A Systematic Review of Methods for Health Care Technology Horizon Scanning

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Preface

In September 2010, the U.S. Agency for Healthcare Research and Quality (AHRQ) established the Healthcare Horizon Scanning System. Its purpose is to conduct horizon scanning of emerging health care technologies and innovations, in order to better inform patient-centered outcomes research investments at AHRQ through the Effective Health Care Program. A literature review and an expert panel meeting were conducted to identify existing best practices and effective methods for health technology horizon scanning and to provide input to AHRQ to optimize its horizon scanning program.

The Health Care Horizon Scanning System gives AHRQ a systematic process to identify and monitor target technologies and innovations in health care and to create an inventory of target technologies that have the highest potential for impact on clinical care, the health care system, patient outcomes, and costs. It is also a tool for the public to identify and find information on new health care technologies and interventions. Any investigator or funder of research can use the AHRQ Health Care Horizon Scanning System to select potential topics for research.

The health care technologies and innovations of interest for horizon scanning are those that have yet to diffuse into or become part of established health care practice. These health care interventions are still in the early stages of development or adoption except in the case of new applications of already-diffused technologies. Consistent with the definitions of health care interventions provided by the Institute of Medicine and the Federal Coordinating Council for Comparative Effectiveness Research, AHRQ is interested in innovations in drugs and biologics, medical devices, screening and diagnostic tests, procedures, services and programs, and care delivery.

Horizon scanning involves two processes. The first is the identification and monitoring of new and evolving health care interventions that are purported to or may hold potential to diagnose, treat, or otherwise manage a particular condition or to improve care delivery for a variety of conditions. The second is the analysis of the relevant health care context in which these new and evolving interventions exist in order to understand their potential impact on clinical care, the health care system, patient outcomes, and costs. It is NOT the goal of the AHRQ Health Care Horizon Scanning System to make predictions about the future utilization and costs of any health care technology. Rather, the reports will help to inform and guide the planning and prioritization of research resources.

We welcome comments on this literature review and meeting summary. Send comments by mail to the Task Order Officer named in this report to: Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850, or by email to effectivehealthcare@ahrq.hhs.gov.

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Structured Abstract

Objectives. Since September 2010, under contract with the U.S. Agency for Healthcare Research and Quality (AHRQ), ECRI Institute has been establishing a national program to conduct horizon scanning of emerging health technology. The program's main purpose is to better inform investments in patient-centered outcomes research at AHRQ by systematically identifying and monitoring target technologies to create an inventory of technologies that have the highest potential for impact on clinical care, the health care system, patient outcomes, and cost. We conducted this study to identify existing best practices and effective methods for health technology horizon scanning and to provide input to AHRQ to optimize its horizon scanning program.

Methods. We performed a comprehensive search for both peer-reviewed and gray literature to identify existing horizon scanning methods for emerging health technologies. We searched major medical databases, including MEDLINE, EMBASE^{TM}, CINAHL$^{®}$, PsycINFO$^{®}$, and the Cochrane Library. We also conducted targeted searches of digital libraries, relevant non-health-care-focused journals and databases, and the Web sites of the organizations that have extensive experience in technology horizon scanning or forecasting. We further sought input from a panel of experts and potential users of horizon scanning to identify additional methods. A two-day expert panel meeting was held in June 2011 to discuss the methods identified and potential approaches to incorporate the methods into AHRQ's horizon scanning process.

Results. Our search identified 23 formally established health technology horizon scanning programs, most of which are members of the International Information Network on New and Emerging Health Technologies (EuroScan). We also identified less structured horizon scanning activities performed by other entities, including U.S. government agencies and nongovernmental entities. These programs or activities often have different goals. As a result, their target technologies, time horizon of interest, and methods used for scanning or technology assessment may also vary. However, formally established programs share two sequential components in their horizon scanning process: (1) identification and monitoring of technologies of interest and (2) evaluation of potential impacts of the identified technologies. Most commonly used methods include searching a wide spectrum of sources—electronic and nonelectronic—to identify potential target technologies and seeking input from experts to prioritize or evaluate the technologies identified.

Conclusions. Existing horizon scanning programs use different methods to identify and assess emerging health technologies. The choice of the methods for AHRQ's horizon scanning program should be based on the goal, scope of work, time frame, and funding for the program. It appears that optimization of a horizon scanning program may take longer than a few years.

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Introduction

In September 2010, the U.S. Agency for Healthcare Research and Quality (AHRQ) awarded ECRI Institute a contract to establish a system to conduct horizon scanning of emerging health care technology to better inform investments in patient-centered outcomes research at AHRQ through the Effective Health Care Program. The purpose of this first national Health Care Horizon Scanning System is to provide AHRQ with a systematic process to identify and monitor target technologies in health care and to forecast which target technologies have the highest potential for impact on clinical care, the health care system, patient outcomes, and cost. (The methods used by the Health Care Horizon Scanning System to determine the technologies' potential for impact are described in its Protocol and Operations Manual, which is publicly available online.[1]) By identifying emerging technologies and monitoring new developments with existing technologies, the Health Care Horizon Scanning System is intended to provide timely input to decisionmakers, helping them allocate scarce resources to patient-centered outcomes research topics that may have the most significant impact and ensure that the technologies being compared remain relevant in the foreseeable future.

AHRQ's horizon scanning system is intended to build on prior work to identify, monitor, and assess target technologies in health care and include novel methods that expand beyond existing systems. To achieve this goal, AHRQ requested that ECRI Institute conduct a systematic review to identify existing health care horizon scanning programs and evaluate components of these systems and their respective protocols. This systematic review will help AHRQ identify existing best practices and effective methods for horizon scanning.

An Overview of Horizon Scanning Systems

Health care horizon scanning systems and programs, also known as early awareness and alert systems or early warning systems, aim to identify, filter, and prioritize new and emerging health technologies; to assess or predict their impact on health, costs, society, and the health care system; and to inform decisionmakers.[2] These programs may also inform the prioritization of technologies for more comprehensive health technology assessment. The health care technologies of interest for horizon scanning are those that have yet to diffuse into or become part of established health care practice. These health care technologies are still in the early stages of development or adoption except where a new application of an already-diffused technology is of interest.

Health care technology has been defined several ways.[3] In its definition of health care interventions relevant to comparative effectiveness research, a report published by the Institute of Medicine (IOM) includes drugs, tests to screen for or monitor disease, surgical techniques, and therapeutic alternatives as well as different means of delivering health care.[4] The Federal Coordinating Council for Comparative Effectiveness Research has defined medical technology as "medications, procedures, medical and assistive devices and technologies, diagnostic tests, behavioral change, and delivery system strategies."[5] AHRQ has indicated that all health care interventions and technology as defined in the IOM and Federal Coordinating Council definitions as areas of interest for horizon scanning, with an emphasis on clinical interventions.[3]

The International Information Network on New and Emerging Health Technologies (EuroScan), an international collaboration of agencies that share information on new and emerging drugs, devices, procedures, programs, and health care settings, has categorized technologies by their evolutionary phase to identify those of interest for horizon scanning:[6]

- New technologies: technology in the adoption phase that has been available for clinical use for a short period of time
- Emerging technologies: technology not yet available for use in the health care system (i.e., pharmaceutical products in Phase II and III trials)
- Established technologies with new indications
- Technologies that are part of a group of developing technologies that may as a whole have an impact

AHRQ also considers health care technologies that fall into one of the four EuroScan categories to be relevant to its horizon scanning program. These interventions or technologies are referred to as "target" technologies.

Public and private entities (e.g., governments, payers, health systems, venture capitalists, technology developers) around the world have long used formal or informal health care horizon scanning programs for various purposes, including commercial planning, health service research prioritization, financial or operational planning, controlled diffusion of technologies, and provision of information to policymakers, purchasers, and health care providers.[2,7-12] EuroScan currently has 20 government-funded members performing horizon scanning in their respective jurisdictions. Although no formal national horizon scanning system has been established in the United States, several federal agencies—including AHRQ, the U.S. Centers for Medicare & Medicaid Services (CMS), the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC)—have been involved in some form of horizon scanning activity. This involvement led to the production of a number of reports or technical briefs covering some emerging clinical or preventive interventions.[13-19] Private organizations, such as ECRI Institute, Frost and Sullivan, Hayes, Ingenix, and Thomson Reuters, have also been performing emerging technology scanning and forecasting for their clients.[20-22]

Horizon scanning systems developed by different entities may differ in terms of goals, target technologies, time horizon of interest, and methods used for scanning and technology assessment. Despite these differences, the systems share two sequential components. The first component is identification and monitoring of technologies of interest. The second component is evaluation of potential impacts of the identified technologies on patient care and outcomes, the health care delivery system, and costs. Among formally established horizon scanning programs, these two components are addressed in a series of stages. For example, the EuroScan member organizations typically go through the following stages:[2]

- Identify the users of the horizon scanning products (e.g., policymakers, purchasers, providers, patients).
- Determine the time frame for the horizon scanning effort.
- Conduct horizon scanning, and identify emerging technologies that potentially have impact on clinical practice, health outcomes, the health care system, and cost.
- Filter the identified technologies by applying criteria for determining the relevance of the technologies to the horizon scanning effort.
- Prioritize the technologies that have passed through the filtering process by applying criteria based on stakeholders' requirements and needs.
- Assess technologies of high priority for the stakeholders, and predict potential impacts of the technologies on clinical practice and outcomes, the health care system, and cost.
- Use peer review to check for quality of the horizon scanning process and outputs.

- Disseminate the information produced via horizon scanning to the relevant audiences in a timely fashion.
- Update the information on a regular basis or when a significant development occurs related to the technology.

Most of these stages involve challenges for carrying out the tasks effectively. For example, at the technology scanning and filtering stages, it is challenging to accurately identify the target technologies efficiently. Decisions must be made on what sources should be scanned and what criteria should be used for filtering the information retrieved. At the stage of predicting the potential impacts of identified technologies, many contextual factors that are likely to influence health care delivery and health outcomes need to be considered. These factors may include competing technologies, the availability of care in different geographic regions, training needed for providers, existing coding or reimbursement barriers, and potential legal and ethical issues.

Health care horizon scanning programs that currently exist around the world use methods specifically designed for addressing the needs of their own constituencies.[2,7-12] These programs' products may not address AHRQ's unique needs for identifying and monitoring potential future topics worthy of comparative-effectiveness research investment. Based on this consideration, AHRQ decided to build its own comprehensive horizon scanning system that takes into account the unique characteristics of the U.S. health care system as well as the needs of AHRQ as a major federal health care research funder. The AHRQ Health Care Horizon Scanning System will establish a clearly defined methodology for the identification of target technologies and the assessment of their contextual landscape and potential impacts.

As AHRQ's contractor to construct the Health Care Horizon Scanning System, ECRI Institute has developed detailed protocols for implementation for the project's first year. Using the protocols, the ECRI project team has identified a large number of potential target technologies. The team has also prepared some preliminary horizon scanning products that are currently still under revision. AHRQ recognized that many ideas and methods developed for existing horizon scanning programs might be applicable to its own Horizon Scanning System. Some of the ideas and methods are publicly available in literature or on the Internet.[1,2,7-12] A systematic review of these methods could provide valuable information to AHRQ in building the Horizon Scanning System. Based on this recognition, AHRQ has commissioned this review to identify existing health care horizon scanning programs, with an emphasis on the methods used by the systems.

Key Questions (KQs)

This systematic review is intended to address the following two key questions (KQs):

- KQ 1: What horizon scanning methods have been used by public and private organizations in the United States and internationally? What are the commonalities and differences among the methods used by different organizations?
- KQ 2: What horizon scanning methods identified need to be incorporated into the future process of the AHRQ Health Care Horizon Scanning System?

Methods

Literature Search Strategy

To address KQ 1 of this study, the ECRI Institute research team performed a comprehensive search for both peer-reviewed and gray literature to identify existing horizon scanning methods for emerging health technologies. We searched major medical databases, including MEDLINE, EMBASE™, CINAHL®, PsycINFO®, and the Cochrane Library. To identify methods for forecasting impacts of emerging health technologies, we also searched non-health-care-focused databases that cover business, economic, and social science literature. These databases include ABI/Inform®, Economic Abstracts, INSPEC®, RePEc (Research Papers in Economics), Social Sciences Citation Index®, and Sociological Abstracts.

In addition, we conducted targeted searches using Internet search engines (e.g., Google, Bing™) and digital libraries. We also performed hand searches to identify literature by reviewing tables of contents of publications focusing on horizon scanning and forecasting. These resources include:

- Foresight – The journal of future studies, strategic thinking and policy
- International Journal of Forecasting (research publication of the International Institute of Forecasters)
- Foresight: The International Journal of Applied Forecasting
- Technological Forecasting and Social Change: An International Journal.

We also searched the Web sites of the EuroScan organizations that have extensive experiences in health care technology horizon scanning to identify the methodologies that they use. In addition, we scanned the proceedings of meetings of organizations with experience in technology horizon scanning and forecasting that are mentioned in this document. We also sought input from a panel of experts and potential users of horizon scanning to identify relevant studies.(We discuss the expert panel in a later section.)

The overall goal of our search was to efficiently identify methods and ideas that are most likely to be useful to AHRQ to revise its current horizon scanning protocols within a very constrained time frame. A detailed description of the search strategy is listed in Appendix A of this report.

Inclusion/Exclusion Criteria

To be included for review for KQ 1, studies/documents must have met one of the following criteria:

- The study/document described or evaluated methods that had been used or piloted by a horizon scanning program or system in at least one of these areas: scanning, filtering, prioritizing, or monitoring emerging or new technologies; predicting potential impacts of these technologies; or disseminating findings from horizon scanning to target audiences. In the following section, Data Abstraction, we further specify the type of data on horizon scanning methods that we sought.
- Studies/documents reviewed, compared, or summarized methods used by different health technology horizon scanning systems.
- Studies/documents provided the contextual information required for understanding the methods used by a horizon scanning program, such as its purpose, mandate,

intended audience, and target technologies, including types and time horizon of interest (also see the Data Abstraction section).

- When multiple studies/documents were available to describe methods used by the same health care horizon scanning program, those that provide the most up-to-date data or data not reported in other studies were used as the primary information source. We used other sources to crosscheck the accuracy of the data we had collected.
- We considered slides, abstracts, white papers, and other gray literature for inclusion if the materials were from a credible source (e.g., a EuroScan member agency) and provided information with sufficient detail about methods used by a horizon scanning program.

Given the limited time and resources available for searching, translating, and reviewing non-English literature, we focused our search on literature published in English. However, we considered including non-English studies/documents identified from the Web sites of EuroScan member organizations if a member of the expert panel brought the studies/documents to our attention and considered it important.

The following types of studies/documents were not included for this review:

- Non-technology-focused studies/documents. During the preliminary search process, we identified many studies that described or evaluated methods for "environmental scanning" for health care or general business. During the same process, we also identified a large number of general "future studies" that described a conceptual model, framework, or process for predicting futures for certain industries or the overall society. Based on our preliminary assessment, these non-technology-focused studies rarely provided information that could be effectively incorporated into the methodologic protocols for AHRQ's Health Care Horizon Scanning System.
- Literature from non-health-care sectors (with a few exceptions).The body of literature on horizon scanning or forecasting methods used in non-health-care sectors (e.g., military, aerospace, information technology, new materials, environment protection) is enormous. A comprehensive search and review of this literature was not feasible due to the limited time and resources available for this study. Based on our preliminary assessment, we found that the technology scanning methods used in non-health-care sectors was of limited relevance to the health care sector in terms of sources being scanned and criteria used for prioritizing technologies. However, we felt that the methods for forecasting the impacts of non-health-care technologies might provide useful information to this AHRQ-funded horizon scanning project. To efficiently identify important non-health-care-oriented studies on forecasting impacts of technologies, the ECRI team actively sought input from experts in the area (particularly the members of the expert panel for this study) and manually searched the reference lists of included health-care-focused publications.
- Economic analysis. While economic analysis (e.g., cost-modeling, cost-effectiveness analysis, cost-utility analysis) can potentially be used to predict the economic or cost impacts of emerging technologies, the extremely large body of literature in this area makes it infeasible for us to include it for review. Therefore, we relied on the expert panel members for this study to inform us of any important literature on economic analysis that needed to be included in this review.
- Studies that evaluated existing evidence for a new technology but did not focus on assessment of the technology's future impacts.

Data Abstraction

To answer KQ 1, we posed the following questions to guide the data abstraction:

- What is the mandate/purpose of the health care horizon scanning program?
- Who are the people/stakeholders that the horizon scanning program intends to inform? These people/stakeholders may include patients and patient advocacy organizations, policymakers, payers, health care professionals, health care providers, researchers, technology developers, venture capitalists, and health technology assessment agencies.
- What deliverables is the horizon scanning program expected to produce? Deliverables may include the types, formats, and numbers of the information products.
- What are the target technologies of the horizon scanning program? The target technologies may include pharmaceuticals, devices, diagnostics, procedures, care delivery programs, community care, and public health interventions.
- What is the time horizon that the program is looking at? Time horizon refers to the expected time frame for a technology to diffuse into health care practice. It may be expressed as the number of years before the technology becomes part of established health care practice. It may also be indicated by the stages of product development (e.g., basic research, preclinical research and development, clinical development [Phases I, II, and III]) that are of interest to stakeholders.
- What methods does the horizon scanning program use to identify target technologies?
  - Is it a proactive or reactive horizon scanning program? A proactive program searches a range of sources for information on emerging technologies. By contrast, a reactive program relies on stakeholders informing the program about emerging health technologies.
  - What sources are scanned for identifying target technologies? How frequently is the list of the sources reviewed and revised? How frequently are different types of sources scanned?
- What criteria are used to filter scanned technologies? The criteria may include the relevance to the stakeholders' needs, types of target technologies, and time horizon for scanning.
- How are the technologies that have passed through the filtration process prioritized?
  - What criteria are used for prioritization? Criteria may include prevalence/incidence, burden of disease, availability of alternative treatments, potential impacts of the technology, and relevance to the stakeholders' requirements.
  - Who prioritizes? Prioritization can be carried out in-house, by permanent or *ad hoc* committees of experts, or by the customer.
  - What process (e.g., consensus building, voting, using a scoring system) is used for prioritization?
- What methods are used to assess or predict potential impacts of the technologies?
  - What types of assessment (e.g., rapid, brief, in-depth) are performed?
  - What content is included in the assessment?
  - Who performs the assessment?
  - What methods are used for making the assessment or predictions?

