresponding to the accomplishment of milestones towards (or the time until) the expected introduction of an innovation (19).

A related activity that bridges dissemination and evaluation is the updating of horizon-scanning information. This comprises four essential elements: (a) continually checking and pruning sources based on their usefulness, relevance, and evolution, (b) monitoring and updating changes in signals by periodically refreshing the horizon scan, (c) reassessment of signals when sufficient new data are available or a step-change in technology has occurred, (d) validating annually, for example, the horizon-scanning update by a team of expert researchers, practitioners and journalists.

Evaluation of the results of horizon-scanning can be performed in the short, medium and long-term. A short-term evaluation may involve the following actions: survey of an appropriate audience on the usefulness of horizon-scanning in decision-making; use of metrics (e.g., provided by Google Analytics), such as number of downloads, page views, average session duration, citations in publications and funding applications; reports of failures; consistency with other horizon scanning methods. In the medium-term, an evaluation would include the responsiveness of the horizon-scanning team to requests; the ability to keep the horizon-scanning content up-to-date; to compare findings with "gold" standards (e.g., EuroScan, The Agency for Healthcare Research and Quality); and to measure sensitivity and associated predictive value. Finally, a long-term evaluation assesses the usage of horizon-scanning information in arriving at decisions; the accuracy of projections; the timeliness with which new technologies were detected; the prioritisation criteria which best signalled the impact of the technology.

A process and output audit represents another approach to evaluation and ensures the completeness of the search record; records of external input; records of expert contact details; clear filing of information used; and a clear statement of the innovation in the briefing. A focus group of users can be employed to review the information input and dissemination and to develop a user-friendly interface through which to access the database.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and	9

PRISMA 2009 Checklist

		simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Risk of bias was assessed in accordance with the BMJ guidelines and the Cochrane risk of bias tool. Most bias were not applicable to these non-clinical qualitative studies, however the following were: - A form of publication bias was likely in which only horizon scanning undertaken in organisations with a strong background in publishing academic publications were discovered. It was not possible to correct for this. - Outcome bias may have occurred as the papers reported systematic methodological aspects of horizon scanning, whereas some horizon scanning may occur in an ad-hoc manner e.g. a signal discovered by word of mouth. - The competing interests of the authors were not considered beyond the standards of the source journals. This was because it was not thought highly relevant to the reporting of methodologies.
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8

PRISMA 2009 Checklist

Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	N/A
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9 (See point 12)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21-22
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	22
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	23
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	24

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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BMJ Open

Scanning the horizon: A systematic literature review of methodologies

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SCANNING THE HORIZON: A SYSTEMATIC LITERATURE REVIEW OF METHODOLOGIES

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ABSTRACT

Objectives: Society is confronted with the rapid emergence of innovation in science and technology. To manage this, horizon scanning is being adopted globally to identify, assess and prioritise innovations and trends at an early stage of their development. This enables decision-makers to be better informed and to prepare for change. The aim of this paper is to systematically identify and evaluate horizon scanning methodologies employed in the healthcare and biomedical fields.

Methods: A systematic literature review was performed using PubMed and Embase, and was supplemented with grey literature searches (2008 to 2018). The principal methodologies used in horizon scanning were extracted.

Results: Approximately 100 articles were summarised in a literature map. The search revealed many examples of horizon scanning across disciplines. Challenges, such as the need to refine prioritisation criteria, manage uncertainty inherent in the findings, and improve the dissemination of identified issues, have been highlighted.

Conclusion: Horizon scanning, when performed appropriately, is a flexible and potentially reliable tool, with a wide variety of methods. Horizon scanning can inform and influence decision-making, through identifying opportunities and challenges, from an organisational to an international level. Further research to identify the most effective methodologies available would add depth to this landscape and enable the evolution of best practice to most efficiently anticipate novel developments and innovations.

Strengths and limitations of this study

- This systematic review offers an up-to-date perspective on horizon scanning methodologies – incorporating practices from a number of different fields; however, as reviews into horizon scanning in healthcare have been undertaken previously, some duplication of findings was inevitable.
- A detailed evaluation, and a more practical guide to all the methodologies, could not be performed for practical reasons; specifically, the inconsistent reporting of the horizon-scanning details and their efficacy, and the continually evolving approaches employed.
- The paper may be subject to omission bias as the literature reported systematic methodological aspects of horizon scanning; therefore, some ad-hoc horizon scanning methods may not be captured.

INTRODUCTION

Across organizations worldwide, the rapid emergence of high impact innovation is a major challenge faced by decision makers [1]. To respond, the identification of future innovations and trends is being undertaken in a comprehensive, systematic and sustainable manner so that policy makers, and other stakeholders, can respond appropriately and enable innovations to reach the market with minimal developmental, legal, regulatory, process or procurement bottle-necks. To catalyse the achievement of this objective, horizon scanning is emerging as a valuable and viable strategy. This is particularly true in the health sector, where the European Medicines Agency (EMA) is seeking to promote the availability of innovative medicines using horizon scanning. This foresight will in turn inform the Agency's Regulatory Science Strategy and the European medicines regulatory network strategy [2-4].

Horizon scanning has been in use for many years, initially by commercial organisations and later by public bodies; Japan was an early adopter of foresight methodologies in the 1970s [5 6]. Since then, horizon scanning has been used across diverse sectors to aid financial, policy, process and research planning [7 8]. There are many definitions of horizon scanning [9 10], but most can be captured by its generic characterisation as a systematic examination of information sources to detect early signs of important developments. The approach generally targets the early lifecycle of technologies – i.e., in an early phase of adoption before their introduction onto the market - but may also scan for broader trends, challenges and opportunities. It provides an early warning of 'signals', rather than a comprehensive study of their impact.

Horizon scanning generally follows a process of signal detection, filtration, prioritisation, assessment and dissemination (Fig 1). Its use is growing across sectors [11], and this risks the duplication of efforts (both in design and execution) as similar stretches of the horizon are scanned by many.

Fig 1. Common stages of Horizon scanning from the EuroScan network [9].

There have been no recent reviews of horizon scanning methods used in the health sector [9 12], or those looking at broader biomedical sectors [6 7 12-14]. As a result, the aim of this literature review is to systematically identify and evaluate horizon scanning methodologies employed in the healthcare and biomedical fields. The overall goal is to broaden and update knowledge on the methodologies used, and through mapping and evaluation, provide a useful guide for the establishment and optimisation of future horizon scanning initiatives. This includes the activities of the EMA's recently established Regulatory Science Observatory, as well other international efforts to reduce duplication including the EU Innovation offices Network, the European Network for Health Technology Assessment, and the International Coalition of Medicines Regulatory Authorities (ICMRA) [4 15].

METHODS

A systematic review of the literature was performed to capture and map the use of horizon scanning activity, and the widespread use of modern IT/web capabilities, over the period from 2008 to 2018 (see supplementary file 1) [16]. Three researchers were involved and a systematic protocol was followed to minimise inter-rater bias; this involved cross validation between two researchers, with diverging opinions then arbitrated by the third. This systematic approach also permitted gaps and inconsistencies in the field to be identified. Data collection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]: the literature was first screened and filtered using inclusion and exclusion criteria; the accepted papers then underwent data extraction and analysis; and, finally, the scanning methodologies were mapped.

Search strategy

Medline and Embase bibliographic databases were searched to identify research papers on the use of horizon scanning, and the methods used for this purpose. The date range was between 2018-01-01 and 2018-07-04. The final search took place on 2018-07-04. Grey literature and bibliographies of the most relevant research papers supplemented this search. The primary search terms used were derived from previous literature: "horizon scan*" OR "strategic foresight*" OR "systematic early dialogue*" OR "early warning and alert system*". All literature, of which the title or abstract contained any of the keywords above, was flagged.

Inclusion and exclusion criteria

Only articles published in English or Italian from 2008-2018 were included. In the first round of quality appraisal and screening (see supplementary file 1), the publication abstracts or title had to indicate:

(a) either a methodology for horizon scanning or strategic foresight, or a discussion, or experience provided, of horizon scanning;

(b) a breadth of horizon scanning of the relevant field or address a methodological aspect which may be generally applicable across different fields.

In the second round, the full texts of the selected articles were then reviewed according to additional inclusion criteria:

(a) the horizon scan or foresight methodology was detailed, and

(b) the priority areas included relevant science and/or technology, and

(c) a collaborative/international approach was used, and

(d) the horizon scanning undertaken spanned a period of between 2 and 15 years.

Alternatively, the paper was required to demonstrate methodological aspect(s) of foresight or horizon scanning of potentially general applicability.

The foresight period of 2-15 years reflected the fact that signals suggesting impact in less than two years concern innovations that are already in late-stage development, while those anticipated to 'mature' in 15-20 years' time are too distant and uncertain to be useful. A collaborative/international approach was sought because of the global nature of innovation and change.

The mapping was elaborated using the EuroScan International Information Network method, a scientific association of member organizations and individuals for the exchange of information on important emerging new drugs, devices, procedures, programs, and settings in health care (EuroScan), and novel methodological aspects from the searched literature [9].

Patient and Public Involvement

The patients and public were not directly involved in the design or conduct of the study.

RESULTS

There were 413 papers identified through the initial database searches and grey literature, of which 252 were removed due to duplication or failing to meet the inclusion criteria. 60 papers were excluded because of language issues or lack of access to full-text. 101 publications were included in this study after reading the full text as indicated (Fig. 2).

Fig 2. Literature selection process flowchart [17]

Consistency between the selection of papers by the two researchers, who undertook the screening, was fair (Cohen's unweighted Kappa = 0.28) [18]. A third researcher therefore screened the excluded literature according to the criteria to ensure that all relevant papers were captured (and resulting in one further publication being selected).

Most of the studies included in this review address horizon scanning as whole, following the process outlined in Fig. 1, and of these, many operate in a national context. A few papers also focus on the use of specific methodological aspects such as Delphi techniques (see Table 1). Given the databases interrogated, the most prevalent priority areas identified were environmental issues ([9]), gene therapy (8), oncology (9) and clinical practice. Public sector bodies in the UK, USA, Sweden and Australia published most often on the topic. Internationally, EuroScan was repeatedly referenced for its role in harmonizing horizon scanning methodology, supporting its members and encouraging international collaboration.

Risk of bias was assessed in accordance with the BMJ guidelines and the Cochrane risk of bias tool [19]. While bias was not typically found in these non-clinical qualitative studies, there were three exceptions:

- A form of publication bias was likely in which only horizon scanning undertaken in organisations with a strong background in publishing academic publications and transparency were discovered. It was not possible to correct for this.

- Omission bias may have occurred as the papers reported systematic methodological aspects of horizon scanning; however, some horizon scanning may occur in an ad-hoc manner, e.g., a signal discovered by word-of-mouth.

- The competing interests of the authors were not considered beyond the standards of the source journals. This was because it was not thought highly relevant to the reporting of methodologies.

Mapping

The process outlined in the EuroScan Method toolkit was used as a basis and novel methodological aspects found in the literature were added [9]. The resulting map is segmented into: signal identification and detection, criteria and methods of filtration and prioritisation, assessment, dissemination and updating of information, and overall evaluation of the process. Notable references are given and the full dataset is provided in the supplementary file 2.

Information sources and signal detection

Signals are detected from manifold sources in a horizon scanning exercise; Table 1 summarises the most common.

Review of the scientific and biomedical literature is perhaps the most common place to identify innovation. Searches can be structured, using systematic and validated strategies, for broad or targeted topic areas [20-22]; a two-step approach, first to survey the field and, second, for a 'deep dive', can be used. Recently issued patents and published patent applications (e.g., the European Patent Office) [23] represent an alternative source of early

signals, particularly of innovations originating in industry (large, medium and small). Systematic and/or ad hoc scanning of direct or indirect information about new findings from industry or industry associations [24 25] (such as investment of venture capital in SMEs) is also useful for monitoring research pipelines. Similarly, other sources, such as clinical trials databases [26 27] and intelligence gathered from research infrastructures and consortia, and from university and research institute technology transfer offices, are valuable.

