CANCER PEDIA

RESEARCH

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CHAPTER
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RESEARCH

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A. INTRODUCTION

Cancer centres are uniquely positioned to advance the standard and quality of cancer care through research. Research generates new knowledge that in turn serves to improve patient outcomes and can be transferred beyond the centre.

Research programs have many benefits. They help attract and retain talented healthcare professionals, and allow for the early adoption of new treatments or procedures.[1] Institutions participating in clinical trials have better patient outcomes compared with institutions that do not participate in studies; this may arise from changes in behavior or processes that result from the discipline of conducting research.[1] Finally, research naturally fosters collaborations with other institutions and funders, which can generate new research initiatives and educational opportunities.

A cancer centre's research enterprise typically supports the vision, priorities and capabilities of the organization. A successful program of research not only includes independent and internally-generated discovery using a wide range of professionals, patients and volunteers, but also strategic collaborations with external researchers in other cancer centres and organizations locally, nationally and globally. To build a robust research enterprise, appropriate resources are required along with a commitment to improve the quality and impact of research.

This chapter presents an overview of research in the cancer centre. It discusses the types and areas of cancer research, research structures, the resources required to establish and run a research program, the importance of effective management and quality performance, and future trends.

B. OVERVIEW

1. TYPES OF CANCER RESEARCH

There are four types of cancer research.[2]

Basic

Basic research focuses on understanding the fundamental nature of cancer through the study of stem cells, cell signaling, cell biology, structural biology, immunology, genomics and proteomics. Basic research takes place in laboratories, and provides the foundation for scientific and technical advances against cancer.

Clinical

Clinical research involves the use of patient information, materials and tissue samples, or engages patients directly in testing the safety and efficacy of drugs, technologies or any other interventions to improve patient care. Clinical trials test new interventions as well as refine and validate these interventions to make them ready for general use. Clinical trials can be classified into different phases:[3,4]

- ***Phase 0***: Determine if an intervention behaves the way it is expected based on laboratory studies. Tests are conducted on a very small number of people. Not all clinical trials use this phase.
- ***Phase 1***: Identify safe doses, best delivery methods, side-effects, and the impact of the intervention on cancer. Tests are usually conducted on a small number of people (i.e., approximately 15 to 30).
- ***Phase 2***: Determine best doses, side-effects and their management, and the impact of the intervention on various types of cancer. Tests are usually conducted on up to 100 people.
- ***Phase 3***: Compare the new intervention to current standard treatment. Tests are usually conducted on 100 to several thousand people.
- ***Phase 4***: Assess the long-term risks, benefits and effectiveness of interventions that have been approved and licensed and are on the market.

Translational and Implementation

Translational and implementation research bridge the laboratory and the clinic, or move the results of studies into clinical care, public practice and policy settings. When study results determine that an intervention can improve the health of individuals or a population, additional research may be needed to determine how to do this effectively outside of a controlled setting, or to test ways to overcome implementation barriers. Translational research overlaps with other types of research.

The phrase "bench to the bedside and back to the bench" refers to the fact that the ultimate purpose of research is to improve patient care and treatment, and prevent cancer. Likewise, the patient's experience with cancer treatment influences the research that is conducted.

Population-Based

Population-based research explores the causes of cancer, cancer trends, and factors that affect the delivery and outcomes of cancer care in large groups of people and/or specific populations. Research methods may include analyzing data from registries, conducting observational studies (e.g., comparing two groups of people retrospectively) and surveying groups. Population-based research identifies associations or trends that are difficult or impossible to identify by studying individuals.

2. AREAS OF SCIENTIFIC INTEREST IN CANCER RESEARCH

The International Cancer Research Partnership (ICRP), an alliance of cancer organizations working together to enhance global collaboration and the strategic co-ordination of research, classifies scientific interest in cancer research into six broad areas.[5]

Biology: Research that looks at the biology of how cancer starts and progresses, as well as normal biology relevant to these processes.

Etiology: Research that aims to identify the causes or origins of cancer (e.g., genetic, environmental, lifestyle), and the interactions between these factors.

Prevention: Research that identifies individual and population-based primary prevention interventions, which can reduce the burden of cancer by reducing exposure to cancer risks and increasing protective factors.

Early Detection, Diagnosis and Prognosis: Research that identifies and tests cancer markers, imaging and other methods that are helpful in detecting and/or diagnosing cancer, predicting the outcome or chance of recurrence of cancer, or supporting treatment decision-making in stratified/personalized medicine.

Treatment: Research that identifies and tests treatments administered locally (e.g., radiotherapy, surgery) and systemically (e.g., full body chemotherapy), as well as non-traditional (i.e., complementary or alternative) treatments such as supplements and herbs. This area also includes research into the prevention of recurrence and treatment of metastases.