- What strategies are used for disseminating the information generated by the horizon scanning program?
- How does the horizon scanning program monitor identified technologies and update the information on technologies undergoing development?
- How is the performance of the horizon scanning program evaluated?

Data Synthesis

The data abstracted from literature were organized by horizon scanning programs identified. For each program, methods used at each stage of the horizon scanning process (e.g., scanning, filtering, prioritization, assessment/forecasting) were described. We narratively summarized these methods used across different horizon scanning programs. We presented the data abstracted from literature, as well as the narrative summary, to a panel of experts (discussed in the following section) for input. The ECRI team then synthesized the experts' input with the literature findings.

Expert Panel Meeting

For this study, a panel of experts informed AHRQ and the ECRI Institute research team on horizon scanning methods. The panel included 20 experts from public and private institutions in the U.S. or abroad. The panel members either had extensive experience in the development and implementation of horizon scanning programs or used these programs (e.g., clinicians, payers, policymakers, health systems, venture capital and investment firms, technology assessment groups).

The two-day expert panel meeting took place at AHRQ in Rockville, Maryland, on June 8-9, 2011. Before the meeting, the ECRI Institute research team circulated a draft report that summarized the preliminary findings from literature review on horizon scanning methods. During the meeting, the experts were asked to provide additional information about horizon scanning methods that the ECRI Institute team had not identified. The information the experts provided was incorporated into the findings of this report.

During the meeting, ECRI Institute also presented the protocols used in the initial phase of the AHRQ Health Care Horizon Scanning System and asked the experts to comment on the protocols. Based on the experts' insights, the input from AHRQ staff, and the literature review findings, the ECRI Institute research team addressed KQ 2 of this study and revised the protocols of the AHRQ Health Care Horizon Scanning System.[1] The protocols have been published on AHRQ's Effective Health Care Web site.

Findings

In this chapter, we report the findings of the systematic literature review and summarize the input from the expert panel. We first provide an overview of the evidence base. We then summarize the identified health technology horizon scanning programs as well as the horizon scanning methods used by these programs. (This summary addresses KQ 1.) At the end, we summarize the input from the expert panel and, based on that input, address the question about what horizon scanning methods need to be incorporated into the future process of the AHRQ Health Care Horizon Scanning System (thereby addressing KQ 2).

Evidence Base

Using the search strategy described in the previous chapter, we identified more than 150 peer-reviewed studies, unpublished reports, white papers, abstracts, slides, and white papers—as well as hundreds of Web pages—that appeared to yield data about health technology horizon scanning programs or methods. In most cases, it was necessary to review the full-text document or to go through all pages in a Web site to determine whether we should include the document or the Web site in the review. Due to the broad range of data we searched for, we rarely eliminated a document based on its abstract (that is, if an abstract were available for the document, as for a peer-reviewed study).

Except for two studies,[23,24] all documents or Web pages included for review can be considered qualitative studies. Most of these studies described, reviewed, summarized, or compared horizon scanning systems or methods. Additional studies provided information on methods for identifying and assessing new or emerging technologies not used by a formal horizon scanning system. Two studies quantified the accuracy of a prediction made by a horizon scanning program related to emerging technologies.[23,24]

One of the main challenges that we encountered during the search was that many of the documents that we identified—particularly those from peer-reviewed journals—were published several years ago (some more than 10 years ago). To avoid missing important data, we included all relevant documents for review regardless of their publication year. However, when we cite these documents, we also provide the publication date where appropriate, providing readers with a context for judging whether the information being reviewed is likely to be out of date.

In this report, we considered the information identified from the Web site of a horizon scanning organization to be current. When multiple data sources were available for the same health care horizon scanning program identified, we used the host organization's Web site as the primary data source. We used data from other sources when data were not available from the organization's Web site.

Another challenge that we encountered during the search process was that, for most of the horizon scanning systems that we identified, limited data on the methods used were available. As we detailed in the Data Abstraction section of the previous chapter, we intended to collect a broad range of methods-related data for each of the health care horizon scanning programs. Only for a few health care horizon scanning programs (e.g., National Horizon Scanning Center in England, Australia and New Zealand Horizon Scanning Network, Ludwig Boltzmann Institute for Health Technology Assessment) were we able to identify most of the data elements that we were searching for. Therefore, when we summarized or compared the methods used by the identified horizon scanning systems, we often relied on the findings of existing reviews or comparison studies that other groups (e.g., EuroScan) had conducted.

Overview of Identified Health Care Horizon Scanning Programs

Our search identified 23 formally established health technology horizon scanning programs. The 20 members of EuroScan composed the majority of the horizon scanning programs that we identified.

EuroScan Member Horizon Scanning Programs

EuroScan horizon scanning systems include the following:

- Agencia de Evaluación de Tecnologías Sanitarias (AETS). Instituto de Salud Carlos III, Spain
- Agencia de Evaluación de Tecnologías Sanitarias de Andalucía, Spain (AETSA)
- Agenzia nationale per i servizi sanitari regionali, Italy (Age.na.s)
- 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)
- Committee for Evaluation & Diffusion of Innovative Technologies, France (CEDIT)
- Council of the Netherlands, The Netherlands (GR)
- Danish Centre for Evaluation and Health Technology Assessment, Denmark (DACEHTA)
- Division of Medical Technology Policy, Ministry of Health, Israel (DMTP)
- German Institute for Medical Documentation and Information, Germany (DIMDI)
- Haute Autorité de Santé, France (HAS)
- Health Information & Quality Authority, Ireland (HIQA)
- Italian Horizon Scanning Project, Servizio Farmaceutico Territoriale, Italy (IHSP)
- Ludwig Boltzmann Institute for Health Technology Assessment, Austria (LBI-HTA)
- Managed Uptake of Medical Methods programme, Finnish Office for Health Technology Assessment, Finland (Finohta [MUMM])
- National Horizon Scanning Centre, England (NHSC)
- Norwegian Knowledge Centre for the Health Services, Norway (NOKC)
- Swedish Council on Technology Assessment in Health Care, Sweden (SBU)
- Swiss Federal Office of Public Health, Switzerland (SFOPH)[2]

Most EuroScan member programs evolved from the work of health technology assessment (HTA) agencies. The main difference between a traditional HTA program and a health care horizon scanning program is that the latter focuses on technologies early in the life cycle while traditional HTA organizations focus more on technologies that have already diffused into clinical practice.[25-27] Most EuroScan horizon scanning systems are part of a national or regional HTA agency. Others are located at a university, a federal social insurance office, and a hospital group.[28] These EuroScan horizon scanning systems are often part of, or connected to, HTA agencies and can even be viewed as the first stage of a comprehensive HTA process. For example, new technologies identified and prioritized by NHSC made up a significant part of the National Institute for Health and Clinical Excellence's (NICE) appraisal program.[11] Some EuroScan horizon scanning systems focus only on specific medical fields or technology types

(e.g., LBI-HTA's horizon scanning system has a special focus on anticancer drugs), whereas others (e.g., NHSC, CADTH) address the whole range of technologies and specialties.

For several EuroScan member programs, including NHSC, ANZHSN, and LBI-HTA, we identified most methodology-related data elements that we intended to collect (see the Data Abstraction section of the previous chapter). These data are summarized in Tables 2 through 7 in Appendix B. However, for most other programs, our search did not identify publicly available methods. Due to the lack of data for many programs, we were unable to perform a truly comprehensive comparison of these horizon scanning programs based on the data collected. As a consequence, we had to depend on findings from existing reviews or comparison studies that other groups conducted, particularly EuroScan.

Over the years, EuroScan performed a series of studies summarizing or comparing the methods used by its member horizon scanning programs.[28-31] The most recent comparison study was conducted in 2009[29] to determine whether the member programs differ in their approaches to horizon scanning and to identify the primary characteristics of an effective horizon scanning program. Member programs were sent a questionnaire containing 40 questions on structure and funding, aims and coverage, customers, partnerships and collaborations, methods, output, dissemination, related activities, and future developments.

The survey found that all 20 EuroScan member programs were funded by public sources. The main source of funding for 16 member agencies is the national health system or department of health. Two agencies are mainly funded by regional health systems, one by hospital funds, and one by taxes on promotional spending by companies.[29] The main difference between the member programs was the level of funding and staffing. Funding ranged from less than €5,000 to more than €1 million per year. Staffing levels ranged from one part-time worker working one day/week to a team of 13 full-time equivalents.[29]

According to the survey, the main purpose of these EuroScan horizon scanning programs is to inform decisionmaking on coverage or reimbursement of health services, capital or recurrent spending, and undertaking primary research or secondary research (i.e., HTA).[29] The main customers of EuroScan programs include the following:

- National government health departments and ministers (80% of programs)
- Health care providers, including hospitals (65%)
- Health care professionals (55%)
- Health service purchasers, commissioners, or other decisionmakers (55%)
- Regional, state, or provincial government (45%)
- National research and development programs (45%)
- Insurance or reimbursement organizations (40%)
- Consumers (10%)[29]

Target technologies being covered varied among for the EuroScan member horizon scanning programs. Ninety percent of the programs consider devices and diagnostics, 80% consider procedures, 70% consider pharmaceuticals, 60% consider programs, and 50% consider health care settings. All but one EuroScan member programs considered all disease areas.[29]

Although these EuroScan member programs are financially independent from industry or commercial influences, collaboration with relevant external individuals and groups was common.[29,30] Ninety percent of the EuroScan member programs worked with clinical or scientific individuals, 70% had existing expert groups, and 50% used specially convened groups.[29] Meanwhile, 45% of the programs used commercial companies, developers, or sponsors in their work.[29] These experts and industry contacts were used in almost every stage of the

horizon scanning process, including identification of technologies, filtration, prioritization, impact assessment, and review of the reports.[30]

EuroScan member programs have been collaborating closely over the years in sharing information about emerging technologies and the development of methods for horizon scanning. The agencies have developed a database of emerging technologies. According to a 2008 study, 80% of the technologies identified between 2000 and 2008 were in the investigational phase.[31] Among the 14 agencies that had become members of EuroScan by May 2008, four agencies contributed 80% of the technologies included in the database. Almost 45% of the technologies were drugs, and almost 20% were devices.[31]

Given the similarity between the AHRQ Health Care Horizon Scanning System and many EuroScan member programs in terms of goals and stakeholders, we have put more emphasis on the methods used by EuroScan horizon scanning systems in this review. We believe that EuroScan member programs provide the most relevant experience that AHRQ's horizon scanning program may learn from during the process of optimizing its horizon scanning protocols.

Horizon Scanning Activities Outside EuroScan Member Horizon Scanning Programs

In addition to the EuroScan horizon scanning programs, we identified horizon scanning activities performed by U.S. government agencies. The Technology Assessment Program (TAP) at AHRQ provides technology assessments for CMS. TAP publishes a type of technology assessment report, called "horizon scan" reports, on selected medical areas (e.g., laboratory-developed molecular tests, genetic tests for cancer, genetic tests for noncancer conditions).[14-19] CMS uses these horizon scan reports to inform its national coverage decisions for the Medicare program. These reports have typically focused on technologies already available for clinical use and are commissioned on an *ad hoc* basis. They are different from the EuroScan type of horizon scanning systems, which are standing programs, continuously scanning, monitoring, prioritizing, and assessing emerging technologies. As a consequence, the goals, scope, intensity, and process of work are rather different. The methods used for TAP's horizon scan reports are not the focus of this review.

CDC has also engaged in some horizon scanning activities. The agency published a report on emerging genomic tests and technologies for improving safety and health of working people.[13,32] FDA also monitors emerging health technologies that may potentially fall into its regulatory responsibility. From 2007 through 2008, FDA's Center for Devices and Radiological Health (CDRH) analyzed emerging medical device technologies to identify major trends projected over the next 10 years. The goal of the forecasting initiative was to support CDRH's scientific preparation for upcoming generations of products. The work of the initiative was summarized in a technical report, *Future Trends in Medical Device Technologies*, on the agency's Web site.[33] The report anticipated the types of device technologies that may emerge to pose new questions and challenges.

In addition to the horizon scanning activities performed by the U.S. government, we also identified formal or informal horizon scanning activities performed by private institutions such as the contractor and subcontractors of the AHRQ Health Care Horizon Scanning System. The methods used by these contractors and subcontractors have also been incorporated into the current protocols used by AHRQ's Health Care Horizon Scanning System.[1] To avoid

redundancy, we do not provide a separate review of the methods used by the contractor or subcontractors of the AHRQ Health Care Horizon Scanning System in this report.

We also identified other horizon scanning programs, including UK PharmaScan and the Oxford Centre for Monitoring and Diagnosis in Primary Care. Several publicly or privately funded groups (e.g., the AHRQ Health Care Innovations Exchange, Innovation Consultancy Kaiser Permanente, Innovation Learning Network, and Szollosi Healthcare Innovation Program) that facilitate information exchange on innovative ideas and methods for delivering health care may have developed methods for scanning and monitoring these innovations. Commercial companies that specialize in health market research or technology research (e.g., Frost & Sullivan, GBI Research, Hayes, Kalorama Information) may also have a function of forecasting future trends related to health technologies.[34-36] However, our search did not identify any publicly available documents that provided detailed information about their scanning or forecasting methods. Therefore, we invited some of these groups and companies to participate in the expert panel meeting to inform AHRQ and ECRI Institute on the methods they use.

We also identified several papers describing *ad hoc* horizon scanning activities focused on specific health topics, including arthritis, prostate cancer, reproductive technologies in Africa, and innovations for future elderly.[37-40] These studies provided some information about the methods used for their horizon scanning activities. This information was incorporated into the summaries of the horizon scanning methods in this chapter, whenever deemed appropriate.

Methods Used by the Identified Horizon Scanning Programs

We found a consensus on the general scanning process among the major health care horizon scanning programs that we identified. On its Web site, EuroScan published a toolkit for the identification and assessment of new and emerging health technologies.[2] This document describes the following stages of horizon scanning:

- Identify the users of the horizon scanning products.
- Determine the time frame for the horizon scanning effort.
- Conduct horizon scanning, and identify emerging technologies that potentially have impact on clinical practice and outcomes, the health care system, and cost.
- Filter the identified technologies by applying criteria for determining the relevance of the technologies to the horizon scanning effort.
- Prioritize the technologies that have passed through the filtering process by applying criteria based on stakeholders' requirements and needs.
- Assess technologies of high priority for the stakeholders, and predict potential impacts of the technologies on clinical practice and outcomes, the health care system, and cost.
- Use peer review to check for quality of the horizon scanning process and outputs.
- Disseminate the information produced via horizon scanning to the relevant audiences in a timely fashion.
- Update the information produced via horizon scanning on a regular basis or when a significant development occurs related to the technology.

Overall, the protocols developed for the AHRQ Health Care Horizon Scanning System follow a similar process.[1] Since AHRQ has determined the users and the time frame appropriate for its horizon scanning program, this review focused on those more challenging elements in the horizon scanning process, including identification of emerging technologies, filtration and

prioritization of identified technologies, assessment of key technologies, and dissemination of the information.

Methods for Identifying Emerging Technologies

Proactive Versus Reactive Approaches

Emerging technologies can be identified by using proactive or reactive approaches or both.[2] When a proactive approach is used, a range of sources is searched for information on target technologies. When a reactive approach is used, the horizon scanning program creates a mechanism for stakeholders, health professionals, and consumers to inform the horizon scanning entity about target technologies. Reactive approaches require fewer resources than proactive methods but may not be as comprehensive.[2] Many of the health care horizon scanning programs, including those used by NHSC, ANZHSN, and OSTEBA, use a combination of both approaches, although OSTEBA seems to rely primarily on using a group of experts to identify target technologies (see Appendix B).

Categories of Information Sources for Scanning

When proactive approaches are used to identify emerging technologies, the health care horizon scanning program needs to decide which sources to scan. NHSC in England classifies the sources offering information on health technologies into three categories: primary, secondary, and tertiary sources, described as follows:[41,42]

- Primary sources provide information directly from developers or manufacturers.
- Secondary sources are those for which some topic filtering has already been undertaken and include key medical journals, consultation with experts in the field, and Internet media sources.
- Tertiary sources provide information from other horizon scanning organizations such as EuroScan, ANZHSN, and CADTH.

Of these information sources, each has its own advantages and disadvantages. Primary information sources are likely to provide earlier warning but are uncertain indicators of the likely adoption of a new technology.[43] They often provide little detail on the potential new technology. Secondary and tertiary sources, on the other hand, often provide later warning but greater detail and more accurate predictions of its likely impact.[43] Some horizon scanning systems (e.g., NHSC LBI-HTA) use all primary, secondary, and tertiary sources to identify target technologies.[41,42] A combination of different types of sources could potentially increase the amount of useful information regarding an emerging technology. A Delphi study conducted by the HTA Program in the UK recommended using a combination of the following information sources: key pharmaceutical journals, pharmaceutical and biotechnology companies, specialist medical journals (i.e., those containing early case reports, case series, and uncontrolled studies), principal medical journals, medical engineering companies, private health care providers, and newsletters and other bulletins from other national and regional health technology assessment agencies.[43]

Developers and Manufacturers as Sources of Information

One of the challenges of early assessment in horizon scanning programs or systems is the lack of evidence and the limited access to information on technologies under development. Contacting primary information sources (i.e., health technology developers, manufacturers) could potentially help identify these emerging technologies. Some horizon scanning programs

(e.g., NHSC) routinely contact major pharmaceutical, diagnostic, and medical device companies to invite them to discuss their pipeline developments.[11,42]

In 2008, NHSC tested the feasibility of sending a pipeline mail-out request to pharmaceutical companies, asking them for information on new active products and license extensions for existing products, which they anticipated would be available in the UK within the next 2 to 3 years. The survey findings were compared against the NHSC database and outputs to determine which products or indications the NHSC had already identified or reported. Eighteen of the 21 companies responded with 98 new active products and 101 potential license extensions. There were 118 instances (59%) in which NHSC could determine that it had already identified the new product or indication; 66 instances (33%) in which NHSC could determine that it had not identified the new product or indication; and 15 instances (7.5%) in which NHSC was unsure whether it had previously identified the product or indication.[11]

It is worth noting that manufacturers' or developers' Web sites often provide limited information on emerging technologies. Use of the companies' Web sites as the sole source of information on product pipelines might not be an effective strategy for identifying emerging technologies.[42] Actively contacting the companies might be a more effective way to get the information, as long as the process does not involve collecting confidential business information.