Information sources (signal detection)
• Scientific/biomedical literature review • Patents • Input from industry and industry associations • Other observatories • Media • International institutions and forums • Individuals, committees and expert groups • Surveys • Government bodies • Meetings and conferences • Other organisations • Grey literature

Table 1: Information sources used for signal detection in horizon-scanning

Additional observatories of potential value include repositories of innovation and trends generated from the horizon scanning outputs of international regulators and the committees and expert groups of governmental bodies, such as OECD and EuroScan [28-30]. The media -

print, electronic and social - generate substantial topic-specific and commercially-relevant information, available via RSS feeds [11], Twitter, Facebook, and so on [31]. Social media also provide signal suggestions from stakeholders. Workshops can also be useful to bring together diverse experts (chosen on the basis of their area of specialisation, breadth of knowledge, publications and commitment to the process) to discuss areas of novel science and technology and to collaboratively scan the horizon from different points of view [32]. These 'sand-pit' exercises can be supplemented by participants from the scanning organisation itself, appropriate stakeholder groups, external consultants and policy-makers [33 34]. For sustainable and continuous horizon scanning, it may prove valuable to create a steering committee, think tank or "idea radar" including representatives of the aforementioned participants [12 35].

Delphi studies are widely used to pool knowledge and build consensus around emerging issues. There are two or more rounds involved. In the first, participants identify relevant issues, which are then pooled and ranked; the second round sees these issues discussed followed by their re-ranking. This process is iterated until a consensus is reached. Several Delphi variations have been described, from more conventional workshop formats to the use of online tools such as Nvivo (quantitative analysis of text) or Wordle.net (a word cloud tool) [36]. The design of a Delphi study should take into account the sample size and confounding factors, such as the level of conformity in the group [7 37 38].

Surveys, conducted via the web or by mail [12 25], enable staff of an organisation, stakeholders and the public to be asked to identify new technologies or trends [39]. These may be most useful when horizon-scanning in well-defined fields [7]. Semi-structured interviews covering a standard set of questions can also be used, with similar outcomes [21]. However, public input was not found to be hugely productive in topic identification [40]. Likewise, an attempt to establish a Wikipedia community has been largely unsuccessful [40].

Finally, a number of additional sources have been identified including draft legislation and policy papers from governmental bodies, the proceedings of scientific conferences and symposia, professional and scientific societies, interest groups, think-tanks and research funders (government, charities, venture capital, etc.), the so-called grey literature where global shifts that influence society, the economy and the environment - megatrends - [41] are sometimes foreseen. Google alert queries, Google Trends, Google News Timeline, Google Insight, and blogs were also mentioned [40 42].

Filtration criteria and methods

Table 2 presents the criteria and methods commonly used to discard irrelevant signals.

Several key criteria concerning a signal's potential impact were used [12 22 43-45] including what are the costs, and the cost-utility ratio, of resource consumption, and what are the implications in terms of quality of life, burden of disease and patient safety [45 46]?

The level of evidence is a further important criterion that has been ranked using a simple traffic light system [47], where green denotes sufficient evidence to support the uptake of the signal, yellow indicates insufficient evidence to support uptake but the evidence may constitute useful information, and red implies unsupportive or insufficient evidence.

In terms of filtration methods, these may be separated into those which tag signals according to the criteria in a binary yes/no fashion, or those which use distinct or graduated categories, e.g., confirmed, likely, potential, unlikely, and questionable [27]. Automated text-mining tools can be used with databases to enable the identification, tagging and categorisation of signals and facilitate clustering and filtering [7]. Individual or group filtration may be performed by organisational staff, who can also undertake some initial peer review that is ultimately performed in-depth by external experts. The latter can also contribute to, or determine, the weighting of signals, according to the criteria, using an evidence framework [22 32].

Filtration criteria (discarding irrelevant signals)	Filtration methods
• Potential impact • Size of affected population or global relevance • Novelty • Level of innovation • Evidence • Organisational impact • Plausibility • Levels of stakeholder and media interest • Policy priority • Stage of development • Ethical and social issues • Within time-frame of 2-15 years	• Classification criteria • Automated text-mining tools • Individual and group filtration • Peer review • Expert participation

Table 2: Filtration criteria and methods used in horizon-scanning to discard irrelevant signals

Prioritisation criteria and methods for assessing signals

The signals which have met the filtration criteria can then be prioritised. The prioritisation criteria which must be met, and the methods used to do so, are collected in Table 3.

Prioritisation criteria (assessing signals)	Prioritisation methods
• Potential impact on outcomes • Size make-up of the affected population • Expected variation of impact • Likely time-frame • Evidence of effectiveness • Relevance to strategic and political priorities • Effect on other related policies • Desirability • Factual basis • Requirement of availability of expertise • Novelty	• Qualitative approach • Quantitative or semi-quantitative approaches • Rating and ranking • Best-worst scaling • Risk analysis • Standardisation of signals • Delphi approach • Public consultation • Engagement of experts • Mixed methods

Table 3: Prioritisation criteria and methods used in horizon-scanning to assess signals

Logically, the criteria consider the potential impact on outcomes, a clear example being resource consumption, and the cost implications [12 43]. The size and composition of the affected population are therefore important factors [12 46 48 49], as well as the expected variation that may be observed between different subsets [43 48]. For the signal to be prioritised, the timeframe must be realistic [8 12 50], and there must be a clear, factual indication of true novelty and desirability. In addition to evidence of effectiveness,

consideration must be given to the relative added-value over current practice [12], and whether this sufficient to satisfy strategic and/or political priorities and policies (e.g., reduction in inequality) [43].

With respect to prioritisation methods, a simple qualitative approach uses short summaries of the signals as a basis to prioritise [51]. Quantitative or semi-quantitative approaches are obviously more rigorous and typical.

There were several novel Delphi approaches developed, for example, to acquire expert input online in a continuous feedback forum or market place. Here, participants prioritise, or purchase, a limited number of signals which then accrue a "price" that can ultimately be used to prioritise those of greatest value [35]. Controls are possible to counteract the possibility of scoring fatigue [52].

Finally, it should be emphasised that the engagement of experts for prioritisation must ensure diverse participation from different sectors, geographical regions, disciplines, and demographics [31 44 53]. Public consultation is a valuable asset to provide input and involvement from citizens and users in prioritisation, and can be achieved in person, via email or online [12 40].

Signal assessment and methods

The signals which have met the prioritisation criteria are then assessed. The factors assessed, and the methods employed to do so, are in Table 4 (e.g., in terms of resource implications and broad financial perspectives).

Signal assessment	Assessment methods
• Impact, e.g., resource (financial) implications • Level of innovation • Expected utilisation and diffusion • Risk assessment • Actions required and time to impact • Legal and ethical issues • Barriers to market • Stakeholder perception	• ExpertLens • Driver analysis • Scenario planning • Expert, user and policy-maker participation • Peer review

Table 4: Signal assessment and methods used in horizon-scanning

A key factor to consider in the assessment of any signal, of course, is the resource implications. The expected utilisation and availability of the innovation across different geographical regions is also important [12 34 46], as is an assessment of risk. A number of practical issues must also be considered, including actions needed to translate the signal into use (such as further research, the development of new processes, and whether complementary technology, for example, is essential to realise the value of the signal), the time and investment required to do so, the need for new or specialised training of personnel involved [8], the cooperation and acceptance of key stakeholders, any ethical issues, access to the necessary experts [7] and the intellectual property associated with the signal, and

whether legislative or regulatory guideline changes are required. As always, impact on the market must be taken into consideration. Is the innovation likely to have a disruptive effect, will it encounter reimbursement barriers, what are the timelines and milestones [35], etc.? A consensus level of innovation can be sought (e.g., important, moderate, modest) [54].

Insofar as the methods used for signal assessment are concerned, a number of approaches are available.

Dissemination and evaluation of the results of horizon scanning

The key elements involved in the disseminating and evaluating the results of horizon scanning are listed in Table 5.

Dissemination	Evaluation
• Format • Methods • Audience • Frequency • Updating	• Short, medium and long-term • Process and output audit • Validation and sensitivity • Focus groups • Metrics • Access to database

Table 5: Dissemination and evaluation of the results of horizon-scanning

In terms of dissemination, the assessment of an individual signal can be summarised in a document with the following elements: authors, lay summary, assessment objectives and methods, background and current practice, signal description, impacts and other issues, estimated time to impact, comparator signals (innovations), expert opinion, and declaration of any conflict of interests. It may also be beneficial to include policy recommendations which are linked to decision-making priorities, structures, and individual and cross-cutting

policies [20 32 39 46 49]. Dissemination can be achieved, when a new report is available, via numerous pathways, including email, social media, notification of target groups [40 44], public events involving the participation of policymakers [7 12], publicly-accessible repositories of data or outputs that are clearly indexed, easily searchable and categorised, for example, by level of evidence and other metrics [42 55].

Dissemination of any new report should be made systematically through diverse platforms [44] and shared directly with relevant organisations [42]. The frequency of dissemination depends on circumstances.

A related activity that bridges dissemination and evaluation is the updating of horizon-scanning information. This comprises four essential elements: (a) continually checking and pruning sources based on their usefulness, relevance, and evolution [12], (b) monitoring and updating changes in signals by periodically refreshing the horizon scan [49], (c) reassessment of signals when sufficient new data are available or a step-change in technology has occurred [56], and (d) validating annually, for example, the horizon-scanning update by a team of expert researchers, practitioners and journalists [31].

Evaluation of the results of horizon-scanning can be performed in the short, medium and long-term [12]. A short-term evaluation may involve the following actions: survey of an appropriate audience on the usefulness of horizon-scanning in decision-making; use of metrics (e.g., provided by Google Analytics), such as number of downloads, page views, average session duration, citations in publications and funding applications [57]; reports of failures; consistency with other horizon scanning methods. In the medium-term, an evaluation would include the responsiveness of the horizon-scanning team to requests, the ability to keep the horizon-scanning content up-to-date, comparing findings with other horizon scanning agencies/databases (e.g. EuroScan,), and measuring sensitivity and associated predictive value. Finally, a long-term evaluation assesses the usage of horizon-scanning information in arriving at decisions, the accuracy of projections, the timeliness

with which new technologies were detected, and the prioritisation criteria which best signalled the impact of the technology [54].

A process and output audit represents another approach to evaluation and ensures the completeness of the search record, records of external input and expert contact details, clear filing of information used, and a clear statement of the innovation in the briefing [58]. A focus group of users can be employed to review the information input and dissemination and to develop a user-friendly interface through which to access a database [40 59].

DISCUSSION

There was a wide variety of sources and methods used to identify new and emerging issues. However, it was common to use scientific literature, individuals, committees and expert groups, the web and Delphi methodologies. That the scientific literature dominates is expected as innovation often begins in an academic environment and because widely-accessible bibliographic databases have powerful search and filtering capabilities. The frequent use of the Delphi methodology may be explained by its ability to 'crowd-source' information and build a consensus amongst participants in a relatively short timeframe. This consensus, particularly expert consensus, adds weight to the conclusions drawn from horizon scanning.

Overall, the majority of the methods used were manual or semi-automated, with relatively few automated aspects. This could be due to the limited availability of software and budget constraints. Complex filtration, prioritisation and assessment criteria are some of the barriers to full automation that may be resolved in the not-too-distant future by the rapidly evolving fields of machine learning and artificial intelligence [60].