Cancer Control, Survivorship, and Outcomes: Research that includes many areas, including: patient care and pain management; tracking cancer cases in the population; beliefs and attitudes that affect behavior regarding cancer control; ethics; education and communication approaches for patients, family, caregivers and healthcare professionals; supportive and end-of-life care; and the quality and cost effectiveness of healthcare delivery.

C. STRUCTURES AND ENABLERS

Research is complex, costly and requires attention to safety, quality and ethical conduct. Oversight structures are required to ensure that adequate resources are available to undertake research in a high-quality manner that is compliant with all applicable regulations. Research support services facilitate and enable research.

3. FORMAL RESEARCH PROGRAM

The cancer centre's research program should take a broad, co-ordinated approach in order to facilitate individual research initiatives or studies, and the scope of the program should be both extensive and intensive.[6] A cancer centre's research program should include internal and collaborative research, which brings together investigators from the centre and other organizations (e.g., multi-site clinical trials), as well as transdisciplinary research that includes basic, clinical and population sciences research.

The research program may be organized by type of research and/or by scientific research group. For example, the research program's basic research unit may include groups in cancer genetics, genomics, stem cells, systems biology and so on. The clinical research unit may include research groups in imaging, pathology, nursing, supportive care, palliative care, radiotherapy, medical oncology, surgical oncology and so on. The scale and scope of research will be dependent on local expertise, interest and resources.

The research program should establish clear roles, responsibilities and deliverables, along with supporting policies and procedures to guide its activities. In addition, the program must establish appropriate executive and management committees to help guide program-wide decision-making.

4. RESEARCH SUPPORT SERVICES

Research support services include, but are not limited to, the following.

Clinical Trials Support

Clinical trials support provides expertise for managing studies and meeting all regulatory and data requirements and standards. For requirements and standards related to designing, conducting, recording and reporting trials involving human subjects, see the International Conference on Harmonization's *ICH E6: Good Clinical Practice: Consolidated Guidance* and its addendum.[7,8]

For clinical research to succeed, there must be buy-in at every level of the hospital. Hospital administration, healthcare providers and support services must all see research as an important activity and understand their role in the endeavor. A clinical research champion should be utilized to lead the development of a clinical research unit.

Clinical trials must be seen as an important option for patients. The success, activation and conduct of a clinical trial not only requires specific research staff and an appropriate infrastructure, but also support from allied specialties. For example, radiologists are required for imaging to document patient responses and to support Response Evaluation Criteria in Solid Tumors (RECIST) reporting. Pathologists are required for tumour biopsies to support pharmacodynamic studies, and to review and prepare samples. Engagement of all relevant departments and specialties prior to activating a clinical trial is crucial.

Dedicated clinical research staff are needed to run a clinical trial, including clinical research nurses, pharmacists, data managers, ethicists, regulatory experts, finance experts and contract experts. All must have expertise in regulatory guidelines and Good Clinical Practice (GCP), as well as any other applicable local regulations for the conduct of clinical research. Some staff undertake clinical research within their role as healthcare providers, while others have a sole research role. The oncology research nurse provides patient care over the course of clinical trials, with a specialty focus on working with the study team and patients and caregivers to implement and facilitate protocol-driven procedures, assess patient adverse events, document all activities and evaluations, and advocate for the ethical care of clinical trial patients.

The majority of clinical trials evaluating a new treatment intervention include the collection of biospecimens, which may include tumour and tissue, blood or urine samples. The collection of biospecimens requires processes for processing, handling, storing, shipping, tracking and documenting samples.

Research Ethics Board

A mandatory requirement for a research program involving human participants or human material, including information, is a research ethics board (REB), which may be known by other terms such as a research ethics committee, ethics review committee or institutional review board. Investigators who wish to interact with human subjects must demonstrate that their research meets the highest scientific and ethical standards, and that safeguards are in place to protect research participants. All studies involving human subjects must have a written REB approval. The REB must set standard requirements and follow a rigorous process to assess applications for research using human participants, with ethical principles that are consistent with the *Declaration of Helsinki*, GCP and all applicable regulatory requirements. An REB is required to provide an initial review of all studies followed by a continuing review of each study at a minimum of once per year.

REBs must include an appropriate composition of scientific experts, legal and ethical experts, lay representatives and members who are independent of the site at which the research will be conducted. The REB should be gender balanced and reflect the cultural diversity of the community from which subjects will be enrolled. All members must be independent from the research being reviewed.