The Internet as a Tool for Identifying Technologies

Of the different types of sources, the Internet holds the promise of timely and efficient searching.[2] Internet sites that are easy to scan, free of charge, appear to provide objective information, and have an email alert service were most attractive for horizon scanning.[44,45] New Web sites were mostly found through word of mouth or through links from another site.[41] Frequently, an information specialist prioritized new sites in an informal way. Sites may also be followed for a short period of time to determine whether the site should be included or excluded in the routine scanning activity. Sites that appear to produce more or a similar amount of useful information than sites that are already scanned were likely to be added to the list of sites to scan.[44,45]

A survey of EuroScan member programs conducted in 2003 found that the total number of sites scanned by the six agencies that provided the authors with complete information ranged from 11 to 27. Most of the Web sites are scanned weekly (41%) or monthly (33%). Two Web sites provided Listservs (a service that sends selected information from the site to a personal email address on a daily or weekly basis). For each program, one to five Web sites were scanned daily, and three to 15 were scanned weekly.[44]

The survey also found variation between individual horizon scanning programs in terms of what individual Web sites were selected for scanning and judged as important. Meanwhile, not all EuroScan horizon scanning programs used the Internet as the primary source to identify emerging health technologies. Some programs searched the Internet for information on already identified technologies.[44] In the EuroScan study, a large number of Web sites were listed. Web sites considered "highly important" and searched by all EuroScan horizon scanning systems being surveyed were noted. However, since the survey results were published in 2003 and many of the Web sites have changed, we did not list them in this report.[44]

The EuroScan collaborators pointed out that the frequency of scanning varied depending on the source. Email alerts were sent at regular intervals (usually daily or weekly), paper publications were generally scanned less frequently (weekly or monthly), and some sources may need scanning only annually (e.g., conference proceedings).[2]

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Selecting Information Sources for Scanning

Discussions have taken place among EuroScan member programs to develop a common list of valuable sources that all these systems can share. However, the decision on what sources to scan will ultimately depend on the particular mandate and goals of the individual horizon scanning program.[2,41,44] Health care horizon scanning programs in different regions of the world may need to consider different sources (e.g., the U.K. Gene Therapy Advisory Committee, FDA) that are more relevant to their respective regions.[42]

Resources available (time and money) for the horizon scanning program also need to be considered for selecting information sources for scanning.[2] NHSC routinely scanned 35 sources to identify new and emerging health technologies.[42] In a pilot study, LBI-HTA searched 63 different information sources available on the Internet (see Table 4 in Appendix B). Search of a broad spectrum of sources could be very resource-intensive and time-consuming.[46] Therefore, the selection of sources to scan may be cost-dependent for horizon scanning programs with limited budgets.[42] Horizon scanning programs that do not have the resources to scan proactively may even rely on existing specialized databases (e.g., EuroScan) as efficient sources.[2]

A particular challenge for identifying emerging technologies is to scan an extremely large number of data sources. Many scientific developments appear on the horizon but never reach the market. Others diffuse rapidly throughout the health care systems, seemingly from nowhere.[41] A telephone survey of existing health care horizon scanning programs that was published in 1999 suggested that liaison with experts could help overcome the challenge.[43] Such an approach allows access to the informal networks in a particular field that communicate research findings by personal contact before they are known through publications.[43]

New and potentially valuable sources of information were often identified by health care horizon scanning programs *ad hoc* from current scanning processes or through information exchange with other horizon scanning or HTA agencies. The health care horizon scanning program may try the new sources informally and then make a judgment about whether to include the sources in routine scanning.[42]

Some health care horizon scanning programs have attempted to use a more systematic approach to selecting information sources for identification of emerging technologies. Criteria had been proposed in the late 1990s for evaluating the value of potential information sources. These criteria included timeliness, time efficiency, sensitivity of source, correlation with other sources, objectivity, depth of source (level of detail), elucidation of potential impacts of the technology, specificity of source (identification of only the most important new technologies), and explicitness of limitations.[45] A Delphi study conducted by the UK's HTA program in 1999 ranked the timeliness and the efficiency of searching the sources as the most important criteria for judging the value of a source to a horizon scanning program.[43]

In 2008, NHSC developed another set of criteria to evaluate the value of scanning sources for identification of emerging health technologies. NHSC developed the criteria based on literature review and discussions within the NHSC team. These criteria were piloted on six randomly selected scanning sources. NHSC identified eight of the criteria as being most relevant for assessing the value of scanning sources (in order of priority):[42]

- Coverage—Approximate percentage of relevant information in a source
- Quality of information—Accuracy, objectivity, reliability
- Efficiency of information search—Estimated time to identify one potentially significant health technology or other relevant information

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- Accessibility of information—Level of effort required (e.g., automatic email alerts, Internet sites or email alerts that require link/registration, printed sources/manual scanning)
- Frequency of scanning—Based on how often the source information is updated (e.g., daily, weekly, monthly)
- Cost— Level of annual subscription or registration cost
- Memory or archive
- Contact point provided

NHSC horizon analysts applied the eight criteria to 35 scanning sources that NHSC used at the time and identified seven sources that fell beneath the predefined cutoff. NHSC removed these seven sources from its horizon scanning.

LBI-HTA (2008) also used a similar set of criteria to judge whether a source was suitable for its scanning process.[47] These criteria included the following:
- Timeliness of information (periodic updates)
- Quality of information provided (objectivity, transparency of primary source, and credibility)
- Accessibility (available free or with free subscription)
- Oncology-related content
- Usability (easy to scan, not too time-consuming, electronic alerts, or newsletters available)
- Geographic coverage (international or national coverage)

EuroScan recommended that the sources of information should be reviewed periodically to determine their usefulness (i.e., yielding topics, providing sufficient yield for cost of subscription), where there is overlap, and when other sources are required.[46]

Methods for Filtration

Filtration means consideration of technologies that were found at the identification stage and, by the application of preset criteria, selection of those that are relevant to the health care horizon scanning program.[2] Filtration helps narrow the potential number of technologies to evaluate; EuroScan recognizes it as an individual step in the horizon scanning process.[2] However, not all horizon scanning programs have a filtration step in their horizon scanning process (see Tables 3-7 in Appendix B). According to a survey of 13 EuroScan member horizon scanning programs in 2006, 64% of the programs had a filtration step to discard trivial technologies before the actual selection of technologies.[28]

Filtration could be an implicit process (i.e., mainly taking place in someone's head) or be performed in a formal fashion. Two horizon scanning programs surveyed in the 2006 EuroScan study used a form with predefined questions to consult experts on the novelty of the technology for the health care system, the time horizon of introduction of the new technology in the health care system, and the likely impact of the technology on the health care system.[28] Use of a filtration form can help to ensure consistency of information gathering and application of filtration criteria.[2]

The filtration step should take into account the interests of the stakeholders and the time horizon.[2] EuroScan recommended that health care horizon scanning programs consider asking the following questions at the filtration stage:[2]
- Is the technology appropriate for stakeholders and relevant to the health system?

- Is the technology new/innovative?
- Is the technology a modification of an existing technology, or is it the same technology being used for a new indication?
- Is the technology within the time frame of the horizon scanning system? (The answer may vary depending on technology type and the scope of the horizon scanning system.)
- What is the associated disease burden?
- Are there existing treatments for this condition?
- What are the anticipated clinical, economic, and budgetary impacts of the technology?

NHSC's filtration criteria were dependent on NHSC's agreements with each national decisionmaking body, and generally considered the following factors around timing and innovation:[11,48]

1. The technology is emerging or new to NHSC or is a significant change in indication or use of an existing technology
2. The technology has an innovative quality, such as:
   a. It may be a new drug class or pharmacologic target for the specific patient group.
   b. It may be more effective than current preventive, diagnostic, treatment, or rehabilitative options.
   c. It may have a better risk-benefit ratio than current options.
   d. It may offer improved identification of those who may benefit or be harmed by an intervention.
   e. It may offer significant potential for cost savings or expenditure if fully adopted.
   f. It may require significant service reorganization for optimum use.[48]

For pharmaceutical and nonpharmaceutical technologies, the NHSC filtration criteria are slightly different. The filtration criteria for pharmaceuticals in development include

- time to license and
- the presence of innovation in relation to current treatment options or patient outcomes.[11]

The filtration criteria for nonpharmaceutical topics include

- time to licensing,
- innovation, and
- the potential to have a significant impact on health outcomes and/or resources.[11]

Each national decisionmaking body's input was sought in the filtering process. Any technology that passes the relevant customers' filtration criteria was selected for further investigation. Wherever possible, information was sought from the relevant commercial developer and/or distributor, and a very limited search of a small number of other sources was undertaken.[11]

Methods for Prioritization

Due to limited resources and time, it is infeasible for a health care horizon scanning program to assess all target technologies identified. Methods must be developed for selecting those technologies that are in most urgent need of evaluation.[43] The general objective of the

prioritization effort in horizon scanning is to define the potentially most significant emerging technologies in which to invest scarce assessment resources.[41] Because the process of selecting technologies by agreement is susceptible to subjectivity, EuroScan recommended using some tools to enhance accountability in the selection process. These tools may include use of a checklist of explicitly defined prioritization criteria and documentation of the decision-making process.[41]

Some horizon scanning programs are commissioned to assess all new health technologies proposed as the prioritization has been or will be undertaken by stakeholders.[2] For other horizon scanning programs, EuroScan recommended constructing a set of predefined prioritization criteria based on the requirements for the stakeholder or customer.[2] Technologies must satisfy one or more of these criteria before being accepted for further consideration or assessment. Otherwise, the technologies will be put on a list for monitoring.

Prioritization criteria that EuroScan recommended that horizon scanning systems consider include the following:[2]

- Patient group related—number of patients/size of group (prevalence/incidence), burden of disease, current options for patients
- Potential impact
    - Patient (e.g., impact on morbidity, mortality, quality of life, diagnosis)
    - Cost (increased costs or savings, large capital outlay, direct and indirect costs for patients and society)
    - Service/organizational (e.g., increased or decreased use, service reorganization, structural changes, staff training)
    - Societal (e.g., ethical issues, controversial methods)
- External emphasis—policy-related, patient groups, experts
- Potential for inappropriate diffusion given available evidence—too fast, too slow, and misuse

In 2006, EuroScan surveyed its 13 member programs to understand how these programs prioritized emerging technologies for further assessment. Two programs mentioned that they had attempted to use formal priority-setting methods (i.e., a method in which criteria were scored and weighted, with a final ranking achieved on the basis of decision rules).[28] However, both programs had stopped using these formal methods. One program found that the lengthy procedure, including use of Delphi panels, did not fit the agency's conditions. The other program judged that the experts involved in the prioritization process would need more training and time to get accustomed to the scoring and weighting criteria. As a consequence, the program used the prioritization instrument only as a checklist.[28]

The 2006 EuroScan survey also found that eight (73%) of its member programs used explicit criteria for prioritization, two programs used a combination of explicit and implicit criteria, and one program used implicit criteria.[28] Of those programs using explicit criteria, one exclusively used the EuroScan criteria, but all other programs had developed their own criteria. However, the EuroScan criteria were usually well represented in the criteria developed by the individual programs. Only a minority of EuroScan members used a criterion of cost-effectiveness. The number of criteria used to select technologies ranged between 3 and 13. The median number of priority-setting criteria mentioned by the horizon scanning programs was six. The most popular criteria used included costs (at the population level); health benefits (at the population level);

organizational consequences of the technology; rate of diffusion of the technology; ethical, legal, and social aspects; and the number of patients involved.

No EuroScan members surveyed in 2006 mentioned weighting criteria explicitly, but several indicated that some criteria were considered more important than others.[28] Few members had operationalized individual criteria beyond expressions such as "large," "major," "obvious," and "far-reaching." Two members had operationalized "number of patients" (relevant = more than 1,000), and one operationalized "costs per patient" (high = more than €10,000; low = less than €500), and "cost impact" (high = more than €10 million; low = less than €1 million). For almost all health care horizon scanning programs, the process was described as subjective, and it was unclear whether prioritization criteria had been applied systematically and consistently during the process.

The survey also revealed that experts with diverse backgrounds were typically used in the prioritization process. These experts might include clinicians from relevant clinical specialties, policymakers, and other health care stakeholders (e.g., industry representatives).[28] The final decision on which technologies to assess was made by the horizon scanning group or the HTA agency that hosted the horizon scanning system (45%) or was delegated to experts (55%). All horizon scanning systems being surveyed made the prioritization decision based on agreement by consensus and did not experience any difficulties in arriving at a consensus. The process of deciding on technologies for assessment was documented in only one horizon scanning system. This horizon scanning system documented afterward which criteria had been taken into account and to what extent these had been discussed in a priority-setting meeting.

In 2009, the European Network for Health Technology Assessment (EUnetHTA) developed criteria for prioritizing emerging health technologies topics for a newsletter it was piloting.[41] This scoring system used the following criteria:

1. Is this an innovative therapy for a condition with no satisfactory standard treatment?
2. Is there potential for a significant health benefit to the patient group if the technology reaches its potential?
3. Is there potential for inappropriate diffusion (too fast or too slow) or inappropriate use of the technology?
4. Is there potential for a significant cost impact if the technology is diffuses widely?
5. Will significant service reorganization, purchase of equipment, or staff training be required?

For each question, the answer could be Major, Moderate, Minor, Uncertain, or Unknown. The scores assigned to these answers are 2, 1, 0, 0, 0, respectively.[41] Using this scoring system, EUnetHTA selected topics for articles in the newsletter's pilot issue. While this EUnetHTA scoring system, as well as the prioritization criteria, were not developed for a health care horizon scanning program, they may be worth considering for horizon scanning programs developing their own prioritization methods.

In 2010, Pluddemann and colleagues developed criteria for the selection of new diagnostic technologies for in-depth assessment or implementation.[49] The research team used a two-round Delphi process to gain consensus among an international panel of 26 experts. Participants represented a range of health care and related professions, including government, industry, health services, and academia. Based on the responses to the questionnaires and discussion among the experts, 16 criteria were chosen and placed into two categories: high (seven) and intermediate (nine) priority. Criteria in the high priority category include:

1. The technology has potential to affect morbidity and/or mortality of the disease or target condition.
2. The new technology reduces the number of people receiving a false diagnosis of the disease or target condition.
3. Improved diagnostic precision using the technology would lead to improvement(s) in treatment (e.g., shorter time to initiating treatment, reduction in morbidity or mortality).
4. The new technology improves the ability to rule out the disease or target condition.
5. The disease or target condition to which the diagnostic technology will be applied can be clearly defined.
6. There is evidence of test accuracy in the setting in which the new diagnostic technology will be applied.
7. The new technology would enhance diagnostic efficiency or be more cost-effective than the current diagnostic approach.

Criteria in the intermediate priority criteria include:
1. The prevalence or incidence of the disease or target condition is high.
2. The accuracy of the current diagnostic approach for the disease or target condition is problematic.
3. Variation exists in treatment or patient outcomes resulting from current diagnostic variability.
4. The current diagnostic pathway for the disease or target condition could be improved by obtaining information in a less risky fashion or in a manner more acceptable to patients.
5. The safety profile of the new technology has been established.
6. The technology improves the ability to "rule in" the disease or target condition.
7. The new technology has a clearly defined role in the diagnostic pathway (e.g., replacing an existing test, as a triage tool, after the diagnostic pathway as an add-on test).
8. The disease or target condition is highly relevant to current regional or national health policies and/or priorities.
9. It would be feasible to change current practice to incorporate this technology (e.g., additional training, infrastructure, quality control).

The authors developed prioritization criteria specifically for diagnostic technologies based on the consideration that the existing prioritization methods were developed primarily for therapeutic interventions and might not apply to diagnostic technologies.[49] For example, the prevalence or incidence of a disease, a primary criterion listed in many existing prioritization frameworks, might carry less weight for diagnostic tests. A test for a relatively uncommon disease (e.g., pancreatic cancer) may still be important.

The prioritization methods used by the health care horizon scanning programs that we identified are provided in Tables 2 through 7 in Appendix B. Prioritization criteria differ significantly across these systems. The differences in the nature and number of prioritization criteria may reflect the differences in values, cultures, and health care priorities in different countries. For example, in some countries, cost containment may be the highest priority, whereas in other countries, faster access to modern treatment may be an important policy goal as well.

Methods for Assessing Emerging or New Technologies

Assessing or predicting potential impacts of emerging technologies is an important activity that horizon scanning systems perform. Such programs may have a variety of stakeholders, such as government-sponsored health technology assessment agencies, research organizations, health care financing bodies, technology regulators, provider groups, and health care facilities. Depending on their stakeholders' interests and needs, health care horizon scanning programs may produce different types of assessments. EuroScan members frequently produce the following types of assessments:[2]

- Rapid assessment—one-page brief overview that is usually conducted within 24 to 36 hours in response to a specific request from a stakeholder.
- Brief overview—a more in-depth but still brief overview taking approximate 0.5 to 2 weeks and four to six pages in length. The assessment typically includes background on the technology, information on how it works, the clinical burden of the disease, current comparators, safety and effectiveness, costs, and social, ethical, and legal concerns.
- In-depth assessment—a review of more than 40 pages that may take approximately 12 weeks to produce. This type of assessment is not a systematic review but a rapid or focused assessment.

EuroScan recommends using an assessment template that will remain unchanged across different topics. The template may cover the following areas:[2]

- Technology-related information: name, description, mode of administration, dose range, company or developer, stage of development, type (e.g., drug, device), use (e.g., therapeutic, diagnostic), and licensing/reimbursement plans.
- Patient- and setting-related information: indications, specialty, patient numbers, setting for technology use, alternative or complementary technology, and current technology.
- Impact predictions: health impact predicted diffusion; cost, infrastructure, and economic consequences; and ethical, social, legal, political, and cultural impact.
- Evidence and policy: clinical evidence and safety, economic evaluation, ongoing research, and ongoing or planned HTA.

A recent comparison of the 20 EuroScan member programs identified several areas, as follows, that were most commonly covered in horizon scanning information products (the number and percentage of agencies covering the area are listed in parentheses):[29]

- Potential for significant health service impact (17, 85%)
- Safety and efficacy (18, 90%)
- Assessment of clinical effectiveness (15, 75%)
- Assessment of cost effectiveness (9, 45%)
- Other impacts (e.g., legal, social, ethical (4, 20%)

EuroScan also recommends developing a search strategy with a level of comprehensiveness appropriate to the type of assessment (i.e., rapid, brief, or in-depth assessment). The specific guidance EuroScan provides includes:[2]

- Assessment resources will include the topic source (e.g., journal, news alert, industry, expert).
- Search the EuroScan database to ascertain whether any other programs have also identified the technology.