Dissemination of horizon-scanning reports appear to have rarely fed directly and systematically into policymaking. This may simply be a reflection of the unpredictable and political nature of policymaking, as well as a mismatch with the longer time-scale of horizon-scanning. Equally, it is probably fair to say that the information gathered by horizon-scanning lacks, at least to some extent, the conventional measures of credibility and authority required to influence policymaking [32]. New tools and approaches (e.g., via generation of complex scenarios and the clear weighting of evidence) [32 61] are probably needed to enable horizon-scanning to be considered more seriously by policymakers.

The distance of the horizon scanned was also found to be a tricky balance between the need to assess signals as early as possible to inform decision makers, and the limited information

available at an early stage [62]. There were many different evaluation methods employed, covering different time-spans, reflecting *inter alia* cultural differences, resource limitations and a time-lag between horizon-scanning and its critical evaluation (for example, a high false-positive rate of horizon-scanning implied the need for tighter filtration criteria) [14].

From a public policy standpoint, horizon-scanning has both informative and creative functions, alerting policy makers to emerging issues, and providing new, plausible policy options [7]. This use of horizon-scanning is well established for identification of emerging issues, both positive and negative, in global conservation and biological diversity [63]. In some contrast, however, in the biomedical field, in which this review has concentrated, horizon-scanning is biased towards identification of positive, innovative signals as those with low value inevitably have little impact.[64] Finally, in addition to its institutional value, horizon-scanning can significantly help related stakeholders, such as technology developers or civil society - it can reveal barriers to innovation and allow proactive engagement to reduce these barriers [43].

Limitations

As systematic reviews into horizon scanning in healthcare have been undertaken previously, some duplication of findings was inevitable [6 7 13 14 65]; however, this review offers an up-to-date and wider perspective, and includes methodologies from beyond the health field, e.g., conservation. Resource limitations have precluded evaluation of horizon-scanning in other, related sectors, and consideration of material in languages other than English and Italian. Lastly, a detailed evaluation, and a more practical guide to all the methodologies, could not be performed for practical reasons: the inconsistent reporting of the horizon-scanning details and their efficacy, and the continually evolving approaches employed. This effort must be viewed as a 'snapshot', therefore, of a rapidly moving target.

Conclusions

To respond to accelerating innovation, horizon-scanning methodology is being adopted both nationally and internationally, particularly in the public sector. The range of methods used, and the limited assessment of their performance, renders recommendation of a single approach premature and explains why combining two or more techniques makes sense for validation and for improving the accuracy of predictions [6 7].

Undoubtedly, automation and the development of artificially 'intelligent' horizon-scanning, which self-assesses and improves its signal management, are short-term milestones that will significantly improve the process, enhancing the evidence base, disseminating the acquired outputs efficiently, and facilitating decision-making. Self-evidently, given the need for horizon-scanning across diverse disciplines, involving large numbers of interested stakeholders with related information needs, the process can only benefit from international collaboration. To this end, initiatives are underway, including within the International Coalition of Medicines Regulatory Authorities in which the EMA is taking an active role [15 66-68]. Of course, scanning the horizon for signals is not an endpoint, in and of itself, but rather a window through which current and future opportunities and policies can be linked [69]. It is essential, therefore, that further research be performed to develop, assess and ultimately implement the most efficacious methods of scanning and to ensure their acceptance and uptake by relevant stakeholders.

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Data sharing

The dataset is available in the supplementary file 2 or upon request.

Competing interests

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Fig 2. Literature selection process flowchart [17]

Flow diagram depicting the different stages of the systematic literature review according to the PRISMA format.

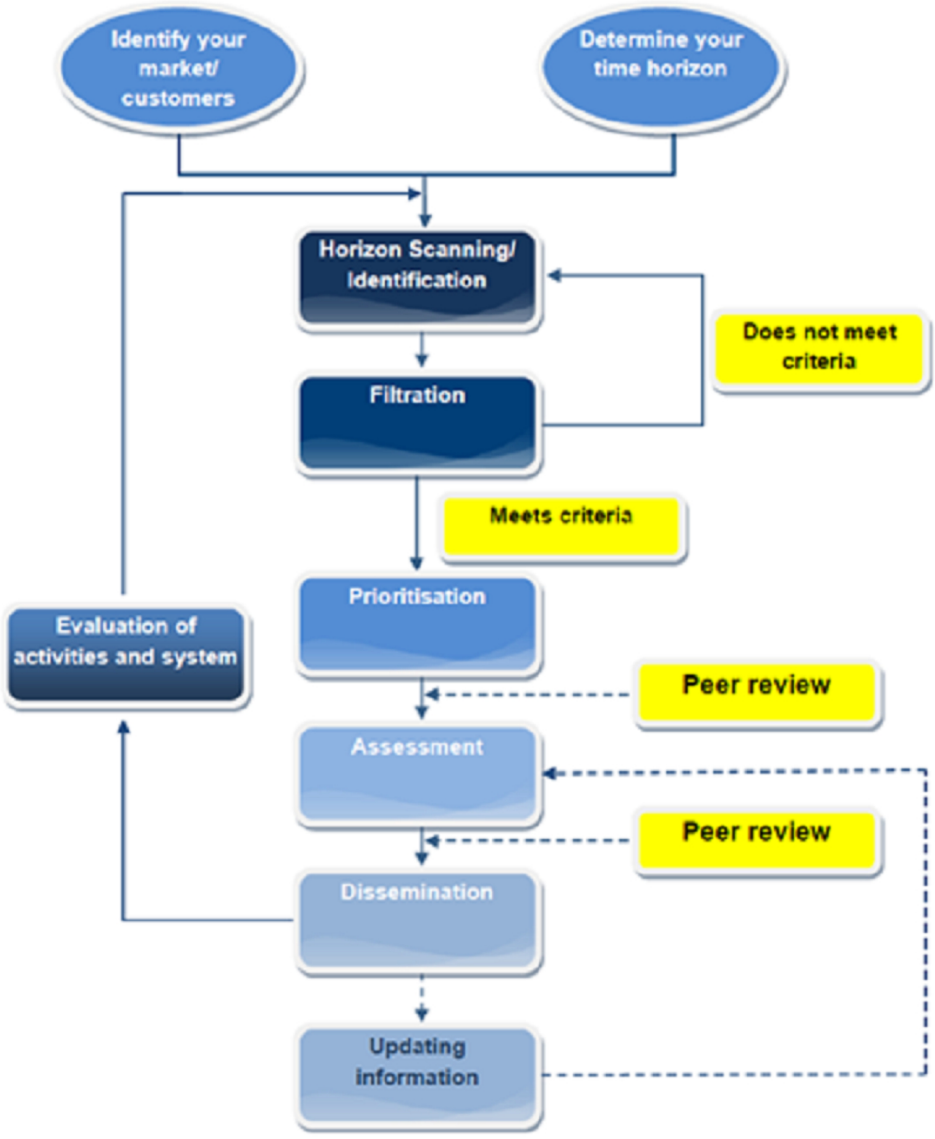
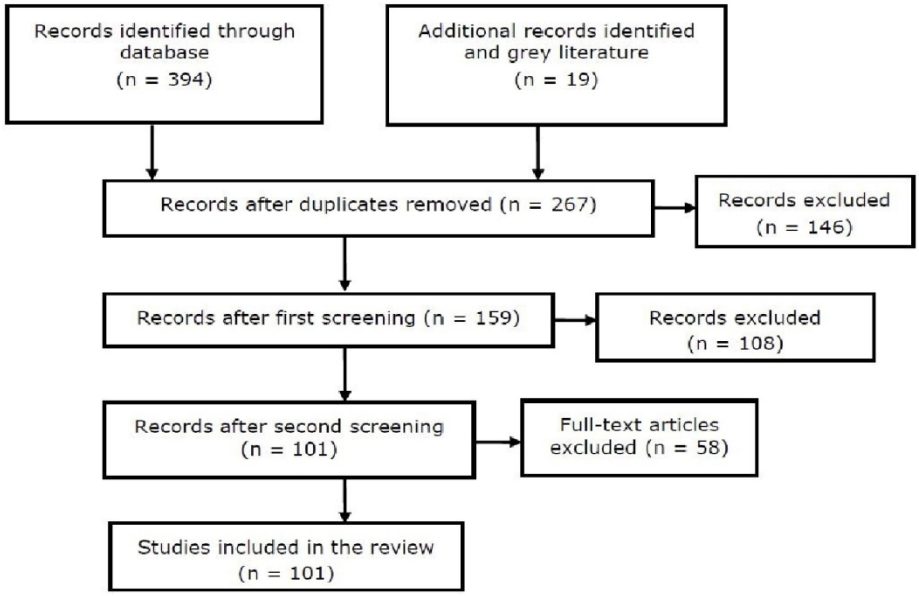


Fig 1. Common stages of Horizon scanning from the EuroScan network (12). This figure is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike4.0 International License (CC BY-NC-SA 4.0)

97x113mm (300 x 300 DPI)



Caption : Fig 2. Literature selection process flowchart (16)

150x102mm (300 x 300 DPI)

Search strategy

Medline and Embase bibliographic databases were searched to identify research papers on the use of horizon scanning, and the methods used for this purpose. The date range was between 2018-01-01 and 2018-07-04. The final search took place on 2018-07-04. Grey literature and bibliographies of the most relevant research papers supplemented this search.

The primary search terms used were: "horizon scan*" OR "strategic foresight*" OR "systematic early dialogue*" OR "early warning and alert system*". All literature, of which the title or abstract contained any of the keywords above, was flagged.

In the database searches, a single set of entry terms were applied:

('horizon scan*':ab,ti OR 'strategic foresight*':ab,ti OR 'systematic early dialogue*':ab,ti OR (('early awareness' NEXT/2 'alert system*'):ab,ti))

In Fields:

horizon scan* in Abstract
horizon scan* in Title
strategic foresight* in Abstract
strategic foresight* in Title
systematic early dialogue* in Abstract
systematic early dialogue* in Title
'early awareness' NEXT/2 'alert system*' in Abstract
'early awareness' NEXT/2 'alert system*' in Title

Quality appraisal

The appraisal was conducted at the screening stage as part of the inclusion/exclusion criteria. The questions regarding internal and external validity are indicated in Table 1.

To ensure that the quality appraisal and screening were being applied harmoniously, a third researcher appraised and screened the excluded literature according to the same criteria to ensure that all relevant papers were captured (resulting in one further publication being selected).

Table 1. Quality appraisal items and inclusion/exclusion criteria for screening

	Internal validity	**External validity**
First round of appraisal and screening (108 excluded)	(a) either a methodology for horizon scanning or strategic foresight, *or* a discussion, or experience provided, of horizon scanning.	(b) It was also essential for the abstracts to indicate a breadth of horizon scanning of the relevant field level *or* address a methodological aspect which may be generally applicable across different fields.
Second round of appraisal and screening (58 excluded)	(a) the horizon scan or foresight methodology was detailed, *and*	(b) the priority areas included relevant science and/or technology, *and*
		(c) a collaborative/international approach was used, *and*
		(d) the horizon scanning undertaken spanned a period of between 2 and 15 years.
		Alternatively, the paper was required to demonstrate methodological aspect(s) of foresight or horizon scanning of potentially general applicability.

Risk of bias was assessed in accordance with the BMJ guidelines and the Cochrane risk of bias tool. While bias was not typically found in these non-clinical qualitative studies, there were three exceptions:

- A form of publication bias was likely in which only horizon scanning undertaken in organisations with a strong background in publishing academic publications and transparency were discovered. It was not possible to correct for this.

- Omission bias may have occurred as the papers reported systematic methodological aspects of horizon scanning; some horizon scanning, however, may occur in an ad-hoc manner, e.g., a signal discovered by word-of-mouth.