- Conduct a brief search for additional material (background, safety, and effectiveness). MeSH terms from the original topic source may be useful for this.
- Identify recent publications by using databases, including MEDLINE, PubMed, and EMBASE.
- Pharmaceutical searches include:
  - industry databases (e.g., Pharmaprojects, Adis),
  - registration and licensing sites (European Medicines Agency for orphan drug designations, EudraPharm for authorized products, Scottish Medicines Consortium, FDA, Canadian Common Drug Review), and
  - relevant scientific conferences (e.g., American Society of Clinical Oncology)
- Consult databases on ongoing clinical trials (e.g., World Health Organization International Clinical Trials Registry, Current Controlled Trials, Clinical Trials.)

EuroScan also recommends using standard evidence assessment methods (e.g., specifying criteria for selecting studies, conducting study quality assessment, and grading the level of evidence) whenever possible for early assessment of technologies.[2]

Because of the rapid nature of horizon scanning, the assessments of identified technologies are typically not exhaustive and are often based on a limited quantity of low-level evidence.[50] They aim at informing decisionmakers and are not definitive assessments of the safety, effectiveness, ethical considerations, or cost effectiveness of a technology.[50] Prediction of potential diffusion patterns or impacts of emerging technologies may often require watchful waiting.

To assess or make predictions about emerging technologies, some health care horizon scanning programs used a group of experts with diverse backgrounds. When experts are used in the horizon scanning process, the selection of experts and the way they are accessed are important issues. While opinion leaders in the area of interest can be considered "experts," it is unclear exactly what constitutes expertise in relation to forecasting the impact of new technologies, and more research into which experts to select would therefore be needed.[24]

Common techniques used for eliciting opinions from experts include use of surveys, focus groups, email discussion, or formal Delphi exercises. The Delphi exercise is an iterative method of achieving consensus in which participants receive a series of statements, rank their level of agreement, receive feedback on the results of the rankings, and then re-rank the statements in response to the feedback. Focus groups were felt to be a more labor-intensive method to adopt but might be used preceding Delphi exercises.[43] The Delphi method has been reported to be used or piloted in some technology foresight exercises.[51] A study conducted in 2000 analyzed three Delphi exercises for technology forecasting conducted in Germany, UK, and Austria. The study found that, for all three countries, consensus and conclusions were successfully reached on general trends about innovations in medicine and sociomedical services.

From 2007 to 2008, FDA's CDRH used a modified Delphi process to project major trends in emerging medical device technologies over the next 10 years. CDRH's method combined the Delphi methods with an initial interview of 15 nonfederal experts in medical device technologies, several rounds of iterations to define trend themes, and a 1-day workshop for interactive discussion.[33] The Delphi method has also been used to aid national investment in technology development—health care and non–health care—in Japan since the 1970s.[52]

In addition to the Delphi method, nominal groups or other techniques may also be used to help an expert group reach consensus and improve the accuracy of a prediction. However, our

literature review did not find any health care horizon scanning programs that reported using these techniques.

Methods for Predicting Impacts of Technologies on a Specific Aspect of Health Care

During our search and review of literature, we identified several studies that described or piloted a method for predicting impacts of new or emerging technologies on one specific aspect of a health care system (e.g., impacts on health benefit, hospital length of stay, utilization, cost). Although our search did not identify any health care horizon scanning program that had actually used these methods, we felt that the methods could potentially be useful to AHRQ's Health Care Horizon Scanning System, and we therefore summarize them in this section.

In 2005, Simpson and colleagues developed a framework for use by early warning systems to predict the impact of new health technologies on average length of hospital stay.[53] Through literature review and input from EuroScan members, they concluded that new health technologies have a variable impact on individual and average length of stay. For example, certain technologies may allow patients with less severe disease to be treated as outpatients, resulting in a shift in the inpatient case mix to sicker patients, and leading to a longer length of stay. Conversely, if a new inpatient treatment with less risk than current options extends treatment to a population with less severe illness, the result could be a lower average length of stay given the likelihood that healthier patients will be discharged sooner.

In 2010, Guthrie and Markland published a paper describing an approach implemented at AstraZeneca (London, UK) to forecast the commercial success of new pharmaceutical products. The approach used group assessment of the uncertainties for new products developed at AstraZeneca with long development times. AstraZeneca brand teams were first asked to develop base-case forecasts and then complete day-long workshops to assess the upside and downside uncertainties surrounding the base-case forecast. During the workshops, the assumptions underlying the base-case forecasts, which generally tended to be overly optimistic, were challenged and a broad-based picture of the uncertainties, potential outcomes and their likelihood of occurrence, and impact on eventual product sales were discussed. The discussions are supported by Monte Carlo simulation models, and the results are displayed in graphics.

AstraZeneca's workshop approach is similar to scenario planning, a forecasting method commonly used in business management, in that both methods attempt to describe possible futures.[54] However, differences also appear between AstraZeneca's workshop approach and traditional scenario planning. One of the challenges of scenario planning is that only a limited number of scenarios can be managed, especially when many assumptions make up the future scenario. Therefore, the scenario approach typically looks to limit the number of variables under consideration. In comparison, AstraZeneca's approach sought to identify all the relevant sources of uncertainty and group similar sources of uncertainty around outcomes. This approach did not try to identify a specific set of alternative scenarios but rather asked participants to look at each assumption and explore the alternatives separately. As the authors discussed, this might be a weakness of the approach, as one assumption may have a downstream impact on another assumption. However, the independence assumption might allow the forecast team to explore more possibilities and potentially identify uncertainties that might, at first, appear more certain or have less impact. The AstraZeneca approach might be useful for horizon scanning programs in making predictions regarding the adoption of emerging technologies in clinical practice.

One study published in 2011 attempted to predict the future impact of emerging technologies on hepatocellular carcinoma (HCC).[55] This study surveyed 120 clinician experts in 10 different

countries to explore their views on potential impacts of 11 emerging technologies on HCC outcomes in the next 5 to 10 years. The 11 technologies were identified before the survey through qualitative research. The experts' views were studied using best-worst scaling. The experts were asked to identify those technologies that they think will have the most and least likely impact on HCC outcomes within 5 to 10 years. A statistical analysis of the survey data revealed the technologies considered by the surveyed experts to have the most or least impact. Technologies considered to have the most impact included early detection of HCC, molecular targeted therapy, genetic/genomic biomarkers, hepatitis C vaccination, and stem cell therapy. Technologies considered to have the least impact included adjuvant/neoadjuvant therapies, interventional radiology, biopsy-free HCC diagnostics, transplant technology, improved surgical techniques, and immunomodulation. This study concluded that preference-based methods, such as best-worst scaling, are valued tools in understanding differences in opinions about the likely impact of emerging medical technologies. Horizon scanning programs could use these methods to predict the impact of technologies on health outcomes.

Another study published in 2011 used a case study approach, which involved bibliometric analysis and the Bass diffusion model, to assess the growth rate and market penetration of pulsed electromagnetic field (PEMF) therapy as an emerging biomedical technology.[56] The study simulated the penetration and growth rate of user acceptance of the technology in a global context across a 15-year period. The authors concluded that technology diffusion traces exist for PEMF therapy technology, as is evident from the bibliometric PEMF global data presented. The study demonstrated the possibility of simulating the PEMF technology diffusion process with a Bass diffusion model. This model might be used by horizon scanning programs in predicting the diffusion pace of other technologies.

During our literature review, we also identified several studies discussing methods that health care managers use for long-term planning, such as scenario-building methods to predict disease burden and predictive modeling to identify high-risk patients.[57,58] As mentioned in the Methods chapter, we did not attempt to summarize those studies. In addition, we identified a review article that summarized common methods for early assessment of medical technologies, including use of interview or surveys to solicit opinions from experts and patients, building scenarios, and quantitative modeling.[59] These methods have already been discussed in this chapter.

We also attempted to identify technology forecasting or prediction methods used in non-health-care sectors that may be useful to AHRQ's horizon scanning program. As explained in the Methods chapter, we primarily relied on the input from experts and a manual search of the reference lists of the included health-care-focused publications to identify these methods. Particularly, we attempted to identify any methods that had not been mentioned in health-care-focused literature.

Our search identified two studies that we felt provided an excellent overview of technology forecasting methods in non-health-care sectors.[60,61] These forecasting methodologies generally fall into four types: judgmental or intuitive methods, extrapolation and trend analysis, models, and scenarios and simulations.[60] Judgmental or intuitive methods rely on opinion to generate a forecast. These methods include solicitation of experts' opinions and the Delphi method. It appears that judgmental or institutive methods were the major methods that existing health care horizon scanning programs used. Other methods (i.e., extrapolation and trend analysis, modeling, scenarios and simulations) had been used for health-care-related forecasting (e.g., strategic planning, insurance premium setting), but were rarely used in horizon scanning programs. This might be because the methods are more time-consuming and do not fit fast-paced horizon

scanning programs (which typically need to assess a very large number of topics in a short period of time). We brought these methods to the expert panel meeting for further discussion about whether they could fit in health care horizon scanning (see the summary of the expert panel meeting later in this chapter).

Methods for Disseminating Information

A dissemination strategy is a vital element of a health care horizon scanning program that ensures the information produced reaches the appropriate audience in a timely fashion. This strategy should be based on stakeholders' interests and needs.[2]

Based on the data we collected (see Appendix B), the common methods used by health care horizon scanning programs to disseminate horizon scanning products include:

- Directly delivering the products to the stakeholders via email or other channels
- Making the horizon scanning products available on the Internet—either publicly available or on a password-protected site
- Sharing with other health care horizon scanning programs (e.g., EuroScan members)
- Producing peer-reviewed publications or presenting the findings in other academic venues

This observation echoes the findings of a recent survey of EuroScan members. The survey found that, among EuroScan member agencies, horizon scanning products were disseminated by email (70% of the agencies), Web sites (50%), paper versions (30%), and medical journals (5%). Some reports were for internal use only and were not disseminated externally (10%).[29]

EuroScan recommends using a structured method to disseminate horizon scanning products.[2] EuroScan's recommended specific strategies include:

- Establishing an email list. Ideally, this should be an automated list to reduce management time. RSS feeds could be considered.
- Maintaining an up-to-date Web site for "publishing" new material.
- Creating newsletters on key/significant technologies.
- Joining and actively participating in EuroScan activities.

Methods for Evaluating Health Care Horizon Scanning Programs

Our search and review of literature did not identify any studies that systematically evaluated the overall performance of a health care horizon scanning program. However, we identified two studies that evaluated the accuracy of a prediction made by a horizon scanning program.

In 2004, Simpson and colleagues studied the accuracy of the NHSC's prediction methods in a way similar to the evaluation of diagnostic tests.[24] The study investigated the accuracy of predictions that NHSC made in the period 1997 to 1999. A stratified random sampling of the 610 technologies from six target clinical specialties—cardiology, diabetes, neurology, oncology, rheumatology, and obstetrics and gynecology—that NHSC identified was used for analysis. The sensitivity, specificity, and predictive values of NHSC's prediction methods were estimated with reference to expert opinion of the impact 3 to 5 years after prediction. The study found that the sensitivity of predictions was 71% (95% CI, 0.36–0.92), the specificity was 73% (95% CI, 0.64–0.8), the negative predictive value was 98% (95% CI, 0.92–0.99), and the positive predictive value was 14% (95% CI, 0.06–0.3). The authors concluded that NHSC methods were

"reasonably good at identifying lower priority developments, but tended to assign significance to more topics than the experts considered significant in their later practice."

This NHSC study provided a fresh approach to evaluating the performance of the prediction methods used by a health care horizon scanning program. However, as the authors discussed, their approach should be further investigated because measuring the accuracy of the prediction methods used by a horizon scanning program is difficult.[24] The lack of a gold standard for the comparison makes it challenging to perform quantitative assessment of the accuracy of predictions by a health care horizon scanning program. Meanwhile, health care horizon scanning programs may themselves influence the impact of a technology because they may have helped to increase or decrease diffusion of the technology. The authors further pointed out that health care horizon scanning programs are unlikely to ever be completely accurate. Given that only a small percentage of the hundreds of new technologies developed and marketed each year ultimately have a major impact on health services, it is important that the method of forecasting identifies these most significant technologies.[24]

In another study, researchers investigated the accuracy of the prediction made by six Danish oncology experts using an approach similar to that of the NHSC study.[23] In 2000, the experts were asked whether a sample of 19 new anticancer drugs would affect Danish health care over the next 5 years. In 2005, the accuracy of their predictions was assessed. The specificity, sensitivity, negative predictive value, and positive predictive value of the Danish experts' prediction was 100% (95% CI, 0.74–1.00), 63% (95% CI, 0.31–0.86), 79% (95% CI, 0.52–0.92), and 100% (95% CI, 0.57–1.00), respectively. The authors reached the following conclusions:

- Clinical experts have the ability to predict which new anticancer drugs are unlikely to have an impact.
- As the experts missed 37% of drugs that had an impact, they should not be relied on to select drugs relevant for evaluation.
- A positive predictive value of 100% appeared to be a good result for a test, but this is influenced by a high prevalence (42%) of drugs that actually had an impact on the Danish health system.[23]

Similar to the NHSC study,[24] the Danish study also lacked gold standards for comparison. Consequently, the study findings are difficult to validate.

We did not identify any other studies that evaluated the performance of a health care horizon scanning program. It is unclear what kind of study should be conducted and what measurements should be used to evaluate the overall performance of a horizon scanning system. It can be difficult to evaluate the value of a health care horizon scanning program to policymakers. Sometimes, policymakers need to know only that an intervention is about to diffuse; an early, but possibly unsound, prediction of impact is less useful.[46] The value of a horizon scanning system for health technology assessment purposes should be judged by the extent to which it facilitates timely research-based evidence on new technologies.[43] The value of a health care horizon scanning program for controlling the diffusion of new technologies should be judged by whether it helps promote the adoption of proven effective technologies or slow the adoption of unproven technologies.[62] The value of a health care horizon scanning program for prioritizing topics for research investment might need to be judged by whether it improves return on investment for the research program.[63]

Input From the Expert Panel

This section is a summary of the expert panel meeting for the AHRQ Health Care Horizon Scanning System. As described in the *Methods* section, an expert panel was organized for this study to collect additional information on horizon scanning methods and seek input for revising the protocols for the AHRQ Health Care Horizon Scanning System. More than 30 panel members from the U.S. and abroad attended the expert panel meeting held June 8-9, 2011, at AHRQ's campus in Rockville, Maryland. The panel included individuals who have experience in the development and implementation of horizon scanning programs, as well as the users of these programs (e.g., clinicians, payers, policymakers, venture capital and investment firms, market research firms). We will provide a full list of experts who attended the panel in the final version of this report.

During the panel meeting, the ECRI Institute team presented the preliminary findings of this systematic literature review of horizon scanning methods. The team also presented the protocols that had been implemented for the AHRQ Health Care Horizon Scanning System since the start of the program. Five panel members from international horizon scanning programs, two staff members from the AHRQ Health Care Innovation Exchanges, and a researcher from the Lewin Group gave presentations. Relevant data from their presentations were incorporated into this systematic review of horizon scanning methods.

Six discussion sessions, as follows, on a variety of issues related to horizon scanning followed the presentations:

1. Construction of a horizon scanning system addressing key stakeholders' needs
2. Useful sources for identifying emerging technologies and process innovations
3. Approaches to filtering and prioritizing identified technologies and process innovations
4. Methods for predicting potential impacts of emerging technologies and process innovations
5. Dissemination and Updating of horizon scanning information
6. Evaluation of horizon scanning programs

This document summarizes the discussions among the panel members and the horizon scanning team and is organized by the main subjects of the six sessions.

1. Construction of a Horizon Scanning System Addressing Key Stakeholders' Needs

Regarding the stakeholders and goals of its Health Care Horizon Scanning System, AHRQ made the following clarifications:

- The primary stakeholders of its horizon scanning program are funders of patient-centered outcomes research, such as AHRQ, the National Institutes of Health (NIH), and the Patient-Centered Outcomes Research Institute. The horizon scanning program is intended to guide these stakeholders in identifying topics that may potentially have a significant impact, and thus should be a high priority for research funding.
- The horizon scanning program also considers other public or private entities (e.g., FDA, CMS, private funders, technology manufacturers), as well as the public at large, as its stakeholders. The information that the program generated is intended to

help these stakeholders anticipate what is coming far enough in advance so that they can make necessary preparations.

- The horizon scanning program covers not only drugs, health devices, and medical procedures, but also health care delivery innovations and programs, such as programs for lifestyle changes. Off-label use of regulated medical technologies is also within the scope of work. However, the program would not cover laboratory-developed tests (LDTs) because LDTs (e.g., laboratory-developed cancer and noncancer genetic tests) had already been, or will be, covered by other projects funded by federal agencies, including AHRQ, CMS, and NIH.

In general, the expert panel agreed that the AHRQ Health Care Horizon Scanning System had set the goals appropriately and would serve its stakeholders well by providing useful input to their decision-making process related to funding research or other business activities (e.g., capital equipment planning). The panel suggested the horizon scanning program to carefully balance the needs of different stakeholders that may potentially be conflicting in terms of what they want the horizon scanning program to achieve and the time horizon relevant to their decisions. The panel also encouraged AHRQ to collaborate with other horizon scanning programs in the world to minimize potential duplications of efforts. When using the content produced by other horizon scanning programs, the AHRQ Health Care Horizon Scanning System may need to make appropriate customization to ensure the content to fit the program's unique needs.

2. Useful Sources for Identifying Emerging Technologies/ Innovations

In the second discussion session, the ECRI Institute horizon scanning team first provided an overview of the approach to identifying emerging technologies/innovations that had been used since the program's start. In brief, the ECRI Institute team had used about 100 selected sources to identify leads to potential target technologies. The sources cover a wide spectrum, from peer-reviewed journals to Internet blogs (the horizon scanning program's protocols list the sources). The team continually added and dropped sources based on their usefulness. During the discussion, the panel members suggested some sources that they thought the ECRI Institute team should consider. Most of these sources had already been used by the ECRI Institute team to identify target technologies.

Overall, the ECRI Institute team attempted to cast a wide net to capture as many target technologies as possible. While the team's approach was rather thorough in terms of finding the information potentially relevant, it was resource-intensive and may not have been efficient. The panel members offered the following suggestions to improve the efficiency of the search effort:

- While the ECRI team still needs to search a broad range of sources, the team may consider focusing on a smaller number of key journals to improve the efficiency of the search for "real innovations" that may ultimately diffuse into clinical practice. For the same reason, the search effort should focus more on technologies with less uncertainty for reaching the market (e.g., those in later phases of development).
- The ECRI team needs to continue tracking useful sources and those that are a distraction and update the list on a regular basis.
- As long as the budget is available, the ECRI team may continue using existing commercial, subscription-based databases (e.g., Thomson Reuters Pharma™) to help

reduce time and number of people required for information searches. However, the team should be aware of the potential data inaccuracy or lag of information (behind original sources) in these databases and should not rely exclusively on such databases.

- Directly seeking information from developers or companies may help the ECRI team to efficiently identify technologies that are most likely to receive commercial license or approval and ultimately emerge on the horizon. A database of pipeline products of manufacturers could be useful for horizon scanning. Due to the conflict-of-interest concern, some mechanisms or tools need to be used to gauge and track the informants' credibility. This approach may require a large amount of time and thus may not fit the timeframe for the current AHRQ's horizon scanning project.

The panel also provided suggestions on how to identify care delivery innovations, a unique challenge faced by the AHRQ Horizon Scanning System. These suggestions include:

- Innovations can mean different things to different people depending on organizational and other contextual factors. The ECRI team may consider using the AHRQ Innovations Exchange program's definition and criteria to determine whether a change in a health system would be considered an innovation.
- Often, it is difficult to differentiate "innovation" from "improvement." The major distinction between the two concepts has to do with the degree of discontinuity or break with usual thinking. Therefore, any assessment of innovativeness must take into account what is being changed and what is being left untouched compared to the status quo. The deeper the discontinuity or break with past paradigms, the more innovative the idea.
- Use of a jury of peers or an expert panel or scoring of proposed innovations may help assess the degree of discontinuity. Since this assessment is context-specific, it is critically important to specify the context that is being used in the assessment of the innovation.
- Using multiple sources to identify leads for emerging innovations. These include monitoring health care publications and various Web sites, attending conferences, relying on word of mouth from colleagues, and maintaining contacts within AHRQ. Particularly, the AHRQ Health Care Innovations Exchange program should be used as an important source of information.

3. Approaches to Filtering and Prioritizing Identified Topics

Filtration is a phase of horizon scanning in which preset criteria are applied to narrow the potential number of technologies to evaluate. The expert panel provided the following input on the methods for filtering topics identified in the initial stage of horizon scanning:

- The filtration criteria that AHRQ Horizon Scanning System uses should be accountable to its key stakeholders and transparent
- In addition to AHRQ's prioritization of 14 clinical areas as a criterion, the ECRI team may consider using additional filtration criteria to determine which topics identified should move on to the next stage of horizon scanning for further research. To make the determination, the horizon scanning analysts ask two key questions: 1) Does the topic purport to address any unmet needs from the perspectives of patients and the

general public? 2) Is there something new or innovative about the technologies or interventions?

- There are many incremental changes in existing technologies or care delivery methods. Sometimes, these incremental changes may reach a tipping point where an "old" technology starts to have a significant impact and be viewed as an innovation or something new. Often, it is not easy to find objective criteria or signals to identify the tipping points.
- To judge whether a topic identified should move on for further research, asking a more basic question might be helpful. This question is: "Is this technology, indication, or method going to be relevant to patients and clinicians?" As long as it is relevant to patients and clinicians, in that they might end up using it, the technology is worth tracking.

Within each of AHRQ's 14 priority areas, the ECRI Institute team needs to prioritize the topics that have passed the filtration phase and select as many as 20 topics of potentially high impact for further assessment. The expert panel made the following suggestions on the methods for prioritizing topics:

- The method and criteria used for topic prioritization should depend on the needs of the key stakeholders for the horizon scanning program (i.e., what concern these stakeholders the most) and be transparent.
- The AHRQ Health Care Horizon Scanning System could potentially use a broad range of criteria for topic prioritization. These criteria include the size of the affected population, burden of illness, acuity or severity of the disease, impacts on health outcomes, cost or resource consumption, and the likely time frame for the technology being commercialized or otherwise incorporated into practice.
- Soliciting input from informants or experts could potentially increase the objectivity of the prioritization process and ensure that the needs of the key stakeholders would be better met. The informants or experts could include clinicians, health organization administrators, payers, policymakers, engineers, technology developers or manufacturers, and patients. It could be a labor-intensive process to get the informants committed, to get their comments back once they had committed to provide them, and to synthesize the comments by different experts on each topic.
- The ECRI team may consider various options on the Internet (e.g., social media and SharePoint sites) to solicit input from the public or health care professionals for collecting information and prioritizing or assessing emerging technologies. However, setting up a Web site for input and abstracting data from a potentially large volume of public comments could be very time-consuming and may not be feasible for the AHRQ horizon scanning program under its current time frame.

The expert panel also provided valuable input for revising an online instrument for soliciting expert opinions that had been piloted by the ECRI Institute team in the initial phase of the program.

4. Methods for Predicting Potential Impacts

Since one of the AHRQ Health Care Horizon Scanning System's main purposes is to provide input to CER funders, it is essential to assess or predict future impacts of the technologies so that

the research funder may set funding priorities based on the assessment. However, due to lack of data or the uncertainty of data, it is challenging to assess the impacts of technologies that are still in the early stage of development. In the panel meeting, various methodologic issues regarding the assessment and prediction were discussed.

Use of Experts

Input from expert informants is an important element that the program considers when forming opinions about the potential for an emerging technology to work, be adopted, and have significant impact. The expert panel provided valuable suggestions on finding appropriate expertise for assessing potential impacts of emerging technologies. These suggestions include:

- It is possible to find experts on specific topics via using professional services provided by commercial expert networks (e.g., Guidepoint Global) or recruiting via specialty societies. However, recruiting clinical experts through commercial expert networks could be more expensive and may not be feasible for AHRQ's Health Care Horizon Scanning program.
- It is sometimes possible to get a large number of clinical experts to provide input on some topics on a volunteer basis, but the horizon scanning program needs to ensure that these experts will not be burdened by the workload (e.g., not asking them too many questions on a single topic).
- Experts' opinions should not substitute for comprehensive, proactive searches of other sources of information. The "herd mentality" that potentially exists among experts could sometimes have a negative impact on the team's capacity to identify innovations that these experts have not noticed.
- The ECRI Institute team should not overly rely on academic experts who may not always be the right people for seeking information or opinions on adoption of new technologies. The predictive value of the input from well-known academic experts could sometimes be inferior to other sources.
- Building a database of experts appropriate for specific topics might be helpful to the AHRQ horizon scanning program in the long run. The program may use tools to document which experts consistently provide information that is useful and, based on the record, updating the expert pool periodically.
- Potential conflict of interest is an important factor to consider in selecting expert informant. Some informants (e.g., the developer of a new technology) who apparently have conflict of interest may have unique insights.

Use of Quantitative Modeling

During the meeting, the panel discussed the potential role that quantitative modeling could play in horizon scanning. In the health care field, quantitative models have been used to predict utilization, cost, and sometimes, outcomes of technologies. Among the experts, there are two main concerns about the utility of using quantitative modeling in AHRQ's horizon scanning program:

- First, the prediction accuracy of these models could be difficult to validate, particularly in a timely fashion. Quantitative models largely rely on the assumptions the modeler makes. The uncertainty in the assumptions regarding emerging technologies—particularly those for technologies in very early phases of development—could be too high.

- Quantitative modeling is generally time-consuming and expensive. It is not possible to apply the method to hundreds of topics that the AHRQ horizon scanning program covers. Application of the method to a few topics may have very limited value for improving the overall performance of the horizon scanning program.

On the other hand, some panel members posited that quantitative modeling could be very helpful to the AHRQ Health Care Horizon Scanning program. The main reasons behind their position include:

- Quantitative modeling would provide valuable input to stakeholders to reduce uncertainty in their decision- making process. Although modeling results may not always be accurate, sensitivity analysis—including providing a range of possible outcomes—could help decisionmakers see the best- and worst-case scenarios and judge whether all possible outcomes would reach the threshold that tips the decision one way or the other.
- The intelligence and insight developed during the modeling process could be valuable for stakeholders. This intelligence and insight may include the assumptions that were made for the model, the parameters (e.g., the target population of the technology) that were defined, the data sources used, and other lessons learned during the iteration process.

During the discussion, the panel members also made other comments or suggestions for using quantitative modeling in horizon scanning, including the following:

- As the main client of the modeling work, AHRQ needs to inform the modeling team about the specific needs or purpose of the modeling task because choice of models in part depends on what question AHRQ wants to answer. The accuracy of the prediction also depends in part on the granularity of the prediction that the client requests. For example, a prediction on whether a cancer drug would have *any* impact on patients' health would have a better chance to be correct than a prediction on a specific health outcome of a drug-eluting stent.
- The prediction's accuracy depends on the availability and quality of data. Quantitative modeling may not be appropriate for making predictions on technologies that are too early in their development cycle (e.g., pharmaceutical products in phase II trials) due to paucity of data and high uncertainty in the findings from early studies.
- Devices, diagnostics, or unregulated innovations (e.g., surgical procedures, care delivery methods) tend to become available in clinical practice in the U.S. based on the evidence from studies equivalent to phase II trials for pharmaceutical products. Potentially high uncertainty in data makes modeling regarding these devices or innovations more challenging.
- It is important to acknowledge the uncertainty in the prediction made with quantitative modeling and explicitly communicate to the stakeholder the limitations of modeling.
- Seeking input from external experts may potentially help reduce the uncertainty in the modeling process and thus improve the model's performance. These experts could be engaged at various stages of modeling, from making assumptions and defining parameters at the beginning to peer reviewing the results at the end.

Other Issues Related to Assessment

During the panel meeting, other methods for assessing the impacts of emerging technologies were also discussed. One method briefly mentioned was scenario analysis (creating best- and worst-case scenarios), which some forecasters had used to judge whether any changes brought by the new technology would be significant enough to make it worth tracking. Another method discussed was the "technology impact radar" diagram that ECRI Institute uses in its Health Technology Forecast program (a membership-based service, separate from this AHRQ-funded horizon scanning program). The impact radar presents the program's assessment of emerging technologies in five domains: health impact, process impact, financial impact, utilization expected, and time to early adoption. Some panel members found the radar diagram visually appealing and easily understandable.

5. Dissemination of Horizon Scanning Information

The expert panel also provided input on how to disseminate horizon scanning information effectively and efficiently.

- The choice of methods for disseminating horizon scanning information depends on the target audience and how that audience wants the information to be delivered. The formats of the horizon scanning products and the channel by which the products are disseminated should be customized to fit the target audience's needs.
- Since AHRQ's horizon scanning program has multiple categories of audience members (e.g., decisionmakers, patients, clinicians), there might be a need for different types of horizon scanning products and different ways to deliver the products. Horizon scanning products that are intended to target one category of audience may not necessarily be useful to another category of audience.
- When AHRQ posts horizon scanning products online, it should also post appropriate disclaimers stating that it does not endorse or discourage a particular technology and it is simply providing information about the technology. The disclaimers may also need to note that the assessments are often done early in the technologies' lifecycles, when the available evidence is typically of low strength.
- In the long run, AHRQ could consider developing a dedicated Web site to host horizon scanning products. The Web site could feature some tools or widgets for helping disseminate the products (e.g., cross-mapping relevant content in different AHRQ-funded programs). AHRQ could also consider transforming future horizon scanning products into an online database that is searchable by various parameters, such as the technology's name, categories (e.g., a class of drug), phase of development, and targeted clinical conditions. However, development of such online infrastructure is beyond the scope of the current AHRQ horizon scanning project and would require additional funding from the agency or other sources.

The panel also suggested other strategies for disseminating horizon scanning information, including:

- Publishing the information in peer-reviewed journals
- Sending out electronic newsletters
- Linking to specialty organizations or industry groups (e.g., American College of Cardiology, International Society for Pharmacoeconomics and Outcomes Research,

Academy Health) and using their venues (e.g., conferences, Web sites, newsletters) to reach clinical, research, and policymaker audiences

- Linking to other federal agencies (e.g., FDA, CMS, NIH, CDC, AHRQ's Effective Health Care Program, AHRQ Health Care Innovations Exchange Program) to disseminate information to their stakeholders
- Using interactive approaches, such as face-to-face presentations, to reach audiences such as policymakers.
- Engaging experts/informants (e.g., clinicians, health organization administrators, payers, policymakers, and patients) in the early phases of horizon scanning (e.g., identifying and prioritizing emerging technologies) to increase the likelihood of buy-in and "ambassadorship" for the program.
- Sharing the information with international horizon scanning programs. Comparing the topics identified by different programs may provide valuable insight on why some topics were identified by some programs but were not by others.

6. Evaluation of the AHRQ Health Care Horizon Scanning System

Our search of peer-reviewed and gray literature identified few studies on formal evaluation of horizon scanning programs. The panel members from the five international horizon scanning programs confirmed that their programs did not have a formal, structured process to evaluate their performance, although they had used informal mechanisms (e.g., monitoring the number of downloads of the horizon scanning products, surveying users about the utility of the products) to gauge the potential impact of their programs. In the United States, the FDA's technology forecasting team assessed the accuracy of their projections on technology diffusion using a panel of experts to judge how many of the technologies predicted to diffuse into the U.S. market had actually done so 10 years later.

Theoretically, a horizon scanning program can be evaluated in terms of its *structure*, *process*, and *outcomes*. While it is ideal to focus the evaluation on outcomes, it is often challenging to design and conduct rigorous studies for this type of assessment. For example, one of the outcomes of horizon scanning is the projection about whether certain technologies under development will be adopted into clinical practice within a certain time frame. However, due to confounding factors, it is difficult to design rigorous studies to assess the accuracy of the projections. If a certain technology does not ultimately reach clinical practice as predicted, it might be because the horizon system raised a false alarm or because the horizon scanning process or products had affected the diffusion of the technology.

Another outcome of horizon scanning is the projection made on whether an emerging technology will have a "high impact" in the future. However, deciding how to categorize a technology as "high impact" is not always straightforward. First, the impacts of emerging technologies are multidimensional. When we assess a technology's impact, we have to take into account the potential impacts on cost, care delivery, outcomes, safety, ethics, and many other metrics. Second, most horizon scanning programs, including the AHRQ Health Care Horizon Scanning System, have multiple stakeholders that may define or prioritize the impacts in those dimensions very differently.

There are also other challenges specific to the assessment of projection-related outcomes. The accuracy of the projections made by a horizon scanning program can be assessed in the same way that a medical test is assessed, using measurements such as sensitivity, specificity, positive

predictive value, and negative predictive value. To determine the accuracy, the results of the projections need to be compared to the gold standard (e.g., whether the technology is adopted or starts to make "high impact") at the end of the horizon period (e.g., 5 or 7 years later). This type of comparison typically requires followup for a long period of time (in the case of the AHRQ Health Care Horizon Scanning System, seven years from the projections being made) and would be infeasible to apply to our initial evaluation task, which must be completed by the end of August 2013. Although it is possible to use the projections made by other horizon scanning programs or by *ad hoc* expert panels as comparators, these comparators would not be considered gold standards for the comparison.

Given the constrained time frame, the initial evaluation of the AHRQ Health Care Horizon Scanning System has to be focused on short-term outcomes of horizon scanning. Panel members suggested the following methods to assess short-term outcomes:

- Survey the target audiences of the horizon scanning products, asking whether they think the products have affected their decisionmaking or day-to-day work.
- Monitor the download rate of horizon scanning reports after they are posted on the Web (this is a proxy measure of the impact of the horizon scanning products).
- Measure the number or the proportion of research grants focused on new technologies issued by funding entities with input from AHRQ's Health Care Horizon Scanning System.
- Monitor how frequently the horizon scanning products have been cited.
- Monitor where the horizon scanning products have been cited and whether it well represents the target stakeholder groups.
- Evaluate how well the horizon scanning reports were written, including the understandability, accuracy, and usability of the content.
- Measure the comprehensiveness of the horizon scanning products (e.g., Status Report) in terms of the topics being covered (compared to the databases of other horizon scanning programs).
- Monitor whether the system has failed to identify any "blockbuster" technology or innovation that entered clinical practice and had a significant impact during the initial evaluation.

Most of these short-term evaluation strategies focus on proxy measures of horizon scanning outcomes. It is difficult, if not impossible, to validate these proxy measures within the time frame for the initial evaluation. In addition to short-term *outcome* measures, the panel also suggested measuring the *process* or the *structure* of the Horizon Scanning System. Measures that could be used include the adequacy of funding and staffing for the system, the responsiveness of the horizon scanning team to the requests of key stakeholders, and the promptness of the system to update its database. To assess the performance of a new program that is still under development, such as the AHRQ Health Care Horizon Scanning System, the speed of adaptation of the program (e.g., the growth rate of its database) should be measured.

The expert panel also discussed issues regarding the evaluation of horizon scanning programs from a long-term perspective. Panel members suggested the following measures for the assessment of horizon scanning programs that have a longer track record:

- The impacts of the horizon scanning products or services on decisionmaking—either as perceived by the users of the products or services or measured using indicators such as the number of decisions made based on the products or services

- The accuracy of the projections that the horizon scanning program made (e.g., whether the technologies diffuse into clinical practice within a certain period of time as projected, how often the program has missed a "blockbuster" technology, whether the technologies failed to diffuse into clinical practice or failed to have the "high impact" as predicted)
- How early the program identifies high-impact technologies and where on the S-curve of the diffusion the program became aware of the significance of the technologies

With regard to measuring the accuracy of projections that a horizon scanning program makes, there is a tradeoff between sensitivity and specificity. It is important for the key stakeholders of the horizon scanning program to determine whether sensitivity or specificity is more important. If high sensitivity is more desirable (i.e., the stakeholders do not want to miss any high-impact technologies), then ideally the horizon scanning program may want to generate a bigger list of technologies. This is because a list of the top 100 technologies may have a better chance to include those high-impact ones than a top 20 list. On the other hand, if high specificity is more desirable, the horizon scanning program may want to generate a smaller list of technologies, because a top 100 list may raise more false alarms than a top 20 list.

When assessing the accuracy of the projections regarding technology or innovation diffusion, different criteria might be needed for different categories of technologies or innovations. The diffusion of some interventions (e.g., a disease management program, a surgical procedure) might be more difficult to detect or measure than that of other technologies/innovations (e.g., regulated device or drugs).