- The competing interests of the authors were not considered beyond the standards of the source journals. This was because it was not thought highly relevant to the reporting of methodologies.

Literature Map - Working Excel

Included papers and info			Information sources (proactive and passive)																								Other grey literature	Time horizon	Filtration		Prioritisation		Assessment				Dissemination				Updating		Process Evaluation
Title	Full Text Link ("-" if unavailable; or explanation of non-inclusion)	Abstract	Scientific literature	Pipeline			Patents	Other observatories	Media		Internat-ional institutions and Fora	Individuals, Committees and expert groups		EU bodies	Draft legislation and Law	Innovation queries	Organisations						Meeting and conferences					Criteria		Criteria	Method	Factors	Depth	Method	Peer review	ICT	Structure	Format	Frequency	Audience	Strategy		Method
				Clinical trial registers	Medical literature databases	Commercial sources			Commercial	Medical			Survey techniques				Academia of Industry	Interest groups/Profile	Think Tanks	Research Network	Venture Capitalist													Consultation with wider HS sector								
Australia and New Zealand Horizon Scanning Network, Australia and New Zealand (ANZHSN, including Adelaide Health Technology Assessment (AHTA))																																									
Basque Office for Health Technology Assessment, Basque Country (OSTEBA)																																									
Canadian Agency for Drugs and Technologies in Health, Canada (CADTH)																																									
Supporting Innovation through Regulation and Science: Ireland as an Innovation Hub for Health Products																																									
Italian Horizon Scanning Project, Servizio Farmaceutico Territoriale, Italy (IHSP)																																									
National Horizon Scanning Centre, England (NHSC) + (Their research paper: Past speculations of the future: a review of the methods used for forecasting emerging health technologies)																																									
Swedish Council on Technology Assessment in Health Care, Sweden (SBU)																																									
UK PharmaScan																																									
Oxford Centre for Monitoring and Diagnosis in Primary Care																																									
Masum H, Ranck J, Singer PA. Five promising methods for health foresight. Foresight 2010;12:54–66. doi:10.1108/14636681011020182CrossRefGoogle Scholar																																									
Evaluation of nine consensus indices in delphi foresight research and their relationship on delphi survey characteristics: A simulation study and debate on delphi design and interpretation																																									
A Delphi technology foresight study: Mapping social construction of scientific evidence on metagenomics tests for water safety																																									
Using strategic foresight to assess conservation opportunity																																									
Strategic foresight: how planning for the unpredictable can improve environmental decision-making																																									
Horizon scan of nanomedicinal products																																									
Trans Tasman Radiation Oncology Group: Development of the Assessment of New Radiation Oncology Technology and Treatments (ANROTAT) Framework																																									
Horizon scanning for translational genomic research beyond bench to bedside																																									