Discussion

In this review, we sought information on horizon scanning methods that might be useful to the AHRQ Health Care Horizon Scanning System. Particularly, we focused on methods in use by other health care horizon scanning programs for identifying target technologies, filtering and prioritizing topics, assessing or predicting impacts, disseminating findings, and evaluating the performance of the program. Most of the existing horizon scanning programs that we have identified are EuroScan members. Our searches identified a series of studies EuroScan performed that provided summarized information about the member agencies and some comparisons between them. Given the similarity in goals and scope of the AHRQ Health Care Horizon Scanning System and the EuroScan member programs, the information we have collected provides helpful input to AHRQ to optimize its horizon scanning protocols.

However, our review has a number of limitations. First, our literature search identified documents that described the methods used by programs for horizon scanning (see the tables in Appendix B) for only a few horizon scanning programs (e.g., NHSC, the Australia and New Zealand Horizon Scanning Network [ANZHSN]). Second, some of the documents we identified were published several years ago, and it was not always clear whether the information (e.g., the program's target technologies, funding sources, and methods for identification of technologies) is still current. Third, on several occasions, we found inconsistency in information among different documents about the same horizon scanning programs. In these cases, we always chose to use the data from the more recent sources, although these data do not necessarily reflect the program's current methods.

To a certain degree, the input from the expert panel has helped us fill some of the information gaps. The experts provided us with additional information on horizon scanning programs and methods. They also helped us verify the currency of the information we identified in the literature. The experts' suggestions were particularly helpful to the horizon scanning team for addressing some of the key methodologic issues for horizon scanning.

First, the experts helped us explore some of the philosophical issues in horizon scanning, including how to determine whether a technology is new or an incremental change and how to differentiate "innovation" from "improvement." The experts acknowledged that it is often difficult to find a tipping point to determine whether some changes in a technology or a care delivery method would qualify it as an innovation or improvement. There is a continuum from simple improvement to radical innovation. The distinction between the two concepts lies in the degree of change breaks with usual thinking. Overall, the experts agreed that whether a technology or care delivery method is labeled as new versus increment (or an innovation versus improvement) might not be very important. As long as the technology or the method is deemed relevant to patients and clinicians, it is worth tracking by the horizon scanning program.

The expert panel also helped the horizon scanning team consider methods for engaging manufacturers and developers to help identify new interventions. Contacting developers and companies may help the horizon scanning program improve the efficiency of scanning by having a better understanding of the company's product development strategy and the technologies in its pipeline. Currently, the horizon scanning team seeks information from developers as needed. Due to the constrained time frame and resources, the team does not systematically collect information from developers on every technology being considered. Some panel members cautioned the team about developers' conflict of interest. They suggested that, when collecting information from developers, the team should regularly follow up with the developers and

attempt to gauge the credibility of the information they provide by pursuing other sources of information.

In regard to use of expert informants in horizon scanning, the expert panel encouraged the horizon scanning team to continue using a balanced group of informants of different backgrounds (e.g., clinical practice, academic research, health services administration, health policymaking, technology assessment, clinical engineering). This approach potentially helps balance perspectives and interests of different stakeholders and may decrease the risk of group thinking mentality that is often associated with over-reliance on experts of similar background. Panel members suggested that well-known clinical experts may not always be the right people for seeking information or opinions on emerging technologies. The panel members also suggested the team build a database of trusted experts, track which experts consistently provide information that is useful and, based on the record, update the expert database periodically.

The expert panel expressed different opinions about the potential role that quantitative modeling may play in horizon scanning. Some panel members questioned the utility of quantitative modeling for this AHRQ-funded horizon scanning project. The primary concern was about the potential inaccuracy of the predictions made with quantitative models for emerging technologies that are typically lacking high-quality data. Another concern is that quantitative modeling could be very time-consuming and expensive and that it would not be possible to apply modeling to hundreds of topics that the horizon scanning program might need to cover. Modeling a few topics each year might not be very helpful given the other hundreds of topics.

Some other panel members thought that quantitative modeling could be very helpful to AHRQ's Health Care Horizon Scanning Program. The intelligence developed during the modeling process (e.g., the assumptions that were made for the model, the parameters defined, the data sources used, all other lessons learned during the iteration process) could provide valuable information to stakeholders. Quantitative modeling may also provide a range of possible outcomes, helping decisionmakers see the best- and worst-case scenarios or to determine whether all possible outcomes would hit the threshold that would tip their decision.

However, the panel appeared to agree that quantitative modeling may not be appropriate to apply to technologies that are too early in their development cycle due to uncertainty in the data from early studies. The panel also agreed on the need to explicitly communicate to the stakeholder the potential limitations of quantitative modeling.

The panel also provided AHRQ and the ECRI Institute team with other suggestions for improving the horizon scanning process. Some of the suggestions, such as those regarding revision of the instrument used to solicit input from expert informants, have now been fully incorporated into the horizon scanning program's protocols. However, it may not be possible to incorporate some of the other suggestions in the near term. For example, some panel members suggested developing an online database searchable by many parameters (e.g., technology, clinical condition, phase of development) and a feature-rich Web site dedicated to this horizon scanning project. While the database and the Web site would greatly benefit the audience of the horizon scanning program, the development of these resources would be time-consuming and is beyond the scope of work for the current horizon scanning project. Additional funding from AHRQ or other sources would also be needed to support such work.

Overall, our literature review and the expert panel provided AHRQ and the horizon scanning team with very useful input for the revision of the horizon scanning program's protocols. We have summarized the major inputs that we considered in revising the protocols (see Table 1). The methods used by existing health care horizon scanning programs (e.g., EuroScan) are most

relevant to AHRQ's current horizon scanning work. Methods that were identified from other sources that have not been used by any of these programs, such as forecasting methods using scenario analysis or quantitative modeling, are typically time-consuming and not feasible to apply to the large number of topics that these programs typically need to handle.

We believe that a direct survey of existing health care horizon scanning programs would provide additional useful information. According to NHSC director Claire Packer, M.D., EuroScan plans to update the survey of its member programs that was conducted in 2009 (which is included in this review). During the 2009 survey, the programs completed a questionnaire comprising 40 questions on structure and funding, aims and coverage, customers, partnerships and collaborations, methods, output, dissemination, related activities, and future developments. Findings from the update of the survey are expected to be published in 2012, and we look forward to using that information to further improve the protocols used by the AHRQ Health Care Horizon Scanning System.

Table 1. Main considerations for revising the AHRQ Health Care Horizon Scanning System protocols

Methodologic Area	Main Considerations
Identifying emerging technologies or innovations	• The ECRI Institute team cast a wide net by using about 100 selected sources to identify leads to potential target technologies. This approach helped capture as many target technologies as possible but was resource-intensive and may not have been efficient. • Continuously adding and dropping sources based on their usefulness and focusing more on technologies with less uncertainty for reaching the market could help improve the search efficiency. • Using commercial, subscription-based databases could help improve the search efficiency. However, these databases may contain potential data inaccuracy or information lag (behind original sources). • Directly seeking information from developers may help the team efficiently identify technologies that are most likely to emerge on the horizon. However, the conflict-of-interest concern requires using some mechanisms or tools to gauge and track the informants' credibility. • A database of pipeline products of manufacturers could be useful for horizon scanning. However, building this database may require a large amount of time and thus may not fit the time frame for the current AHRQ's horizon scanning project. • Identifying care delivery innovations could be challenging because it is often difficult to differentiate "innovation" from "improvement." The major distinction between the two concepts has to do with the degree of discontinuity or break with usual thinking. The assessment of the degree of discontinuity is context-specific.
Filtering and prioritizing technologies	• The filtration and prioritization criteria that a horizon scanning program uses should be accountable to its key stakeholders and transparent. • Many incremental changes exist in existing technologies or care delivery methods. Often, it is not easy to find objective criteria or signals to identify the tipping points where an "old" technology starts to have a significant impact and be viewed as an innovation or as something new. • As long as the technology, indication, or method will be relevant to patients and clinicians, in that they might end up using it, it is worth tracking. • Soliciting input from informants or experts could potentially increase the objectivity of the process and ensure that the needs of the key stakeholders would be better met. However, the process could be labor-intensive. • Various options on the Internet could help solicit input from the public or health care professionals. However, setting up a Web site for input and abstracting data from a potentially large volume of public comments could be very time consuming and may not be feasible under the current time frame for the AHRQ horizon scanning program.

Methodologic Area	Main Considerations
Assessing or predicting impacts of emerging technologies	- Due to lack of data or the uncertainty of data, it is challenging to assess the impacts of technologies that are still in the early stage of development. - Input from expert informants could be helpful in forming opinions about the potential for an emerging technology to work, be adopted, and have significant impact. However, experts' opinions should not substitute for comprehensive, proactive searches of other sources of information. - Academic experts may not always be the right people for seeking information or opinions on adoption of new technologies. Building a database of experts appropriate for specific topics might be helpful. - Potential conflict of interest is an important factor to consider in selecting expert informants. However, some informants (e.g., developer of a new technology) who apparently have conflict of interest may have unique insights. - Quantitative modeling is generally time consuming and expensive. It is not possible to apply the method to hundreds of topics that the AHRQ horizon scanning program covers. The high uncertainty in the assumptions regarding emerging technologies in very early phases of development could also affect the predictive value of the models. However, applying quantitative modeling to a few selected topics may be valuable for stakeholders. The intelligence and insight developed during the modeling process could be very informative. - Other methods for assessing the impacts of emerging technologies (e.g., scenario analysis) may also be useful to the AHRQ horizon scanning program.
Dissemination of information and followup on identified technologies	- The choice of methods for disseminating horizon scanning information depends on the target audience and how that audience wants the information to be delivered. The formats of the horizon scanning products and the channel by which the products are disseminated should be customized to fit the target audience's needs. - Since AHRQ's horizon scanning program has multiple categories of audience members (e.g., research funding decisionmakers, patients, clinicians), a need may exist for different types of horizon scanning products and different ways to deliver the products. - Developing a searchable online database or a dedicated Web site to host horizon scanning products would help disseminate information. However, development of these online features is beyond the scope of the current AHRQ horizon scanning program and would require additional funding from the agency or other sources.
Evaluation of horizon scanning programs	- A horizon scanning program can be evaluated in terms of its *structure*, *process*, and *outcomes*. While it is ideal to focus the evaluation on outcomes, it is often challenging to design and conduct rigorous studies for this type of assessment. If a certain technology does not ultimately reach clinical practice as predicted, it might be because the horizon scanning system raised a false alarm or because the horizon scanning process or products had affected the technology's diffusion. - To determine the accuracy of the projections made by a horizon scanning program, the results of the projections need to be compared to the gold standard (e.g., whether the technology is adopted or creates a "high impact") at the end of the horizon period (e.g., five or seven years later). This type of comparison typically requires followup for a long period of time (in the case of the AHRQ Health Care Horizon Scanning System, seven years from the projections being made) and would be infeasible to apply to our initial evaluation task, which must be completed by the end of August 2013. - Given the constrained time frame, the initial evaluation of the AHRQ Health Care Horizon Scanning System has to be focused on short-term outcomes of horizon scanning (e.g., how users think the horizon scanning products have affected their decisionmaking, the download rate of the products). Most of the short-term evaluation strategies focus on proxy measures of horizon scanning outcomes. It is difficult, if not impossible, to validate these proxy measures within the time frame for the initial evaluation. - In addition to short-term *outcomes*, the *process* or the *structure* of the horizon scanning system could also be measured to gauge the system's performance. Measures that could be used include the adequacy of funding and staffing for the system, the responsiveness of the horizon scanning team to the requests of key stakeholders, and the system's ability to keep the content up to date.

Conclusion

AHRQ commissioned this systematic review to identify methods that could be used in its Health Care Horizon Scanning System. The main purpose of the horizon scanning system is to better inform patient-centered outcomes research investments by systematically identifying, monitoring, and assessing emerging health care technologies/innovations or modifications of existing technologies with potential to have the highest impacts in the future. The horizon scanning program can provide timely input to decisionmakers, helping them to identify patient-centered outcomes research topics that are most worth the investment and to ensure that the technologies being compared will remain relevant in the foreseeable future.

The current systematic review is intended to address two key questions (KQs):

- KQ 1: What horizon scanning methods have been used by public and private organizations in the United States and internationally? What are the commonalities and differences among the methods used by different organizations?
- KQ 2: What horizon scanning methods identified need to be incorporated into the future process of the AHRQ Health Care Horizon Scanning System?

Our review identified more than 20 formally established horizon scanning programs around the world. The programs' purposes ranged from commercial planning, health service research prioritization, financial or operational planning, controlled diffusion of technologies, to provision of information to policymakers, purchasers, and health care providers. The majority of these programs are members of EuroScan. We also identified several public or private organizations that are not typical horizon scanning programs but that conduct forecasting of future trends related to health technologies/innovations.

Our review identified a gap in evidence for methods used by existing horizon scanning programs. Most of the horizon scanning methods that we identified were from a small number of EuroScan member programs. We also identified some studies that EuroScan has conducted comparing its members. Overall, EuroScan member programs follow a similar process that consists of a series of phases, as follows:[2]

- Identify the users of the horizon scanning products.
- Determine the time frame for the horizon scanning effort.
- Conduct horizon scanning, and identify emerging technologies that potentially affect clinical practice and outcomes, the health care system and cost.
- Filter the identified technologies by applying criteria for determining the relevance of the technologies to the horizon scanning effort.
- Prioritize the technologies that have passed through the filtering process by applying criteria based on stakeholders' requirements and needs.
- Assess technologies of high priority for the stakeholders, and predict potential impacts of the technologies on clinical practice and outcomes, the health care system, and cost.
- Use peer review to check for quality of the horizon scanning process and outputs.
- Disseminate the information produced via horizon scanning to the relevant audiences in a timely fashion.
- Update the information produced via horizon scanning on a regular basis or when a significant development occurs related to the technology.

The methods used in each phase vary across programs. Choice of methods largely depends on the goals and needs of key stakeholders of the program. In particular, the sources searched for

target technologies and the criteria used for topic filtration and prioritization are all customized to the unique needs of the stakeholders of the program and to provide the most relevant information for meeting those needs. In terms of assessment and prediction of the impacts of identified technologies, all programs opted for methods that allow for quickly producing results for a large number of emerging technology topics within a short time frame. Use of expert informants is particularly common among the programs. Methods that are usually more time-consuming and resource-demanding, such as quantitative modeling and scenarios analysis, had not been used by any of the horizon scanning that we identified.

The expert panel for this study generally agreed that the horizon scanning team's approach appropriately fits the goal, scope of work, and time frame for the AHRQ Health Care Horizon Scanning System. This approach includes conducting a comprehensive search of many sources to identify leads to target technologies, using predefined criteria to filter and prioritize topics that meet stakeholders' needs, seeking insight from a balanced group of expert informants to assess the potential impacts of target technologies, and disseminating horizon scanning information via multiple channels. Much of the input from the expert panel was intended to help AHRQ improve the horizon scanning process over the long term. It appears that optimization of a horizon scanning program may take a longer period of time than a few years. A program that continues beyond the contract period for the current horizon scanning project would have a better chance of benefiting the stakeholders and society at large.

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Appendix A. Detailed Search Strategy

Electronic Database Searches

We searched the following databases for relevant information:

Name	Date Limits	Platform/Provider
EMBASE (Excerpta Medica)	1996 – February 2, 2011	OVID
MEDLINE	1996 – February 2, 2011	OVID
PubMed (In Process and publisher subsets)	Searched February 2, 2011	National Library of Medicine
PsycINFO	1996 – February 2, 2011	

Hand Searches of Journal and Nonjournal Literature

Journals and supplements maintained in ECRI Institute's collections were routinely reviewed. Nonjournal publications and conference proceedings from professional organizations, private agencies, and government agencies were also screened. Other mechanisms used to retrieve additional relevant information included review of bibliographies/reference lists from peer-reviewed and gray literature. (Gray literature consists of reports, studies, articles, and monographs produced by federal and local government agencies, private organizations, educational facilities, consulting firms, and corporations. These documents do not appear in the peer-reviewed journal literature.)

The search strategies employed combinations of free-text keywords as well as controlled vocabulary terms, including the following concepts. The strategy below is presented in OVID syntax; the search was simultaneously conducted across EMBASE and MEDLINE. A parallel strategy was used to search the databases comprising the Cochrane Library.

Medical Subject Headings (MeSH), EMTREE and Keywords

Conventions:
OVID
$ = truncation character (wildcard)
exp = "explodes" controlled vocabulary term (e.g., expands search to all more specific related terms in the vocabulary's hierarchy)
.de. = limit controlled vocabulary heading
.fs. = floating subheading
.hw. = limit to heading word
.md. = type of methodology (PsycINFO)
.mp. = combined search fields (default if no fields are specified)
.pt. = publication type
.ti. = limit to title
.tw. = limit to title and abstract fields
PubMed
[mh] = MeSH heading
[majr] = MeSH heading designated as major topic
[pt] = publication type
[sb] = subset of PubMed database (PreMEDLINE, Systematic, OldMEDLINE)

[sh]   =   MeSH subheading (qualifiers used in conjunction with MeSH headings)
[tiab]   =   keyword in title or abstract

Topic-specific Search Terms

Concept	Controlled Vocabulary	Keywords
Horizon Scanning		Early awareness$ Environmental scan$ Foresight Horizon scan$ Scenario planning Technology roadmapping
Methods	Delphi study/ Delphi technique/ Methods.fs.	Delphi Method$
Subjects of the scans	Biomedical technology assessment/ Health care planning/ Health priorities/ Technology assessment, biomedical/	Innovat$

Search Strings for EMBASE/MEDLINE/PreMEDLINE/Psycinfo

(With Restrictions: English language, human, remove overlap)

Set Number	Concept	Search Statement
1	Horizon Scanning	Horizon Scan$
2		Early awareness
3		Forecasting/ or forecast$.ti.
4		Foresight
5		Environmental scan$
6		Scenario planning
7		Technology roadmapping
8	Combine sets	3 or 4 or 5 or 6
9	Refine	8 and (method$ or mt.fs.)
10	Refine	9 and (Delphi technique/ or Delphi study/ or Delphi)
11	Refine	9 and (technology assessment, biomedical/ or biomedical technology assessment/)
12	Refine	9 and innovat$
13	Refine	9 and (health priorities/ or health care planning)
14	Combine sets	1 or 2 or 10 or 11 or 12 or 13
15	Eliminate overlap	Remove duplicates from 14
16	Limit by language	Limit 15 to English language

Google Searches

Platform	Search Statement
Google	"horizon scanning" (dspace OR "d-space" OR eprint OR "e-print")
Google	"horizon scanning" OR "early awareness and alerting" OR "environmental scan" OR "environmental scanning") (methods OR methodology OR framework) [*Note: After reviewing the first 100 items retrieved by this search string,* *I removed environmental scan from the search phrase.*]

Appendix B. Methods Used by the Identified Health Technology Horizon Scanning Systems[a]

Table 2. The National Horizon Scanning Centre in England

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	The National Horizon Scanning Centre (NHSC) aims to provide key policymakers with advance notice of selected new and emerging health technologies that might require evaluation, consideration of clinical and cost impacts, or modification of clinical guidance around 2-3 years before launch on the National Health Service (NHS) in England.[11,48,64]
Type of host organization and funding sources	NHSC is an independent research team based in the Public Health, Epidemiology, and Biostatistics Department, in the School of Health and Population Sciences at the University of Birmingham.[11] NHSC is funded by the National Institute for Health Research (NIHR).[48,64] NHSC became incorporated into NIHR as a Research Programme during 2006.[11]
Who are the stakeholders that the health care horizon scanning program intends to inform?	The key stakeholders are the Department of Health (DH) and national policymaking bodies within the National Health Service (NHS) in England.[11,48,64] The National Institute for Health and Clinical Excellence (NICE), the Centre for Evidence-based Purchasing, the National Specialized Commissioning Group, the Health Technology Assessment research programme, and the National Screening Committee is the main customers of NHSC.[11] The "customers" listed on the NHSC Web site include: • The Technology Appraisals programme at NICE • The Evaluation Pathway Programme for Medical Technologies at NICE • The Interventional Procedures Programme at NICE • UK National Screening Committee National Specialised Commissioning Team • NIHR Health Technology Assessment programme • Joint Committee on Vaccination and Immunisation • National Innovation Centre • British HIV Association[48]

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[a] Citations in this appendix refer to this report's main reference list.

Table 2. The National Horizon Scanning Centre in England (continued)

Area of Interest	Data Collected
What horizon scanning deliverables are expected to be produced?	NHSC's main output is "technology briefings" on new and emerging health technologies (accessible on the program's Web site at www.haps.bham.ac.uk/publichealth/horizon/outputs/technology.shtml). The technology briefings vary in length and detail but usually include: • a description of the technology, • a description of the related patient group (with estimated patient numbers), • the current diagnostic or treatment alternatives, • an estimated unit cost of the technology (if available), • the current research evidence of clinical effectiveness, • details of any ongoing or related research activities, and, in some instances • an estimate of the clinical, service, and financial impact (usually not in monetary terms).[46] Our search did not identify any information about how many briefings NHSC is expected to produce within a fixed period of time (e.g., monthly, annually) In addition, NHSC has an active research program (available at www.haps.bham.ac.uk/publichealth/horizon/outputs/research.shtml) and has presented or published papers on horizon scanning methods and the diffusion of health technologies (available at www.haps.bham.ac.uk/publichealth/horizon/outputs/pubs.shtml). In the most recent annual NHSC report, the following deliverables were also mentioned: • intelligence reports to the Centre for Evidence-based Purchasing investigation or summary forms on nondrug topics, • short reports listing drugs in development for neuropathic pain to NICE, and • filtration forms on pharmaceutical products for NICE.[11]
What are the target technologies of the health care horizon scanning program?	The target technologies include pharmaceuticals, medical devices, diagnostic tests and procedures, therapeutic interventions, rehabilitation and therapy, and public health and health promotion activities.[48,64]
What is the time horizon of the scanning?	The time horizon of the scanning is around 2-3 years before launch of the technology in NHS in England.[48,64]

Table 2. The National Horizon Scanning Centre in England (continued)

Area of Interest	Data Collected
What methods does the system use for the scanning and early identification of technologies?	NHSC uses a balance of sources to identify target technologies. NHSC categorizes information sources into primary, secondary, and tertiary sources.[42] Primary sources are developers or manufacturers. Secondary sources are those where some filtering of topics has already been undertaken, and include key medical journals, consultation with experts in the field, and Internet media sources. Tertiary sources provide information from other horizon scanning organizations. The scanning strategies that NHSC uses include: (1) focused routine scanning, (2) a specialty-based work program, and (3) in-depth scanning.[48] 1) Focused routine scanning NHSC undertakes regular scanning of primary, secondary, and tertiary information sources by networking with research units and commercial developers and by searching medical and pharmaceutical literature, news and financial reports, licensing agencies, selected Internet sites and databases, including UK PharmaScan and other horizon scanning units.[11,48] This scanning process is designed to identify significant advances regardless of clinical specialty. The process for pharmaceuticals enables pipeline developments from the major pharmaceutical companies to be identified in late phase II or phase III clinical trials and tracked through the final trial and licensing stages.[48] Individual health professionals and researchers may propose technologies that may need NHSC attention via the Center's Web site. NHSC team also contacted or met directly with pharmaceutical, diagnostic, and medical device companies to discuss its development pipelines and its plans for specific products.[11] 2) Specialty-based work program NHSC uses a specialty review program to ensure that all clinical specialties and technology types are allocated time for an in-depth investigation of new developments. The program involves liaison with individual clinicians, the Royal Colleges, and other professional organizations in a specialty to identify any gaps in the program's identification and help the program with the prioritization of technologies in that specialty.[11,48] NHSC also routinely scans specialist trade publications, societies and journals, and reports from specialist groups.[11] 3) In-depth scanning NHSC also undertakes in-depth identification at specific points along a patient pathway. This type of scanning is generally undertaken at the request of and in collaboration with national decision-making bodies. Methods include the development of inclusion and exclusion criteria in conjunction with clinical experts, an extensive search for emerging technologies, and contacts with relevant developers.[48] At one point, NHSC routinely scanned 35 sources to identify new and emerging health technologies.[42] But our search did not identify a comprehensive list of the sources (e.g., the specific databases, journals, Web sites) that NHSC currently scans. Neither did we identify any information about how frequently NHSC reviews and revises the list or how frequently NHSC scans these sources.

Table 2. The National Horizon Scanning Centre in England (continued)

Area of Interest	Data Collected

What criteria are used for filtering scanned technologies?	NHSC use a filtration process for technologies initially identified to discards minor developments and groups related technologies.[11,48] NHSC may perform a search for additional information before filtration and may contact relevant commercial developers or experts in the field. The criteria for final selection are dependent on NHSC's agreements with each national decision-making body but will generally include filtration around timing and innovation:
	1) The technology is emerging or new to NHS or is a significant change in indication or use of an existing technology
	2) The technology has something innovative about it:
	    1. A new drug class or pharmacological target for the specific patient group
	    2. It may be more effective than current preventative, diagnostic, treatment or rehabilitative options
	    3. It may have a better risk: benefit ratio than current options
	    4. It may offer improved identification of those who may benefit or be harmed by an intervention
	    5. It may offer significant potential for cost savings or expenditure if fully adopted
	    6. It may require significant service reorganization for optimum use[48]
	For pharmaceutical and nonpharmaceutical technologies, the filtration criteria are slightly different.
	The filtration criteria for pharmaceuticals in development include:
	• time to license,
	• the presence of innovation in relation to current treatment options or patient outcomes,
	• or relates to major patient group where guidance has been issued.[11,64]
	The filtration criteria for nonpharmaceutical topics include:
	• time to licensing,
	• innovation, and
	• the potential to have a significant impact on health outcomes and/or resources.[11,64]
	Each national decision-making body's input was sought in the filtering process. Any technology that may fall into the relevant customers' filtration criteria is selected for further investigation. Wherever possible, information is sought from the relevant commercial developer and/or distributor, and a very limited search of a small number of other sources is undertaken.[11]

How are the technologies that have passed through the filtering process prioritized?	Information needs for prioritization and prediction of impact. • Estimated usage in England • Estimated size of patient group • Burden of disease • Potential cost per patient • Cost of current diagnostic or therapy options • Potential for savings • Service requirements including training • Potential for other effects (e.g., by lowering diagnostic or treatment thresholds) • Level and extent of evidence of benefit or harm[46]

Table 2. The National Horizon Scanning Centre in England (continued)

Area of Interest	Data Collected
What methods are used to assess or predict the potential impacts of the technologies?	NHSC predicts which new technologies are likely to have a significant impact on the National Health Service (NHS). The method used is multifaceted, using several predetermined criteria (see below), expert opinion, industry information, and corroboration with affiliated agencies.[48,64] NHSC use the following criteria to predict whether a technology will have a significant impact on NHS: 1. There is likely to be a significant health benefit if the technology diffuses widely. 2. There is likely to be a major cost impact if the technology diffuses widely because of unit costs and/or patient numbers and/or service reorganization, retraining, or other requirements. 3. There are indications that the speed of diffusion will be inappropriate (either too slow or fast given the available evidence). 4. There are likely to be significant ethical, social, legal, or patient-related issues with regard to the use of the technology. 5. Current guidelines and clinical guidance will be significantly affected if the technology is adopted.[24]
What strategies are used for disseminating the information generated by the health care horizon scanning program?	NHSC makes all of its technology briefings publicly available in the form of nonconfidential versions after the relevant company has agreed to them. NHSC posts non-confidential technology briefings on its Web site.[11,64] In addition, NHSC also posts on the Web site the paper that it presented or published on horizon scanning methods and the diffusion of health technologies. Members of the NHSC team have been invited to present on the work of the unit at both national and international events.[48] As a member of EuroScan, NHSC also exchanges information with its international partners.[64]
What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	Our search did not identify relevant information.

Table 2. The National Horizon Scanning Centre in England (continued)

Area of Interest	Data Collected
How is the health care horizon scanning program evaluated?	NHSC undertakes regular monitoring and audit of its processes and outputs, such as topics selected and quality of technology briefings.[11] The audit looks at aspects of the process and final output in a random selection of briefings using the following standards: • completeness of the search record, • recording of the company contacts, information, and comments sent, • recording of any expert contact details, • clear and correct recording and filing of the information retrieved and received, • a clear statement of the innovation of the technology in the briefing, and • sources of information are fully referenced, and clarity on which information is confidential.[11] External organizations are also involved in the performance review process. The findings of the review are incorporated into the improvement plan for NHSC.[11]

Table 3. The Australia and New Zealand Horizon Scanning Network

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	The Australia and New Zealand Horizon Scanning Network (ANZHSN) was established "to provide advance notice of significant new and emerging technologies to health departments in Australia and New Zealand, and to exchange information and evaluate the potential impact of emerging technologies on their respective health systems"[50,65,66]
Type of host organization and funding sources	The Australian Horizon Scanning Program is a collaborative Commonwealth and State initiative guided by the Health Policy Advisory Committee on Technology (HealthPACT), which is a subcommittee of the Australian Health Ministers Advisory Council.[50] ANZHSN consists of two main evaluator groups: the National Horizon Scanning Unit (NHSU) from Adelaide Health Technology Assessment; and the New and Emerging Techniques-Surgical (NET-S) group from the Australian Safety and Efficacy Register of New and Interventional Procedures – Surgical (ASERNIP-S), with assistance from New Zealand Health Technology Assessment to deal with the overflow of work.[50]
Who are the stakeholders that the health care horizon scanning program intends to inform?	HealthPACT, which guides the work of ANZHSN, comprises representatives from all state and territory health departments, the Australian Department of Health and Ageing, the Medical Services Advisory Committee (MSAC), the New Zealand Ministry of Health and the New Zealand District Health Boards. HealthPACT provides jurisdictions with evidence-based advice on emerging technologies. This information is used to inform jurisdiction financing decisions and to assist in the managed introduction of new technologies.[50,65,66]

Table 3. The Australia and New Zealand Horizon Scanning Network (continued)

Area of Interest	Data Collected
What are the scanning horizon deliverables expected to be produced?	ANSHZN produces the following types of horizon scanning products:[50] • **Horizon scanning technology prioritizing summaries** are short (approximately 10 pages) reports that provide a summary of new and emerging surgical technologies or techniques that can be used when deciding whether a procedure should be further assessed, monitored, or archived. If further assessment is required on a procedure, then it would be recommended for a horizon scanning report.[50] Prioritizing summary updates are conducted if the committee decides that a prioritizing summary should be monitored for new research and evidence within a 6- to 12-month time frame. • **Horizon scanning reports** are commissioned only once a prioritizing summary has been written.[65] Horizon scanning reports are more comprehensive assessments and are conducted if a technology has a significant impact and/or rapid uptake has, or is likely to occur. The reports present an overview of existing evidence, including a preliminary statement on clinical need, safety, effectiveness, cost-effectiveness and ethical considerations.[50] • **Emerging technology bulletins** provide an overview of the rate of progress and development of a technology or group of technologies that are predicted to have a clinical impact over the next 5 to 10 years in Australia and internationally.[50] Horizon scanning reports and emerging technology bulletins do not constitute a full health technology assessment as they are based on a limited literature search and are not a definitive statement on the safety, effectiveness, or cost-effectiveness of the particular health technology.[50] Our search did not identify any information about how many horizon scanning products ANSHZN is expected to produce within a fixed period of time (e.g., monthly, annually)
What are the target technologies of the health care horizon scanning program?	Health technologies that were considered include devices, diagnostic tests and procedures, and other surgical and nonsurgical interventions.[50] NHSU provides evaluations on: • Devices: nondiagnostic equipment, drug delivery systems, monitoring systems, therapeutic inserts, prostheses, tissue regeneration and bioengineered products used on the surface of the body, nondiagnostic imaging, and biomaterials. • Diagnostics: imaging methods and equipment, testing methods, implants, interventional diagnostic procedures (e.g., new biopsy techniques), gene-based diagnostics, genetic markers, tumor markers, and screening tests. • Programs: population-based health promotion and public health activities (e.g., immunization, screening programs), novel health service delivery or information management programs, or programs aimed at individuals (e.g., rehabilitation, physiotherapy, psychotherapy, radiotherapy).[44] NET-S provides evaluations of new surgical techniques and technologies.[44] ANZHSN does not currently assess pharmaceuticals, vaccines, and blood products.[44,67]

Table 3. The Australia and New Zealand Horizon Scanning Network (continued)

Area of Interest	Data Collected
What is the time horizon of the scanning?	We did not identify any explicit statement from the relevant sources about the time horizon that ANZHSN is interested in when scanning emerging or new technologies. The program's Web site, however, contains the following statements: • "Prioritizing summary updates are conducted if the committee decides that a prioritizing summary should be monitored for new research and evidence within a six to 12 month timeframe."[50] • "Once classified, new health technologies are examined to determine whether they meet a 'prioritizing threshold', in that the technology is likely to emerge in the Australasian health scene within 3 years ..."[50]
What methods does the system use for the scanning and early identification of technologies?	ANZHSN searches a number of sources daily, weekly, biweekly, or monthly for new and emerging health technologies.[50,68] Various sources are used to identify health technologies, including: • Information from relevant stakeholders • Access to Horizon Scanning / Early Warning Systems in other Countries • Review of Industry literature (manufacturing and pharmaceutical) • Review of major and specialist medical and scientific journals • Animal studies • Human trials—devices or procedures first tested on humans • Interest group profiles. • Experts and expert groups, including professional colleges - formal and informal networks • Conference papers • Newspapers and other media sources, including financial reports • Internet • Licensing agencies • Manufacturers • Review on health futures and technology forecasting (time span >10 years)[50] In addition to scanning the sources identified above, ASERNIP-S regularly surveys the Fellows of the Royal Australasian College of Surgeons (more than 5,000 surgeons) for new and emerging technologies.[69] Our search did not identify any information about how frequently ANZHSN scans the sources or how frequently ANZHSN reviews and revise its list of sources.
What criteria are used for filtering scanned technologies?	Technologies that have been identified as new and emerging are first classified into the following categories based on the stage of the technology's development in Australia:[50] • Not yet emerged: Technologies that are not in use in Australasia. • Experimental: Technologies that are used in scientific studies with small numbers of patients; devices in proof-of-concept or safety trials; and surgical procedures limited to use in clinical trials in research centers. • Investigational: Devices that are in efficacy trials and surgical procedures that are limited to use in a few specialist centers; usually conducted in single or small centers.

Table 3. The Australia and New Zealand Horizon Scanning Network (continued)

Area of Interest	Data Collected
	• Nearly established: Surgical procedures and medical devices that are used outside clinical trials but with unresolved issues or controversy concerning clinical benefit and diffusion. • Established: Technology that is licensed or available for marketing and in general use outside clinical trials; multicenter use; or technology is readily accessible. • Established but changed indication or modification of technique: A well-established technology that is being used for a changed indication or has been modified. • Should be taken out of use: The procedure or technology is unsafe or an alternative procedure or technology is more effective on the basis of evidence-based assessment. Once classified, new technologies are examined to determine whether they meet a "prioritizing threshold," in that the technology is likely to emerge in the Australasian health scene within 3 years and satisfies at least one of the following criteria:[50] • The technology has obvious safety or ethical issues or controversies (e.g., the implantation of left ventricular assist devices for patients not eligible for cardiac transplantation). • The technology has not been assessed and is rapidly diffusing throughout the Australian or New Zealand health system (e.g., combined positron emission tomography-computed tomography scanners); • The technology is applicable to a large proportion of the Australian or New Zealand population and may have considerable clinical or cost impact (e.g., a rapid point-of-contact diagnostic test for heart failure). • The technology is applicable to a small proportion of the population but has obvious and far-reaching benefits (e.g., magnetic resonance imaging for women at high risk of breast cancer). Technologies that do not satisfy any of these criteria may be reviewed periodically or archived. If new technologies do reach the priority threshold a preliminary assessment (consisting of about two to three pages detailing background information, clinical burden of disease, diffusion, current comparators or treatment alternatives, safety, effectiveness and cost data, and ethical considerations) is written. ANZHSN recommendations are formulated on the evidence base and are forwarded quarterly, along with the preliminary assessment, to HealthPACT. A decision is taken by HealthPACT to do the following: • Archive the technology. • Monitor the technology in 6-12 months for further evidence. • Request a horizon scanning report from ANZHSN. • Refer the technology to relevant specialist organizations or bodies. • Refer the technology to MSAC for a full health technology assessment.[50]
How are the technologies that have passed through the filtering process prioritized?	The filtering and prioritization processes used by ANZHSN seem to be blended together. See the box above.