Literature Map - Working Excel

Title	Full Text Link ("-" if unnavailable; or explanation of non-inclusion)	Abstract
ASERNIP-S: International trend setting	https://onlinelibrary-wiley-com.ezproxy.ub.unimaas.nl/doi/epdf/10.1111/j.1445-2197.2008.04679.x	The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) came into being 10 years ago to provide health technology assessments specifically tailored towards new surgical techniques and technologies. It was and remains the only organisation in the world to focus on this area of research. Most funding has been provided by the Australian Government Department of Health, and assessments have helped inform the introduction of new surgical techniques into Australia. ASERNIP-S is a project of the Royal Australasian College of Surgeons. The ASERNIP-S program employs a diverse range of methods including systematic reviews, technology overviews, assessments of new and emerging surgical technologies identified by horizon scanning, and audit. Support and guidance for the program is provided by Fellows of the Royal Australasian College of Surgeons. ASERNIP-S works closely with consumers to produce health technology assessments and audits, as well as consumer information to keep patients fully informed of research. Since its inception, the ASERNIP-S program has developed a strong international profile through the production of over 60 reports on evidence-based surgery, surgical technologies and audit. The work undertaken by ASERNIP-S has evolved from assessments of the safety and efficacy of procedures to include guidance on policies and surgical training programs. ASERNIP-S needs to secure funding so that it can continue to play an integral role in the improvement of quality of care both in Australia and internationally. © 2008 The Authors.
Update on Horizon Scans of Genetic Tests Currently Available for Clinical Use in Cancers [Internet].	https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0078750/pdf/PubMedHealth_PMH0078750.pdf	The Coverage and Analysis Group at the Centers for Medicare and Medicaid Services (CMS) is interested in an update report of genetic tests for cancer conditions and the accompanying database to serve as a ready reference for their internal discussions in this area as well as the source for decisions on future topics for systematic reviews. CMS requested that the Technology Assessment Program (TAP) of the Agency for Healthcare Research and Quality (AHRQ) conduct an update of genetic tests for cancer conditions that were identified since the 2006 horizon scan report on Genetic Testing for Cancer. AHRQ assigned this project to the Tufts Medical Center Evidence-based Practice Center (Contract Number: HHSA 2902007 10055 I, Task Order #3, work assignment #2). The main objective of this report is to provide succinct information along with a preliminary estimate on the amount of published literature available on each identified genetic test through grey literature search since 2006. Systematic review of selected tests will be the subject of future focused reviews. The contents in the database and in this report reflect the data of genetic tests that were obtained from manufacturers' Web sites or other commercial Web sites, and should not be construed as definitive clinical evidence or as recommendations for their routine clinical use.
Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain.	[illegible]	Invasive alien species (IAS) are considered one of the greatest threats to biodiversity, particularly through their interactions with other drivers of change. Horizon scanning, the systematic examination of future potential threats and opportunities, leading to prioritization of IAS threats is seen as an essential component of IAS management. Our aim was to consider IAS that were likely to impact on native biodiversity but were not yet established in the wild in Great Britain. To achieve this, we developed an approach which coupled consensus methods (which have previously been used for collaboratively identifying priorities in other contexts) with rapid risk assessment. The process involved two distinct phases: Preliminary consultation with experts within five groups (plants, terrestrial invertebrates, freshwater invertebrates, vertebrates and marine species) to derive ranked lists of potential IAS. Consensus-building across expert groups to compile and rank the entire list of potential IAS. Five hundred and ninety-one species not native to Great Britain were considered. Ninety-three of these species were agreed to constitute at least a medium risk (based on score and consensus) with respect to them arriving, establishing and posing a threat to native biodiversity. The quagga mussel, Dreissena rostriformis bugensis, received maximum scores for risk of arrival, establishment and impact; following discussions the unanimous consensus was to rank it in the top position. A further 29 species were considered to constitute a high risk and were grouped according to their ranked risk. The remaining 63 species were considered as medium risk, and included in an unranked long list. The information collated through this novel extension of the consensus method for horizon scanning provides evidence for underpinning and prioritizing management both for the species and, perhaps more importantly, their pathways of arrival. Although our study focused on Great Britain, we suggest that the methods adopted are applicable globally.
Making processes reliable: a validated pubmed search strategy for identifying new or emerging technologies.	[illegible]	BACKGROUND AND OBJECTIVES: Horizon scanning systems need to handle a wide range of sources to identify new or emerging health technologies. The objective of this study is to develop a validated Medline bibliographic search strategy (PubMed search engine) to systematically identify new or emerging health technologies. METHODS: The proposed Medline search strategy combines free text terms commonly used in article titles to denote innovation within index terms that make reference to the specific fields of interest. Efficacy was assessed by running the search over a period of 1 year (2009) and analysing its retrieval performance (number and characteristics). For comparison purposes, all article abstracts published during 2009 in six preselected key research journals and eight high impact surgery journals were scanned. Sensitivity was defined as the proportion of relevant new or emerging technologies published in key journals that would be identified in the search strategy within the first 2 years of publication. RESULTS: The search yielded 6,228 abstracts of potentially new or emerging technologies. Of these, 459 were classified as new or emerging (383 truly new or emerging and 76 new indications). The scanning of 12,061 journal abstracts identified 35 relevant new or emerging technologies. Of these, twenty-nine were located within the Medline search strategy during the first 2 years of publication (sensitivity = 83 percent). CONCLUSIONS: The current search strategy, validated against key journals, has demonstrated to be effective for horizon scanning. Even though it can require adaptations depending on the scope of the horizon scanning system, it could serve to simplify and standardize scanning processes.
Improving the efficiency and relevance of evidence-based recommendations in the era of whole-genome sequencing: an EGAPP methods update.	[illegible]	To provide an update on recent revisions to Evaluation of Genomic Applications in Practice and Prevention (EGAPP) methods designed to improve efficiency, and an assessment of the implications of whole genome sequencing for evidence-based recommendation development. Improvements to the EGAPP approach include automated searches for horizon scanning, a quantitative ranking process for topic prioritization, and the development of a staged evidence review and evaluation process. The staged process entails (i) triaging tests with minimal evidence of clinical validity, (ii) using and updating existing reviews, (iii) evaluating clinical validity prior to analytic validity or clinical utility, (iv) using decision modeling to assess potential clinical utility when direct evidence is not available. EGAPP experience to date suggests the following approaches will be critical for the development of evidence based recommendations in the whole genome sequencing era: (i) use of triage approaches and frameworks to improve efficiency, (ii) development of evidence thresholds that consider the value of further research, (iii) incorporation of patient preferences, and (iv) engagement of diverse stakeholders. The rapid advances in genomics present a significant challenge to traditional evidence based medicine, but also an opportunity for innovative approaches to recommendation development.
Knowledge integration at the center of genomic medicine.	[illegible]	Three articles in this issue of Genetics in Medicine describe examples of "knowledge integration," involving methods for generating and synthesizing rapidly emerging information on health-related genomic technologies and engaging stakeholders around the evidence. Knowledge integration, the central process in translating genomic research, involves three closely related, iterative components: knowledge management, knowledge synthesis, and knowledge translation. Knowledge management is the ongoing process of obtaining, organizing, and displaying evolving evidence. For example, horizon scanning and "infoveillance" use emerging technologies to scan databases, registries, publications, and cyberspace for information on genomic applications. Knowledge synthesis is the process of conducting systematic reviews using a priori rules of evidence. For example, methods including meta-analysis, decision analysis, and modeling can be used to combine information from basic, clinical, and population research. Knowledge translation refers to stakeholder engagement and brokering to influence policy, guidelines and recommendations, as well as the research agenda to close knowledge gaps. The ultrarapid production of information requires adequate public and private resources for knowledge integration to support the evidence-based development of genomic medicine.
Horizon scanning for new genomic tests.	[illegible]	PURPOSE: The development of health-related genomic tests is decentralized and dynamic, involving government, academic, and commercial entities. Consequently, it is not easy to determine which tests are in development, currently available, or discontinued. We developed and assessed the usefulness of a systematic approach to identifying new genomic tests on the Internet. METHODS: We devised targeted queries of Web pages, newspaper articles, and blogs (Google Alerts) to identify new genomic tests. We finalized search and review procedures during a pilot phase that ended in March 2010. Queries continue to run daily and are compiled weekly; selected data are indexed in an online database, the Genomic Applications in Practice and Prevention Finder. RESULTS: After the pilot phase, our scan detected approximately two to three new genomic tests per week. Nearly two thirds of all tests (122/188, 65%) were related to cancer; only 6% were related to hereditary disorders. Although 88 (47%) of the tests, including 2 marketed directly to consumers, were commercially available, only 12 (6%) claimed United States Food and Drug Administration licensure. CONCLUSION: Systematic surveillance of the Internet provides information about genomic tests that can be used in combination with other resources to evaluate genomic tests. The Genomic Applications in Practice and Prevention Finder makes this information accessible to a wide group of stakeholders.
Evaluating new surgical techniques in Australia: the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical experience.	[illegible]	The Australian Safety and Efficacy Register of New Interventiona lProcedures-Surgical (ASERNIP-S) exists primarily to assess new surgical technologies and techniques. It originally conducted systematic literature reviews, but now uses accelerated reviews, horizon scanning for emerging procedures, research and clinical audits,preparation of patient information, assistance with guideline development,and the production of research protocols of new surgical techniques. Future international cooperation and networking among health technology assessment groups will avoid duplication of effort and maximize outputs. Experience has shown that when surgeons lead in assessing new and emerging surgical techniques and technologies, the benefits of an evidence-based approach are realized, and the surgical community accepts the complementary role of evidence-based medicine in the provision of high-quality patient care.
The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) assesses new surgeries.	[illegible]	The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) is a programme of the Royal Australasian College of Surgeons (RACS). We provide assessments of new and emerging surgical techniques, establish and facilitate clinical and research audits or trials, and produce clinical practice guidelines. We use horizon scanning to identify new techniques. ASERNIP-S conducts systematic literature reviews and accelerated systematic literature reviews on the safety and effectiveness of new surgical techniques before they are widely accepted into the health care system. The RACS recently endorsed two new ASERNIP-S systematic reviews and three accelerated systematic reviews.
Report from the World Health Organization's third Product Development for Vaccines Advisory Committee (PDVAC) meeting, Geneva, 8-10th June 2016	[illegible]	The third meeting of WHO's Product Development for Vaccines Advisory Committee (PDVAC) was held in June 2016, with a remit to revisit the pathogen areas for which significant progress has occurred since recommendations from the 2015 meeting, as well as to consider new advances in the development of vaccines against other pathogens. Since the previous meeting, significant progress has been made with regulatory approvals of the first malaria and dengue vaccines, and the first phase III trials of a respiratory syncytial virus (RSV) vaccine candidate has started in the elderly and pregnant women. In addition, PDVAC has also supported vaccine development efforts against important emerging pathogens, including Middle Eastern Coronavirus (MERS CoV) and Zika virus. Trials of HIV and tuberculosis vaccine candidates are steadily progressing towards pivotal data points, and the leading norovirus vaccine candidate has entered a phase IIb efficacy study. WHO's Immunization, Vaccine and Biologicals (IVB) department is actively working in several pathogen areas on the recommendation of PDVAC, as well as continuing horizon scanning for advances in the development of vaccines that may benefit low and middle income countries (LMICs), such as the recent licensure of the enterovirus 71 (EV71) vaccine in China. Following on from discussions with WHO's Strategic Advisory Group of Experts (SAGE) on Immunization, PDVAC will also look beyond licensure and consider data needs for vaccine recommendation and implementation to reduce the delay between vaccine approval and vaccine impact.
A knowledge base for tracking the impact of genomics on population health	[illegible]	PURPOSE: We created an online knowledge base (the Public Health Genomics Knowledge Base (PHGKB)) to provide systematically curated and updated information that bridges population-based research on genomics with clinical and public health applications. METHODS: Weekly horizon scanning of a wide variety of online resources is used to retrieve relevant scientific publications, guidelines, and commentaries. After curation by domain experts, links are deposited into Web-based databases. RESULTS: PHGKB currently consists of nine component databases. Users can search the entire knowledge base or search one or more component databases directly and choose options for customizing the display of their search results. CONCLUSION: PHGKB offers researchers, policy makers, practitioners, and the general public a way to find information they need to understand the complicated landscape of genomics and population health.
Challenges and priorities for modelling livestock health and pathogens in the context of climate change	[illegible]	Climate change has the potential to impair livestock health, with consequences for animal welfare, productivity, greenhouse gas emissions, and human livelihoods and health. Modelling has an important role in assessing the impacts of climate change on livestock systems and the efficacy of potential adaptation strategies, to support decision making for more efficient, resilient and sustainable production. However, a coherent set of challenges and research priorities for modelling livestock health and pathogens under climate change has not previously been available. To identify such challenges and priorities, researchers from across Europe were engaged in a horizon-scanning study, involving workshop and questionnaire based exercises and focussed literature reviews. Eighteen key challenges were identified and grouped into six categories based on subject-specific and capacity building requirements. Across a number of challenges, the need for inventories relating model types to different applications (e.g. the pathogen species, region, scale of focus and purpose to which they can be applied) was identified, in order to identify gaps in capability in relation to the impacts of climate change on animal health. The need for collaboration and learning across disciplines was highlighted in several challenges, e.g. to better understand and model complex ecological interactions between pathogens, vectors, wildlife hosts and livestock in the context of climate change. Collaboration between socio-economic and biophysical disciplines was seen as important for better engagement with stakeholders and for improved modelling of the costs and benefits of poor livestock health. The need for more comprehensive validation of empirical relationships, for harmonising terminology and measurements, and for building capacity for under-researched nations, systems and health problems indicated the importance of joined up approaches across nations. The challenges and priorities identified can help focus the development of modelling capacity and future research structures in this vital field. Well-funded networks capable of managing the long-term development of shared resources are required in order to create a cohesive modelling community equipped to tackle the complex challenges of climate change.
Priority questions and horizon scanning for conservation: A comparative study	[illegible]	Several projects aimed at identifying priority issues for conservation with high relevance to policy have recently been completed in several countries. Two major types of projects have been undertaken, aimed at identifying (i) policy-relevant questions most imperative to conservation and (ii) horizon scanning topics, defined as emerging issues that are expected to have substantial implications for biodiversity conservation and policy in the future. Here, we provide the first overview of the outcomes of biodiversity and conservation-oriented projects recently completed around the world using this framework. We also include the results of the first questions and horizon scanning project completed for a Mediterranean country. Overall, the outcomes of the different projects undertaken (at the global scale, in the UK, US, Canada, Switzerland and in Israel) were strongly correlated in terms of the proportion of questions and/or horizon scanning topics selected when comparing different topic areas. However, some major differences were found across regions. There was large variation among regions in the percentage of proactive (i.e. action and response oriented) versus descriptive (non-response oriented) priority questions and in the emphasis given to sociopolitical issues. Substantial differences were also found when comparing outcomes of priority questions versus horizon scanning projects undertaken for the same region. For example, issues related to climate change, human demography and marine ecosystems received higher priority as horizon scanning topics, while ecosystem services were more emphasized as current priority questions. We suggest that future initiatives aimed at identifying priority conservation questions and horizon scanning topics should allow simultaneous identification of both current and future priority issues, as presented here for the first time. We propose that further emphasis on social-political issues should be explicitly integrated into future related projects.
Techniques and technologies in radiation oncology: The RANZCR faculty of radiation oncology horizon scan	[illegible]	Horizon Scanning is a regular initiative of the Faculty of Radiation Oncology (FRO) at the Royal Australian and New Zealand College of Radiologists (RANZCR). The ongoing horizon scanning project is intended to provide a resource to key stakeholders that are non radiation oncology experts showing the techniques and technologies that are used in radiation therapy treatment and the way that these are used at a facility, regional and national level. This project was initiated in 2011 and was developed with expert clinical input from radiation therapists, radiation oncology medical physicists and radiation oncologists. The horizon scan and associated position paper have undergone regular review and update (in 2012, 2013 and 2015) to ensure that the information contained within is current and reflective of contemporary practice. The dissemination of the horizon scan also allows for opportunities to meet with stakeholders from areas such as government jurisdictions, policy, radiation oncology professions and industry and discuss issues important to the radiation therapy community. The 2015 Horizon Scan was discussed at the Radiation Therapy Industry Roundtable and Radiation Therapy Innovations Summit.
A Horizon Scan of Global Conservation Issues for 2016	[illegible]	This paper presents the results of our seventh annual horizon scan, in which we aimed to identify issues that could have substantial effects on global biological diversity in the future, but are not currently widely well known or understood within the conservation community. Fifteen issues were identified by a team that included researchers, practitioners, professional horizon scanners, and journalists. The topics include use of managed bees as transporters of biological control agents, artificial superintelligence, electric pulse trawling, testosterone in the aquatic environment, building artificial oceanic islands, and the incorporation of ecological civilization principles into government policies in China.
A horizon scan of future threats and opportunities for pollinators and pollination	[illegible]	BACKGROUND: Pollinators, which provide the agriculturally and ecologically essential service of pollination, are under threat at a global scale. Habitat loss and homogenisation, pesticides, parasites and pathogens, invasive species, and climate change have been identified as past and current threats to pollinators. Actions to mitigate these threats, e.g., agri-environment schemes and pesticide-use moratoriums, exist, but have largely been applied post-hoc. However, future sustainability of pollinators and the service they provide requires anticipation of potential threats and opportunities before they occur, enabling timely implementation of policy and practice to prevent, rather than mitigate, further pollinator declines. METHODS: Using a horizon scanning approach we identified issues that are likely to impact pollinators, either positively or negatively, over the coming three decades. RESULTS: Our analysis highlights six high priority, and nine secondary issues. High priorities are: (1) corporate control of global agriculture, (2) novel systemic pesticides, (3) novel RNA viruses, (4) the development of new managed pollinators, (5) more frequent heatwaves and drought under climate change, and (6) the potential positive impact of reduced chemical use on pollinators in non-agricultural settings. DISCUSSION: While current pollinator management approaches are largely driven by mitigating past impacts, we present opportunities for pre-emptive practice, legislation, and policy to sustainably manage pollinators for future generations.
Looking back on 5 years of horizon scanning in oncology	[illegible]	OBJECTIVES: The regularly structured adaptation of health technology assessment (HTA) programs is of utmost importance to sustain the relevance of the products for stakeholders and to justify investment of scarce financial resources. This study describes internal adjustments and external measures taken to ensure the Horizon Scanning Programme in Oncology (HSO) is current. METHODS: Formal evaluation methods comprising a survey, a download, an environmental analysis, and a Web site questionnaire were used to evaluate user satisfaction. RESULTS: The evaluation showed that users were satisfied with HSO outputs in terms of timeliness, topics selected, and depth of information provided. Discussion of these findings with an expert panel led to changes such as an improved dissemination strategy and the introduction of an additional output, that is, the publication of a league table of emerging oncology drugs. The rather high level of international usage and the environmental analysis highlighted a considerable overlap in topics assessed and, thus, the potential for international collaboration. As a consequence, thirteen reports were jointly published based on eleven calls for collaboration. To further facilitate collaboration and the usability of reports for other agencies, HSO reports will be adjusted according to tools developed at a European level. CONCLUSIONS: Evaluation of the impact of HTA programs allows the tailoring of outputs to fit the needs of the target population. However, within a fast developing HTA community, estimates of impact will increasingly be determined by international collaborative efforts. Refined methods and a broader definition of impact are needed to ultimately capture the efficiency of national HTA programs.

Title	Information sources (proactive and passive): Scientific literature	Pipeline: Clinical trial registers	Pipeline: Research infrastructure	Pipeline: Commercial sources	Patents	Other observatories	Media: Commercial	Media: Medical	International institutions and Fora	Individuals, Committees and expert groups	Individuals, Committees and expert groups: Survey techniques	EU bodies	Draft legislation/guidelines	Innovation queries	Organisations: Academies of science	Organisations: Interest group profiles	Organisations: Think Tanks	Organisations: Research funders	Organisations: Venture Capitalist	Meeting and conferences	Other grey literature	Time horizon	Filtration: Criteria	Filtration	Prioritisation: Criteria	Prioritisation: Method	Assessment: Factors	Assessment: Depth	Assessment: Method	Assessment: Peer review (Comparison with other HS results)	Assessment: ICT	Dissemination: Structure	Dissemination: Format	Dissemination: Frequency	Dissemination: Audience	Updating: Strategy	Updating	Process Evaluation: Method
ASERNIP-S: International trend setting																										short horizon scanning technology prioritizing summaries are used when deciding whether a procedure should be further assessed; recommending a horizon scanning report.												
Update on Horizon Scans of Genetic Tests Currently Available for Clinical Use in Cancers [Internet].						Gene Test Tracker database																			genetic tests that have applications in the common solid tumors and [illegible]							One page	a "one-page [illegible]	Quarterly basis		relevance of the genetic [illegible]		
Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain.	literature review and risk assessment with dynamic consensus method.																																					
Making processes reliable: a validated pubmed search strategy for identifying new or emerging technologies.						[illegible]																[illegible]	[illegible]															
Improving the efficiency and relevance of evidence-based recommendations in the era of whole-genome sequencing: an EGAPP methods update.											[illegible]																[illegible]											
Knowledge integration at the center of genomic medicine.																																	[illegible]					
Horizon scanning for new genomic tests.														[illegible]																			[illegible]					
Evaluating new surgical techniques in Australia: the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical experience.																																						
The Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S) assesses new surgeries.																																						
Report from the World Health Organization's third Product Development for Vaccines Advisory Committee (PDVAC) meeting, Geneva, 8-10th June 2016																																						
A knowledge base for tracking the impact of genomics on population health						[illegible]																											[illegible]					
Challenges and priorities for modelling livestock health and pathogens in the context of climate change																																						
Priority questions and horizon scanning for conservation: A comparative study											[illegible]												[illegible]							[illegible]		[illegible]	[illegible]					
Techniques and technologies in radiation oncology: The RANZCR faculty of radiation oncology horizon scan																										[illegible]												
A Horizon Scan of Global Conservation Issues for 2016								[illegible]															[illegible]				[illegible]									[illegible]		
A horizon scan of future threats and opportunities for pollinators and pollination																						[illegible]	[illegible]			[illegible]												
Looking back on 5 years of horizon scanning in oncology																							[illegible]		[illegible]	[illegible]						[illegible]	[illegible]	[illegible]		[illegible]		

Literature Map - Working Excel

Included papers and info			Information sources (proactive and passive)																					Time horizon	Filtration		Prioritisation		Assessment					Dissemination				Updating		Process Evaluation
Title	Full Text Link ("-" if unavailable; or explanation of non-inclusion)	Abstract	Scientific literature	Pipeline			Patents	Other observatories	Media		Internat-ional institutions and Fora	Individuals, Committees and expert groups		EU bodies	Draft legislation and regulation	Innovation queries	Organisations						Meeting and conferences	Other grey literature		Criteria		Criteria	Method	Factors	Depth	Method	Peer review	ICT	Structure	Format	Frequency	Audience	Strategy		Method
				Clinical trial registers	Medical literature (Research Information)	Commercial sources			Commercial	Medical			Survey techniques				Academics of Note	Interest group profiles	Think Tanks	Research Bodies	Venture Capitalist										Completion with richer HE inputs							
CHANGING HEALTH TECHNOLOGY ASSESSMENT PARADIGMS?																																							
New and emerging technologies for the treatment of inherited retinal diseases: A horizon scanning review																																							
Results from a horizon scan on risks associated with transplantation of human organs, tissues and cells: from donor to patient																																							
Preparedness for emerging infectious diseases: Pathways from anticipation to action																																							
Identifying and selecting new procedures for health technology assessment: A decade of nice experience in the United Kingdom																																							
The role of health technology assessment bodies in shaping drug development																																							
A horizon scan for species conservation by zoos and aquariums																																							
Strategic foresight: how planning for the unpredictable can improve environmental decision-making																																							
Evolutionary rescue in a changing world																																							
Identifying the science and technology dimensions of emerging public policy issues through horizon scanning																																							
Prioritizing genomic applications for action by level of evidence: A horizon scanning method																																							
A horizon-prioritizing method can identify gaps among genomic application guidelines																																							
DEVELOPING A PRIORITIZED LIST OF INNOVATIVE TECHNOLOGIES: THE SPANISH EXPERIENCE																																							
Eu pharmaceutical expenditure forecast																																							
Horizon scanning for emergence of new viruses: From constructing complex scenarios to online games																																							
The headroom method of early economic evaluation of medical devices: A useful tool for device developers?																																							
Horizon scanning in radiation oncology in Australia: Considerations and future trends																																							

Literature Map - Working Excel

Included papers and info			Information sources (proactive and passive)																				Other grey literature	Time horizon	Filtration		Prioritisation		Assessment					Dissemination				Updating		Process Evaluation
			Scientific literature	Pipeline			Patents	Other observatories	Media		Internati-onal institutions and Fora	Individuals, Committees and expert groups		EU bodies	Draft legislation and plans	Innovation queries	Organisations					Meeting and conferences																	
Title	Full Text Link ("-" if unavailable; or explanation of non-inclusion)	Abstract		Clinical trial registers	Medical literature (Research Institutions)	Commercial sources			Commercial	Medical			Survey techniques				Academia of Industry	Impact group profiles	Think Tanks	Research Networks	Venture Capitalist				Criteria		Criteria	Method	Factors	Depth	Method	Peer review	ICT	Structure	Format	Frequency	Audience	Strategy		Method
The 'Assessment of New Radiation Oncology Technology and Treatments' (ANROTAT) project: Update on progress																																						
Using best-worst scaling in horizon scanning for hepatocellular carcinoma technologies																																						
Analyzing 10 years of early awareness and alert activity in the United Kingdom																																						
Implementing a national early awareness and alert system for rare and emerging health technologies in Italy: The COTE project																																						
Innovation and the burden of disease: Retrospective observational study of new and emerging health technologies reported by the EuroScan network from 2000 to 2009																																						
Making predictive ecology more relevant to policy makers and practitioners																																						
Scanning the horizon- Development and implementation of an early awareness system for anticancer drugs in Austria																																						
Identification of innovation in public health																																						
The true role of horizon scanning in Australia: Who it informs and why																																						
Reply to the letter by Mundy, Hiller, and Merlin on the true role of horizon scanning in Australia																																						
Forecasting drug utilization and expenditure in a metropolitan health region.																																						
Issues facing the Australian health technology assessment review of medical technology funding																																						
Evaluation criteria to assess the value of identification sources for horizon scanning																																						
The role of surgeons in identifying emerging technologies for health technology assessment																																						
Information service on new and emerging health technologies: Identification and prioritization processes for a European Unionwide newsletter																																						
The need for environmental horizon scanning																																						
The Italian Horizon Scanning Project																																						