Table 3. The Australia and New Zealand Horizon Scanning Network (continued)

Area of Interest	Data Collected
What methods are used to assess or predict the potential impacts of the technologies?	If the prioritization criteria are met, the technology is flagged for a possible prioritizing summary—a 6-10 page introduction to the technology that will include background material on what the technology is and how it works, the comparator (if applicable), regulatory approval status (including the Australian Therapeutic Goods Administration, FDA, and EU Marking), current utilization in Australia and the potential uptake of the technology. Evidence relating to the safety, effectiveness, and cost-effectiveness of the technology is included and usually includes 3-4 peer-reviewed human studies. As horizon scanning tends to be in the early adoption phase of the technology it is highly unlikely that cost-effectiveness information would be identified, and this section is usually concerned with basic costs. These summaries would take 2-4 days to write by a single researcher.[68]
What strategies are used for disseminating the information generated by the health care horizon scanning program?	The identified technologies and procedures, preliminary assessments, and horizon scanning reports are submitted to HealthPACT.[68] All horizon scanning reports considered by HealthPACT will be available on a dedicated Web site,[50] and impact summaries based on the horizon scanning reports will be submitted to the EuroScan database.[50]
What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	If the technology fails to meet the prioritizing threshold, it is archived and no further action is taken; however, some of these technologies may reemerge in future scanning activities. Some technologies may meet the prioritizing threshold but have insufficient information to support a summary. These technologies are monitored for further information in 12 months.[68]
How is the health care horizon scanning program evaluated?	It appears that the program is not evaluated using any formal structure.

Table 4. Horizon Scanning System in Oncology (Ludwig Boltzmann Institute for Health Technology Assessment)

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	The development of a horizon scanning system aims at identifying and evaluating new drug therapies in oncology before their routine introduction for cancer treatment and prepares Austrian hospitals (hospital administrators and drug commissions, respectively) for new anticancer medicines, and could contribute to making rational decisions and planning prospective budgets.[47]
Type of host organization and funding sources	Ludwig Boltzmann Institute for Health Technology Assessment (LBI–HTA) is an independent entity for scientific decision-making support in the health sector in Austria. Horizon Scanning System in oncology was established as part of the research program in LBI-HTA.[47]
Who are the stakeholders that the health care horizon scanning program intends to inform?	LBI-HTA periodically publishes assessments on novel cancer drugs with a likely therapeutic and/or financial impact. These assessments serve as decision aids for funding agencies and the decision-making network "HTA in hospitals" alike.[70]
What are the scanning horizon deliverables expected to be produced?	LBI-HTA periodically publishes assessments on novel cancer drugs with a likely therapeutic or financial impact. Assessments published since October 2009 (in English) is available at: http://hta.lbg.ac.at/en/content.php?iMenuID=96. An assessment summary typically includes the following sections: • Technology description • Indication • Burden of disease in Austria • Current treatment • Current regulatory status/ Availability • Evidence (efficacy, safety) • Ongoing trials • Estimated costs • Commentary/recommendation • References[70]

Table 2. Horizon Scanning System in Oncology (Ludwig Boltzmann Institute for Health Technology Assessment) (continued)

Area of Interest	Data Collected
What are the target technologies of the health care horizon scanning program?	The target technologies include: • Drugs that are designed for cancer therapy in adults concerning solid malignancies as well as leukemia and lymphoma • Anticancer drugs that are new (in the phase of adoption (i.e., in the launch or early postmarketing stages) or emerging (in phase II or phase III of clinical testing) • Approved anticancer drugs that represent a change in indication (extension of indication) • Anticancer drugs that will be in clinical use in Austria within a time period of 0 to 4 years[47] The following technologies are out of the scope of the horizon scanning program: • Drugs used only for supportive therapy like antiemetics, bisphosphonates, etc. • Other anticancer treatments other than drugs[47]
What is the time horizon of the scanning?	• Anticancer drugs that are new (in the phase of adoption (i.e., in the launch or early postmarketing stages) or emerging (in phase II or phase III of clinical testing) • Anticancer drugs that will be in clinical use in Austria within a time period of 0 to 4 years[47]
What methods are used by the system for the scanning and early identification of technologies?	The horizon scanning program searches 21 freely available sources:[71] • Electronic content table of journals: 5 • Alerts and RSS feeds from regulatory agencies: 4 • Conference abstracts: 3 • Web sites: 9
What criteria are used for filtering scanned technologies?	The program uses the following filtration criteria: phase III results available or application submitted to FDA/European Medicines Agency (EMA). Two researchers perform the filtration work.[71]
How are the technologies that have passed through the filtering process prioritized?	On a quarterly basis, eight experts (five oncologists and three pharmacists) prioritize topics using the following criteria:[71] • Are there already other treatment regimen(s) available for this specific indication, or is this drug a completely new therapy? • Will the new drug replace a current regimen or is it an add-on therapy for this indication? • Is there potential for significant health benefit to the patient group (high clinical impact)? • Is there potential for significant impact on drug budget if the technology diffuses widely? • Is there potential for an inappropriate use of the technology?

Table 2. Horizon Scanning System in Oncology (Ludwig Boltzmann Institute for Health Technology Assessment) (continued)

Area of Interest	Data Collected
What methods are used to assess or predict the potential impacts of the technologies?	To assess a topic, the program will search EMBASE, PubMed, and CRD Database for evidence. The program also does free-text searching and seeks information from manufacturers.[71] The assessments include the following content: drug description, indication, current regulatory status (EMA/FDA), burden of disease, current treatment, evidence, estimated costs, ongoing research, and commentary.[71]

What strategies are used for disseminating the information generated by the health care horizon scanning program?	The program disseminates horizon scanning information using the following methods:[71]
	• Two mailing lists
	  1. HSO-specific mailing list: medical directors of hospitals, heads of pharmacies in hospitals, drug commissions
	  2. general HTA list
	• HTA newsletter
	• Homepage
	• EuroScan

What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	Our search did not identify relevant information.
How is the health care horizon scanning program evaluated?	Our search did not identify relevant information.

Table 5. The SorTek Program of Basque Office for Health Technology Assessment, Basque Country

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	SorTek, the emerging technology assessment program, is established to assist in decisionmaking and in preventing the undesirable consequences of the introduction of new health technologies.[72]
Type of host organization and funding sources	SorTek is a program established within the Basque Office for Health Technology Assessment, Basque Country (OSTEBA), Spain.[72]
Who are the stakeholders that the health care horizon scanning program intends to inform?	The key stakeholders are the decisionmakers in Basque Country.[72]
What are the scanning horizon deliverables expected to be produced?	We did not identify relevant information on the specific format of the horizon scanning products and how frequently they are produced.
What are the target technologies of the health care horizon scanning program?	Technologies of interest included both emerging new technologies and new applications of already adopted technologies. Particularly, the following specialty areas are considered for the SorTek assessment: oncology, radiation cardiology, infectious diseases, psychiatry, gynecology, pediatrics, endocrinology, radiology, neurology, general surgery, genetics, anesthesia, otolaryngology, ophthalmology, nuclear medicine, pharmacy, devices, nursing, and medical inspection.[73]
What is the time horizon of the scanning?	We did not identify relevant information.
What methods are used by the system for the scanning and early identification of technologies?	OSTEBA use several methods to identify emerging technologies: The program creates a "red alert" for emerging technologies that may affect clinical practice by using a group of health care professionals, including physicians, nurses, and professionals involved in health management. Periodically, they are contacted for collecting information on technologies that they consider could have greater impact.[72,74] Other health professional in the Basque health system can also identify and submit proposals for evaluation.[72] The program also uses other sources to identify emerging technologies, such as news media, medical journals, regulatory agencies, and EuroScan members.[72,74]

Table 5. The SorTek Program of Basque Office for Health Technology Assessment, Basque Country (continued)

Area of Interest	Data Collected
What criteria are used for filtering scanned technologies?	The program uses criteria modified from Institute of Medicine criteria (no detail identified).[74]
How are the technologies that have passed through the filtering process prioritized?	Once selected, technologies can also be divided according to their diffusion rate and characteristics, in the following groups: 1. Hot Topics 2. Probable rapid dissemination technologies (less than a year) 3. Diffusion probably higher than a year 4. Considered emerging issues in the local area
What methods are used to assess or predict the potential impacts of the technologies?	In a report on horizon scanning methods published on the OSTEBA Web site, the EuroScan methods were mentioned.[73] We did not identify detailed information about the specific methods OSTEBA uses to assess the impacts of emerging technologies, except that the report mentioned that the health professionals are involved in the process.[73]
What strategies are used for disseminating the information generated by the health care horizon scanning program?	The horizon scanning products are disseminated to the following parties: • Managers, planners, and health policymakers • Health professionals involved in the "SorTek" • Health professionals in clinical practice who may be interested in the information • Agencies of Health Technology Assessment • EuroScan[72]
What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	We did not identify relevant information.

Table 5. The SorTek Program of Basque Office for Health Technology Assessment, Basque Country (continued)

Area of Interest	Data Collected
How is the health care horizon scanning program evaluated?	We did not identify relevant information.

Table 6. Italian Horizon Scanning Project

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	Italian Horizon Scanning Project (IHSP) has the following aims:[75] • To produce periodic lists of emerging medicines and medical devices with medicated coating for which an European Marketing Authorization will be expected within 12-36 months • To evaluate potential clinical and economic impact of emerging medicines and medical devices with medicated coating on the Italian National Health Service • To provide timely information to the Italian National Health Services (NHS) stakeholders based on available information
Type of host organization and funding sources	IHSP is publicly funded. The Italian Medicines Agency, the Veneto Region, and the Verona's Local Health Unit initiated IHSP. Private sponsors are accepted only if they have no conflict of interest with IHSP activities. IHSP can be supported with regional Pharmacovigilance funds. The IHSP Scientific Committee (IHSP-SC) includes representatives of the Italian Medicines Agency, the Veneto Region, the Verona's Pharmaceutical Department, and experts in medicine evaluation. The IHSP Database Team includes pharmacists, IT staff, and administrative employee. The IHSP Evaluation Team (IHSP-ET) for emerging medicines includes a panel of clinicians, with expertise in different medical and surgical fields, and a Scientific Secretary with six pharmacists, and a part-time administrative. The IHSP-ET produces the New Product Information Report.[76]
Who are the stakeholders that the health care horizon scanning program intends to inform?	No information was identified.

Table 6. Italian Horizon Scanning Project (continued)

Area of Interest	Data Collected

What are the scanning horizon deliverables expected to be produced?	IHSP produces the following types of information products:[76]
	1. Emerging medicines: 36-months report
	   IHSP annually produces a report on the pharmaceuticals possibly being authorized by the European Medicines Agency (EMEA) in the subsequent 36 months. This report includes the following components:
	    • medicine name
	    • licensee
	    • stage of development
	    • possible submission date of the marketing authorization dossier to EMEA
	    • main proposed indication(s)
	    • ongoing studies
	2. Emerging medicines: 18-months report
	   Every 6 months, IHSP produces a report on the pharmaceuticals possibly being authorized by EMEA in the subsequent 18 months. This report includes the following components:
	    • general information (active ingredient(s), brand name, licensee, ATC code, administration route, strength, international authorization state, possible launch date)
	    • proposed indication(s)
	    • burden of disease
	    • summary of the available data on clinical efficacy and safety
	    • possible price and economic impact (if available)
	    • probability of success
	    • alternative(s) already on the market
	    • possible competitors in development
	3. The New Product Information Report of prioritized medicines among those listed in the "18 months report."
	4. New Product Information Report (12-months report)—concerning the prioritized medicines possibly being authorized by EMEA in the subsequent 12 months. This report includes the following components:
	    • general information (active ingredient(s), brand name, licensee, ATC code, route of administration, strength, international authorization state, possible launch date)
	    • clinical need and burden of disease
	    • therapeutic alternative(s) already available
	    • summary of the available data on clinical efficacy and safety
	    • quality evaluation of the studies
	    • ongoing studies for the same or other indication(s)
	    • evaluation of the innovation grade and possible place in therapy of the emerging
	    • medicine

Table 6. Italian Horizon Scanning Project (continued)

Area of Interest	Data Collected
	• NHS and financial impact • clinical and patients impact
What are the target technologies of the health care horizon scanning program?	Medicines and medical devices with medicated coating[75]
What is the time horizon of the scanning?	Medicines for which a European Marketing Authorization will be expected within 12-36 months[75]
What methods are used by the system for the scanning and early identification of technologies?	IHSP collects information on emerging medicines from the following sources:[76] • Web sites (pharmaceutical companies, financial analysis companies, international scientific societies, international regulatory authorities, health information Web sites, and others) • Medical-scientific literature • Pharmaceutical companies press releases • Reports from the EuroScan network All the data are recorded in an *ad hoc* database. IHSP is supported by a technological infrastructure for data collection, check, monitoring, and analysis. The database is available, via restricted access, at http://horizon.cineca.it. The IHSP database main features are as follows: • Centralized database with different access profile according to different types of users (IHSP-SC, Database Team; Assessment Team, others) • Historical file and data finding tools • Online predefined reports and possibility of self-making specific reports • Horizon Community with private Web area for documents, data sharing, and discussion forum. Http and SSL protocols with username and password access are in place to ensure high security and secrecy of the recorded data. Data transmission is achieved by a protected and cipher channel. Daily data backup and disaster recovery procedures are in place along with the ISO 9001:2000 quality management systems, and the ISO 27001:2005 (BS 7799) security management system.
What criteria are used for filtering scanned technologies?	No information was identified.

Table 6. Italian Horizon Scanning Project (continued)

Area of Interest	Data Collected
How are the technologies that have passed through the filtering process prioritized?	The IHSP-SC selects the emerging medicines for assessing their clinical and economic value according to the following priority criteria:[76] • possible marketing authorization date • possible innovation grade 14,15, therapeutic and economic impact • possible price and NHS sustainability • other relevant considerations pointed out by the Regulatory Authority or the IHSP-SC itself
What methods are used to assess or predict the potential impacts of the technologies?	The content covered by the IHSP information products is listed in *What are the scanning horizon deliverables expected to produce,* of this table. No information was identified on how the assessment was achieved.
What strategies are used for disseminating the information generated by the health care horizon scanning program?	The IHSP database is available, by a restricted access, at http://horizon.cineca.it/. The IHSP database main features are as follows: • Centralized database with different access profile according to different kind of users (SC-IHSP-SC Database Team, Assessment Team, others) • Historical file and data finding tools • Online predefined reports and possibility of self-making specific reports • Horizon Community with private Web area for documents and data sharing and discussion forum.[76]
What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	No information was identified.
How is the health care horizon scanning program evaluated?	No information was identified.

Table 7. Canadian Agency for Drugs and Technologies in Health Environmental Scanning Program

Area of Interest	Data Collected
What is the mandate/purpose of the health care horizon scanning program?	The Canadian Agency for Drugs and Technologies in Health (CADTH) Environmental Scanning products alert decisionmakers to new and emerging health technologies that are likely to have an impact on the delivery of health care in Canada. The environmental scanning products also look at the health care environment and how evidence is being used to inform practice and policy decisions, both inside and outside Canada. Through active, ongoing literature scanning, the program identifies health technologies in the early development and adoption stages, including those that may affect health care finances, facilities, operations, and patient care. In addition, environmental scanning involves establishing and maintaining networks with key health care stakeholders and scanning the environment to better understand how old technologies are being used.[77]
Type of host organization and funding sources	Funded by Canada's federal, provincial, and territorial governments, CADTH is an independent, not-for-profit agency that delivers timely, evidence-based information to health care leaders about the effectiveness and efficiency of health technologies.[78]
Who are the stakeholders that the health care horizon scanning program intends to inform?	The key stakeholders of CADTH include governments, health care professionals, the public, and industry.[77]
What are the scanning horizon deliverables expected to be produced?	CADTH's horizon scanning program produces the following types of products:[77] • *Issues in Emerging Health Technologies* (aka "Bulletin," 4-12 pages, peer-reviewed, more 'traditional' evidence report, and indexed in PubMed) • Health Technology Update – newsletter (~ 2 issues/year, each issue contains 5-8 short articles, not peer-reviewed, not indexed, "easier to read" format) • Environmental Scans (short reports on current or emerging issues in health care technology, based on a limited literature search, not a systematic review)
What are the target technologies of the health care horizon scanning program?	The target technologies of the program are those "new and emerging health technologies that are likely to have an impact on the delivery of health care in Canada."[77]
What is the time horizon of the scanning?	No explicit description was identified.

Table 7. Canadian Agency for Drugs and Technologies in Health Environmental Scanning Program (continued)

Area of Interest	Data Collected
What methods does the system use for the scanning and early identification of technologies?	To identify drug topics, 20 or more sources were scanned weekly, including 50-100 emails per week, print journals, and topics received through CADTH advisory committees and the Health Technology Inquiry Service.[77] CADTH's rapid response program is also a source of potential topics for the horizon scanning program.
What criteria are used for filtering scanned technologies?	In a presentation by CADTH, the overall strategy for topic filtration, prioritization, and assessment was discussed. Quarterly, the program tries to reach consensus (no formal weighting) on these issues using the following criteria:[77] ● The technology itself (innovative, blockbuster) ● Relevance (fits within our mandate, anticipated customer need) ● Timeliness (can we complete it quickly enough to be useful) ● Impact/disruption (clinical practice, population, cost impact to system, other impact to system)
How are the technologies that have passed through the filtering process prioritized?	See the box above.
What methods are used to assess or predict the potential impacts of the technologies?	See the box above
What strategies are used for disseminating the information generated by the health care horizon scanning program?	The program uses the following methods to disseminate horizon scanning information:[77] • Publicly available for download (free of charge) from Web site • Web site-based search engine • Regular notification of new reports to stakeholders; monthly summary reports posted to Web • Bulletin is PubMed indexed; journal publication is not pursued per se • Contributing to the EuroScan database • Jurisdiction-based liaison officers

Table 7. Canadian Agency for Drugs and Technologies in Health Environmental Scanning Program (continued)

Area of Interest	Data Collected
What methods are used for monitoring future development of identified target technology? How often are the assessment reports updated? How does the system determine when a report needs to be updated?	The horizon scanning product is updated on an *ad hoc* basis and is issue-driven (e.g., MS liberation surgery, PET).[77]
How is the health care horizon scanning program evaluated?	The program is evaluated within the context of regularly occurring formal, independent evaluations as part of the funding agreement between CADTH & Health Canada.