Literature Map - Working Excel

Included papers and info

Title	Full Text Link ("-" if unnavailable; or explanation of non-inclusion)	Abstract
Horizon scanning of new and emerging medical technology in Australia: Its relevance to medical services advisory committee health technology assessments and public funding	http://dx.doi.org/10.1017/S0266462309990031	
Global trends in cardiology and cardiothoracic surgery - An opportunity or a threat?		IHSP is supported by a technological infrastructure for data collection, check, monitoring and analysis. The database is available, by a restricted access (http://horizon.cineca.it/). Currently, 2655 emerging drugs are in the IHSP database.
Early identification systems for emerging foodborne hazards	http://dx.doi.org/10.1016/j.tifs.2007.12.021	This paper provides a non-exhausting overview of early warning systems for emerging foodborne hazards that are operating in the various places in the world. Special attention is given to endpoint-focussed early warning systems (i.e. ECDC, ISIS and GPHIN) and hazard-focussed early warning systems (i.e. FVO, RASFF and OIE) and their merit to successfully identify a food safety problem in an early stage is discussed. Besides these early warning systems which are based on monitoring of either disease symptoms or hazards, also early warning systems and/or activities that intend to predict the occurrence of a food safety hazard in its very beginning of development or before that are described. Examples are trend analysis, horizon scanning, early warning systems for mycotoxins in maize and/or wheat and information exchange networks (e.g. OIE and GIEWS). Furthermore, recent initiatives that aim to develop predictive early warning systems based on the holistic principle are discussed. The assumption of the researchers applying this principle is that developments outside the food production chain that are either directly or indirectly related to the development of a particular food safety hazard may also provide valuable information to predict the development of this hazard.
Modelling downstream effects in the presence of technological change	http://dx.doi.org/10.2165/00019053-200826120-00001	
Emerging health technologies: Informing and supporting health policy early	http://dx.doi.org/10.1016/j.healthpol.2008.01.002	OBJECTIVES: All western healthcare systems are confronted with a rising number of new health technologies. To support decision-making processes with sound information about new health technologies, some countries have established "Horizon Scanning Systems (HSS)". This paper gives an overview of processes and practices of HSS. METHOD: The paper is based on a literature review (Medline and Embase) and on unpublished information gathered from HSS-agencies. RESULTS: The 13 current HSS have been collaborating in the EuroScan network since 1999. EuroScan has agreed on a common terminology, classification and understanding of their activities. All their activities consist of 5 sequenced main components: identification and filtering, prioritization, early assessment, dissemination and monitoring the assessed technologies. Although there is a common understanding with regard to function and processes there are some differences in the scope of the national/regional HSS. CONCLUSION: 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. Because of the common understanding there is a certain stability and integration across the functions of HSS. Nonetheless there are some obvious "blank spots" susceptible to subjectivity, such as an implicit prioritization process. © 2008 Elsevier Ireland Ltd. All rights reserved.
Invasion Science: A Horizon Scan of Emerging Challenges and Opportunities.	[illegible]	We present the results of our eighth annual horizon scan of emerging issues likely to affect global biological diversity, the environment, and conservation efforts in the future. The potential effects of these novel issues might not yet be fully recognized or understood by the global conservation community, and the issues can be regarded as both opportunities and risks. A diverse international team with collective expertise in horizon scanning, science communication, and conservation research, practice, and policy reviewed 100 potential issues and identified 15 that qualified as emerging, with potential substantial global effects. These issues include new developments in energy storage and fuel production, sand extraction, potential solutions to combat coral bleaching and invasive marine species, and blockchain technology.
A 2017 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity.		BACKGROUND: The contemporary environment is a complex of interactions between physical, biological, socio-economic systems with major impacts on public health. However, gaps in our understanding of the causes, extent and distribution of these effects remain. The public health community in Sandwell West Midlands has collaborated to successfully develop, pilot and establish the first Environmental Public Health Tracking (EPHT) programme in Europe to address this 'environmental health gap' through systematically linking data on environmental hazards, exposures and diseases. METHODS: Existing networks of environmental, health and regulatory agencies developed a suite of innovative methods to routinely share, integrate and analyse data on hazards, exposures and health outcomes to inform interventions. RESULTS: Effective data sharing and horizon scanning systems have been established, novel statistical methods piloted, plausible associations framed and tested, and targeted interventions informed by local concerns applied. These have influenced changes in public health practice. CONCLUSION: EPHT is a powerful tool for identifying and addressing the key environmental public health impacts at a local level. Sandwell's experience demonstrates that it can be established and operated at virtually no cost. The transfer of National Health Service epidemiological skills to local authorities in 2013 provides an opportunity to expand the programme to fully exploit its potential.
Environmental Public Health Tracking: a cost-effective system for characterizing the sources, distribution and public health impacts of environmental hazards.		Poor communication between academic researchers and wildlife managers limits conservation progress and innovation. As a result, input from overlapping fields, such as animal behaviour, is underused in conservation management despite its demonstrated utility as a conservation tool and countless papers advocating its use. Communication and collaboration across these two disciplines are unlikely to improve without clearly identified management needs and demonstrable impacts of behavioural-based conservation management. To facilitate this process, a team of wildlife managers and animal behaviour researchers conducted a research prioritization exercise, identifying 50 key questions that have great potential to resolve critical conservation and management problems. The resulting agenda highlights the diversity and extent of advances that both fields could achieve through collaboration.
Research Priorities from Animal Behaviour for Maximising Conservation Progress.		OBJECTIVE: This paper discusses the potential for horizons scanning to identify low-value, inappropriate clinical practices that deliver minimal benefit to patients and represent a considerable financial burden on the health system. METHODS: Platelet-rich plasma (PRP) was identified by routine horizon scanning as a potentially innovative treatment alternative for osteoarthritis of the knee. A rapid, non-systematic assessment of the evidence pertaining to the safety and effectiveness of PRP compared with nonsteroidal anti-inflammatory drugs (NSAIDs) for the treatment of osteoarthritis of the knee was conducted. RESULTS: The evidence base supporting the use of PRP for the treatment of osteoarthritis was poor. No comparative studies were identified that compared the use of PRP to NSAIDs, the current treatment option for osteoarthritis of the knee in Australia. Despite the lack of effectiveness evidence, the use of PRP injections was rapidly increasing in the private sector using an inappropriate Medicare Benefits Schedule item number. CONCLUSIONS: This assessment highlights the potential of using established horizon scanning methodologies to identify targets for full or partial disinvestment of ineffective, inefficient or harmful clinical practices. What is known about the topic? PRP is rapidly diffusing in the private health system in Australia, however the use of a Medicare Benefits Schedule item number meant that this practice was being subsidised by the public reimbursement of treatment fees. What does this paper add? Traditional horizon scanning tends to identify technologies for health systems to invest in. The evidence on the effectiveness of PRP was examined with the purpose of exploring investment in an innovative treatment that may have reduced the number of invasive procedures being performed in the public hospital system. The current evidence base does not support the use of PRP injections for the treatment of osteoarthritis. It does, however, support the use of horizon scanning as an inexpensive methodology to identify possible disinvestment targets associated with potential patient harm and high health service expenditure. What are the implications for practitioners? Practitioners should be aware that public funding for the injection of PRP should not be used for the treatment of osteoarthritis.
Platelet-rich plasma: a case study for the identification of disinvestment opportunities using horizon scanning.		The national effort to use genomic knowledge to save lives is gaining momentum, as illustrated by the inclusion of genomics in key public health initiatives, including Healthy People 2020, and the recent launch of the precision medicine initiative. The Office of Public Health Genomics (OPHG) at the Centers for Disease Control and Prevention (CDC) partners with state public health departments and others to advance the translation of genome-based discoveries into disease prevention and population health. To do this, OPHG has adopted an "identify, inform, and integrate" model: identify evidence-based genomic applications ready for implementation, inform stakeholders about these applications, and integrate these applications into public health at the local, state, and national level. This paper addresses current and future work at OPHG for integrating genomics into public health programs.
Genomics in Public Health: Perspective from the Office of Public Health Genomics at the Centers for Disease Control and Prevention (CDC).		OBJECTIVES: The EuroScan International Network is a global network of publicly funded early awareness and alert (EAA) systems for health technologies. We describe the EuroScan member agency systems and methods, and highlight the potential for increased collaboration. METHODS: EuroScan members completed postal questionnaires supplemented with telephone interviews in 2012 to elicit additional information and check equivalence of responses. Information was updated between March and May 2013. RESULTS: Fifteen of the seventeen member agencies responded. The principal purpose of agencies is to inform decisions on coverage or reimbursement of health services and decisions on undertaking secondary research. The main users of information are national governments; health professionals; health services purchasers, commissioners, and decision makers; and healthcare providers. Most EuroScan agencies are small with almost half having fewer than two whole time equivalent staff. Ten agencies use both active and passive identification approaches, four use only active approaches. Most start identification in the experimental or investigational stages of the technology life cycle. All agencies assessed technologies when they are between the investigational and established, but under diffusion stages. Barriers to collaboration revolve around different system aims, purposes, and requirements; a lack of staff, finance, or opportunity; language differences; and restrictions on dissemination. CONCLUSIONS: Although many barriers to collaboration were identified, the majority of agencies were supportive of increased collaboration either involving the whole EuroScan Network or between individual agencies. Despite differences in the detailed identification processes, members thought that this was the most feasible phase to develop additional collaboration.
EUROSCAN INTERNATIONAL NETWORK MEMBER AGENCIES: THEIR STRUCTURE, PROCESSES, AND OUTPUTS.		The Centers for Medicare & Medicaid Services (CMS) has asked the Agency for Healthcare Research & Quality (AHRQ) and the Tufts-NEMC EPC to perform a horizon scan of gene-based tests in cancer that are currently in clinical use, are being promoted for clinical use, or are being developed for clinical use. CMS has expressed the need for the deliverable to be a ready reference tool to inform discussions in this area.
Genetic Tests for Cancer		The Coverage and Analysis Group at the Centers for Medicare & Medicaid Services (CMS) requested from The Technology Assessment Program (TAP) at the Agency for Healthcare Research and Quality (AHRQ) a horizon scan to summarize the available scientific evidence on the quality of laboratory-developed ("home brew" or "in-house") molecular tests, which are currently not actively regulated by the U.S. Food and Drug Administration (FDA). CMS has concerns about the quality of laboratory-developed tests and the validation currently being performed on these tests. AHRQ assigned this report to the following Evidence-based Practice Center (EPC): ECRI EPC (Contract Number: 290 2007 10063 I). To help CMS to address its concerns, this horizon scan is intended to: 1) identify types of laboratory-developed molecular tests (LDMTs) currently available for conditions relevant to the Medicare over-65-year-old population, 2) identify the methodologies and the processes that have been developed for the assessment of analytical and clinical performance of molecular tests, 3) summarize the role of Federal agencies in regulating LDMTs, and 4) identify the quality standards that have been developed for molecular tests by regulatory bodies, the industry, and the medical community.
Quality, Regulation and Clinical Utility of Laboratory-developed Molecular Tests	https://www.ncbi.nlm.nih.gov/pubmed/25834872	Over the past decade, research efforts such as the Human Genome Project and the International Haplotype Map (HapMap) project, coupled with concomitant advances in genomic technologies and bioinformatics, have contributed to an explosive growth in the field of human genomics. These developments have resulted in cheaper and more efficient genomic technologies, and they, along with other innovations in medical diagnostics and therapeutics, will soon play a substantial role in everyday clinical practice. Genetic tests can be used for a variety of purposes including screening, diagnosis, disease monitoring, risk stratification, and therapeutic management. In addition, genetic tests can be helpful in predicting outcomes and can be used as clinical decisionmaking tools. As new assays become available for clinical use, it is crucial for patients, clinicians, and payers to be well informed as to the breadth of genetic testing available and the appropriate contexts in which they should be used. To that end, the Coverage and Analysis Group at the Centers for Medicare and Medicaid Services (CMS) requested the Technology Assessment Program (TAP) at the Agency for Healthcare Research and Quality (AHRQ) map the landscape of genetic tests available for non-cancer diseases/conditions. AHRQ assigned this project to the Tufts Medical Center Evidence-based Practice Center (Contract Number: HHSA 290 2007 10055 I). The current report presents an updated list of genetic tests for non-cancer conditions, adding those identified since the 2007 and 2010 horizon scan reports on Genetic Testing for Non-Cancer Conditions sponsored by the CMS and funded through the AHRQ. A report concerning genetic tests for cancer conditions is forthcoming in 2013. The goal was to identify genetic tests for non-cancer conditions that are already in clinical practice and are applicable to the Medicare population. Eligible tests were reviewed and summarized for inclusion in an electronic database.
Update on Mapping the Landscape of Genetic Tests for Non-Cancer Diseases/Conditions	https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR433/RAND_RR433.pdf	Public Health England (PHE) commissioned RAND Europe to undertake a horizon scanning study exploring the future of public health and related scientific services. This work was intended to help inform thinking at the strategic level within PHE, firstly in relation to the wider vision of the Agency (which was only established in April 2013) and, secondly, in relation to the proposals for the creation of an integrated public health science hub. The study is based on a literature review, a brief Delphi exercise using the ExpertLens platform and key informant interviews with a range of PHE staff and external experts. It focuses on the different future public health science needs and the extent to which an integrated science hub could serve PHE as it evolves over the next twenty years. Thus, the study considers PHE's future remit and objectives in order that decisions about an integrated and co-located science hub be made in context and with reference to expert perceptions about the future.
The Future of Public Health: A Horizon Scan.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3972886/	The opportunity to reflect broadly on the accomplishments, prospects, and reach of a field may present itself relatively infrequently. Each biennial meeting of the International Biogeography Society showcases ideas solicited and developed largely during the preceding year, by individuals or teams from across the breadth of the discipline. Here, we highlight challenges, developments, and opportunities in biogeography from that biennial synthesis. We note the realized and potential impact of rapid data accumulation in several fields, a renaissance for inter-disciplinary research, the importance of recognizing the evolution-ecology continuum across spatial and temporal scales and at different taxonomic, phylogenetic and functional levels, and re-exploration of classical assumptions and hypotheses using new tools. However, advances are taxonomically and geographically biased, and key theoretical frameworks await tools to handle, or strategies to simplify, the biological complexity seen in empirical systems. Current threats to biodiversity require unprecedented integration of knowledge and development of predictive capacity that may enable biogeography to unite its descriptive and hypothetico-deductive branches and establish a greater role within and outside academia.
An horizon scan of biogeography.		

Information sources (proactive and passive)

Title	Scientific literature	Pipeline: Clinical trial registers	Pipeline: Research infrastructure	Pipeline: Commercial sources	Patents	Other observatories	Media: Commercial	Media: Medical	Internati-onal institutions and Fora	Individuals, Committees and expert groups	Individuals, Committees and expert groups: Survey techniques	EU bodies	Draft legislation /guidelines	Innovation queries	Organisations: Acadamies of science	Organisations: Interest group profiles	Organisations: Think Tanks	Organisations: Research funders	Organisations: Venture Capitalist	Meeting and conferences	Other grey literature
Horizon scanning of new and emerging medical technology in Australia: Its relevance to medical services advisory committee health technology assessments and public funding																					
Global trends in cardiology and cardiothoracic surgery - An opportunity or a threat?																					
Early identification systems for emerging foodborne hazards																					
Modelling downstream effects in the presence of technological change																					
Emerging health technologies: Informing and supporting health policy early																					
Invasion Science: A Horizon Scan of Emerging Challenges and Opportunities.																					
A 2017 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity.																					
Environmental Public Health Tracking: a cost-effective system for characterizing the sources, distribution and public health impacts of environmental hazards.																					
Research Priorities from Animal Behaviour for Maximising Conservation Progress.																					
Platelet-rich plasma: a case study for the identification of disinvestment opportunities using horizon scanning.																					
Genomics in Public Health: Perspective from the Office of Public Health Genomics at the Centers for Disease Control and Prevention (CDC).																					
EUROSCAN INTERNATIONAL NETWORK MEMBER AGENCIES: THEIR STRUCTURE, PROCESSES, AND OUTPUTS.																					
Genetic Tests for Cancer							EuroScan International Network member agencies were asked to complete a questionnaire about their EAA system													he AMP is a not-for-profit scientific society founded in 19955, that is dedicated to the advancement, practice, and science of clinical molecular laboratory medicine and translational research.	
Quality, Regulation and Clinical Utility of Laboratory-developed Molecular Tests				We conducted focused searches of grey literature sources, including online genetic databases, registries, and laboratories, to identify new genetic tests that are currently in clinical use. One definition of grey literature is, "that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers".6 Listed below are Web sites that were frequently visited to gather information on new genetic tests.																	
Update on Mapping the Landscape of Genetic Tests for Non-Cancer Diseases/Conditions	"Following a broad search of relevant literature and drawing on the initial interviews, the study team identified several bodies of literature that were particularly relevant .... With public health england with PHE, we clustered these issues around key domains and focussed our literature review efforts on so-called 'deep dives'. These involved more structured literature searches of peer-reviewed and grey literature in the following domains: "											An interview protocol (see Appendix B) guided interviews, which usually lasted between 30 and 45 minutes. The protocol gave us the basis for ensuring that interviewees were asked a standard set of questions but we took a flexible approach so that interviewees were able to focus on their particular areas of expertise or concern.									
The Future of Public Health: A Horizon Scan.																					
An horizon scan of biogeography.																					

Time horizon, Filtration, Prioritisation, Assessment, Dissemination, Updating, Process Evaluation

Title	Time horizon	Filtration: Criteria	Filtration	Prioritisation: Criteria	Prioritisation: Method	Assessment: Factors	Assessment: Depth	Assessment: Method	Assessment: Peer review (Comparison with other HS results)	Assessment: ICT	Dissemination: Structure	Dissemination: Format	Dissemination: Frequency	Dissemination: Audience	Updating: Strategy	Updating	Process Evaluation: Method
Horizon scanning of new and emerging medical technology in Australia: Its relevance to medical services advisory committee health technology assessments and public funding																	
Global trends in cardiology and cardiothoracic surgery - An opportunity or a threat?																	
Early identification systems for emerging foodborne hazards																	
Modelling downstream effects in the presence of technological change																	thresold and sensitivity analysis with horizon scanning; modelling the cost effcitveness of alternative treatment strategies. Evaluate technological change through economic evaluation.
Emerging health technologies: Informing and supporting health policy early															ideally reassessment should be carried out when sufficient new data is available or when a technology has changed enough. The issue here is to find reliable triggers or threshold for sufficient new data, for example a newly published clinical study with a sufficient number of patients.		
Invasion Science: A Horizon Scan of Emerging Challenges and Opportunities.										Modified delphie: "Each participant proposed two or more topics, either alone or following consultation with members of their networks within and beyond their organizations. Several participants used social media to canvass followers for issues. Proposed topics were required to meet the criteria of global relevance and limited recognition among conservation professionals. The 99 topics that were submitted reflected the input of an estimated 430 individuals"....."Short descriptions of the full list of topics were circulated to all participants in July 2016. Participants then scored each topic on a scale from 1 (well known, or poorly known but unlikely to have substantial effects on conservation of biological diversity) to 1000 (poorly known and likely to have substantial effects on the conservation of biological diversity and the environment). Each participant also indicated whether they had heard of each issue; the percentage of participants that were aware of each issue was considered in the final scoring process as a relative measure of the novelty of an issue. Each participant's scores were converted to ranks, and we calculated the median rank of each topic. Given the time available for discussion, we 3 TRAFFIC, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK 4 Centre for Biodiversity and Biosecurity, School of Biological Sciences, University of Auckland, PB 92019, Auckland, New Zealand 5 British Ecological Society, Charles Darwin House, 12 Roger Street, London, WC1N 2JL, UK 6 Department of Biological Sciences, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada 7 School of Biological Sciences, University of East Anglia, UEA, Norwich, NR4 7TJ, UK 8 Natural England, Eastbrook, Shaftesbury Road, Cambridge, CB2 8DR, UK 9 Fauna & Flora International, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK 10John Muir Institute of the Environment, The Barn, One Shields Ave., University of California, Davis, CA 95616, USA 11 Environment Agency, Horizon House, Deanery Road, Bristol, BS1 5AH, UK 12Environment & Sustainability Institute, University of Exeter, Penryn, TR10 9FE, UK 13RSPB Centre for Conservation Science, Royal Society for the Protection of Birds, The Lodge, Sandy, SG19 2DL, UK 14Institute of Zoology, Chinese Academy of Sciences, Beijing, China 100101 and University of Chinese Academy of Sciences, Beijing, 100049, China 15721 Ohio Street, Bangor, ME 04401, USA 16 Cranfield Institute for Resilient Futures, Cranfield University, Cranfield, MK43 0AL, UK 17The Economist, 25 St James's Street, London, SW1A 1HG, UK 18Natural Resources Wales, Cambria House, 29 Newport Road, Cardiff, CF24 0TP, UK 19BTO, The Nunnery, Thetford, IP24 2PU, UK 20British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge, CB3 0ET, UK 21Centre for Environment and Society and School of Biological Sciences, University of Essex, Colchester, CO4 3SQ, UK 22Global Marine Team, The Nature Conservancy, Department of Physical, Earth and Environmental Sciences, University of Siena, Pian dei Mantellini, 44, 53100 Siena, Italy 23Wetlands International, PO Box 471, 6700 AL Wageningen, The Netherlands 32 Trends in Ecology & Evolution, January 2017, Vol. 32, No. 1 24CSaR, Centre for Research in the Arts, Social Sciences and Humanities, Cambridge University, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK *Correspondence: w.sutherland@zoo.cam.ac.uk (W.J. Sutherland). retained the 35 topics with the highest median ranks and three topics that one or more participants thought warranted further discussion, and one additional topic that was not included in the original 99. Two participants, neither of whom had proposed the topic, researched the feasibility, novelty, and likely effects of each topic if realized (three participants examined the newly added topic). The participants convened in Cambridge, UK, in mid-September 2016. Each of the 39 topics was discussed in turn, with the constraint that the individual who suggested a given topic, if present, was not among the first three people to comment on it. The focus of some topics was modified during discussion. After each topic was discussed, participants independently and confidentially rescored the issue from 1 through 1000 as described above. The 15 topics that received the highest median ranks after discussion at the meeting are reported below."							
A 2017 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity.				[illegible]													
Environmental Public Health Tracking: a cost-effective system for characterizing the sources, distribution and public health impacts of environmental hazards.										We reduced the original 209 questions to 50 in two steps. First, we grouped questions within eight topics of anthropogenic threat or conservation action and discussed them in four sessions of two parallel groups. After discussion, each group rated questions as 'gold' (top 40%), 'silver' (20%), or 'neither' (the rest). This step reduced the 209 original questions to 109 (listed in the Supplemental Information online). In a second step, the best silver questions were identified and then these and the gold questions were pruned by voting to a total of 55 gold and 25 silver questions. In a series of additional discussions and votes, the group eliminated the bottom gold questions and added the top silver ones to produce a final list of exactly 50 questions. The questions could be reworded for clarity at each stage.							
Research Priorities from Animal Behaviour for Maximising Conservation Progress.																the results of included studies are reported in a narrative form	
Platelet-rich plasma: a case study for the identification of disinvestment opportunities using horizon scanning.											cost; ACCE (Analytic validity, Clinical validity, Clinical utility, Ethical, legal, and social implications)						
Genomics in Public Health: Perspective from the Office of Public Health Genomics at the Centers for Disease Control and Prevention (CDC).																	
EUROSCAN INTERNATIONAL NETWORK MEMBER AGENCIES: THEIR STRUCTURE, PROCESSES, AND OUTPUTS.		census, economic and other data sources, databases of ongoing [illegible]															
Genetic Tests for Cancer	Universities						Quality of the systematic reviews was assessed with the 'assessment of multiple systematic reviews' (AMSTAR) measurement tool (Table 29).52 The AMSTAR consists of 11 items, which have been tested for face and content validity. The items assess whether or not a systematic review includes important elements, such as a comprehensive literature search, assessment of study quality, appropriate methods to combine study findings, and assessment of publication bias. Responses to each item are checked as 'Yes' if the review includes that item, 'No' if it does not, 'CA' if the item cannot be answered by the information provided in the review, or 'NA' if the item is not applicable.		scientific literature published in peer-reviewed journals and other publications, giving highest priority to systematic reviews, followed by other publication types, including evaluation studies								
Quality, Regulation and Clinical Utility of Laboratory-developed Molecular Tests																	In order to make the database more widely accessible, we have developed a user-friendly interface through which to access the database, dubbed the "GeneTestTracker." The front end is Web-based and written in the Python programming language (http://python.org), using the Pylons (http://pylonshq.com) Web framework, making [illegible]
Update on Mapping the Landscape of Genetic Tests for Non-Cancer Diseases/Conditions										ExpertLens is an online variant of the Delphi approach to stakeholder engagement			ExpertLens is a modified Delphi technique that allows participants to interact with each other online around a structured set of questions and discussion rounds 4				
The Future of Public Health: A Horizon Scan.					Each biennial meeting is the culmination of ~1.5 years of scoping ideas, gathering information from across the discipline, and nurturing those that mature as synthesis symposia; these mature symposia are given added context by a dozen contributed oral and poster sessions selected during the immediately preceding half-year. The organization of the biennial IBS meeting thus approximates multiple attributes of an 'horizon scan'. (Sutherland and Woodroof 2009)			Word cloud (Wordle)									
An horizon scan of biogeography.																	

Literature Map - Working Excel

Included papers and info			Information sources (proactive and passive)																					Other grey literature	Time horizon	Filtration		Prioritisation		Assessment					Dissemination				Updating		Process Evaluation
Title	Full Text Link (*-* if unavailable; or explanation of non-inclusion)	Abstract	Scientific literature	Pipeline			Patents	Other observatories	Media		Internati-onal institutions and Fora	Individuals, Committees and expert groups		EU bodies	Draft legislation and Laws	Innovation queries	Organisations					Meeting and conferences			Criteria		Criteria	Method	Factors	Depth	Method	Peer review	ICT	Structure	Format	Frequency	Audience	Strategy		Method
				Clinical trial registers	Medical literature databases	Commercial sources			Commercial	Medical		Survey techniques					Academics of relevance	Interest group profiles	Think Tanks	Research Networks	Venture Capitalist										Consultation with wider HS actors								
Wiser horizons, wiser choices: horizon scanning for public health protection and improvement.																																						
PATIENT and PUBLIC INVOLVEMENT in EARLY AWARENESS and ALERT ACTIVITIES: AN EXAMPLE from the UNITED KINGDOM																																						
A transatlantic perspective on 20 emerging issues in biological engineering																																						
The Early Awareness and Alert System in Sweden: History and Current Status																																						
Radar-an important tool for horizon scanning dissemination in Brazil																																						
Horizon scanning in oncology-rapid scanning approach in Slovakia																																						
Climate research priorities for policy-makers, practitioners, and scientists in Georgia, USA.																																						
Strategic foresight, leadership, and the future of rural healthcare staffing in the United States.																																						
Toward sustainable environmental quality: Identifying priority research questions for Latin America.																																						
A 2018 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity.																																						
Integrating horizon scanning and strategic risk prioritisation using a weight of evidence framework to inform policy decisions																																						
How can health systems prepare for new and emerging health technologies? The role of horizon scanning revisited																																						
EU-IN																																						
EMA Sources																																						
Reviewing the effectiveness of UK drug horizon scanning efforts & the production of nice commentary along therapeutic specialties																																						
The multi-criteria decision analysis in the priority setting of emerging medicines																																						

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and	9

PRISMA 2009 Checklist

		simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Risk of bias was assessed in accordance with the BMJ guidelines and the Cochrane risk of bias tool. Most bias were not applicable to these non-clinical qualitative studies, however the following were: - A form of publication bias was likely in which only horizon scanning undertaken in organisations with a strong background in publishing academic publications were discovered. It was not possible to correct for this. - Outcome bias may have occurred as the papers reported systematic methodological aspects of horizon scanning, whereas some horizon scanning may occur in an ad-hoc manner e.g. a signal discovered by word of mouth. - The competing interests of the authors were not considered beyond the standards of the source journals. This was because it was not thought highly relevant to the reporting of methodologies.
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8

PRISMA 2009 Checklist

Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	N/A
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9 (See point 12)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21-22
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	22
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	23
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	24

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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