Research documentation that an REB should obtain and review includes: the research protocol and any subsequent amendments; patient consent materials and any amendments; materials related to participant recruitment or study advertising; any information that will be provided to the subject; the details of any planned compensation; the investigator brochure and safety information; and investigator CVs or records of qualification.

Research applications may be approved, modified or rejected, and decisions must be communicated in writing by the REB to investigators in a timely manner. Non-approval means that the research should not be initiated, or be terminated if it is ongoing.

For additional information on REBs as well as standards and procedures for research with human participants, see the following:

- The World Medical Association's *Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects*[9]
- The International Conference of Harmonization's *ICH E6: Good Clinical Practice: Consolidated Guidance* and its addendum[7,8]
- The Council for International Organizations of Medical Sciences' International *Ethical Guidelines for Biomedical Research Involving Human Subjects*[10]
- The World Health Organization's *Standards and Operational Guidance for Ethics Review of Health-Related Research with Human Participants*[11]
- European Network of Research Ethics Committees[12]

Biostatistics

Biostatistics support is required in all types of research, from trial design and protocol development to data management, monitoring, analysis and reporting. Biostatisticians work closely with other members of the research team to provide statistical design and analysis that supports cancer research. They conduct the majority of their work with the help of statistical software; for example, SAS, R and PASS 14. Statistical standard operating procedures (SOPs) and guidelines are very important and can enhance the transparency and reproducibility of research results. Examples of SOPs for clinical trials include:

- Developing a statistical analysis plan
- Elements of a statistical report
- Interim analysis reporting
- Randomization and blinding procedures

Biobank

Cancer centre biobanks are a collection of human biological specimens (i.e., tissue, blood and body fluids) that are used for research. Specimens may be categorized by a person's genetic profile, age, gender, family history, ethnicity, blood type and environment (e.g., place of birth, location of residence, workplace, lifestyle, exposure to toxic substances, etc.). An effective biobank includes relevant clinical data, describing the specimen, the diagnosis, and the patient's characteristics and treatment details.

Standards and guidelines exist to govern biobanks, which specifically address such issues as informed consent to take samples, the collection of samples, the maintenance of samples and access to samples. Examples of standards and guidelines for biobanks include the following.

- The International Agency for Research on Cancer's *Common Minimum Technical Standards and Protocols for Biological Resource Centres Dedicated to Cancer Research*[13]
- The Organisation of European Cancer Institutes' *From the Biobank to the Research Biorepository: Ethical and Legal Recommendations*[14]
- The Organisation for Economic Co-operation and Development's *Guidelines on Human Biobanks and Genetic Research Databases*[15]

Quality Assurance and Quality Control

Quality assurance is a critical component of research. The quality assurance function should ensure that research is conducted in compliance with a study protocol, ethical standards, applicable regulations, SOPs and institutional policies. The goals of quality assurance are to enable research subject safety, valid and reproducible research results, accurate data collection, the identification of problem areas and corrective action, as necessary. Both source documentation and regulatory documentation must follow GCP guidelines, applicable regulations, protocol-specific requirements and SOPs.

Quality control is focused on fulfilling quality requirements. It encompasses the operational techniques and activities undertaken to verify that requirements for quality have been met. Any process used to conduct and report on internal and external audits should be rolled out using a risk-based approach, and should include support for, and monitoring of, a close out that includes appropriate corrective action and preventative action plans. Audit observations should be tracked centrally to assess trends, identify gaps in processes, enable proactive training to mitigate repetitive errors and drive education initiatives.

A quality management system (QMS) can support quality assurance and quality control. A QMS is a formalized system that supports processes, procedures and responsibilities for achieving quality goals. It includes an organizational structure with resources for implementing quality management. Active participation from the executive leadership of the organization is required. Continual evaluation and improvement of the QMS can help the organization to respond to change and meet evolving needs. For more information, see the *Cancerpedia: Quality* chapter.

Research Education

Research education provides training in a wide range of research-related areas. The clinical research environment is continuously evolving, with new methodology, complexity and regulatory stringency. A well-educated clinical research team is critical to ensuring compliance, patient safety and data integrity. Compiling quality findings from quality assurance systems provides insight into gaps within existing processes and informs educational content. Training topics should be continually reviewed, updated and developed to reflect the current oncology research landscape and training needs.

Training topics may include: diagnosis and treatment; centre programs and orientation; research design; study co-ordination skills; clinical research skills; clinical trials processes and communication; statistics and data analysis; clinical research application skills; and patient education. There should be appropriate orientation of new staff to ensure compliance with training requirements across the institution. This should include investigator orientation to the clinical research program as well as training in electronic documentation, clinical research process and SOPs. For more information, see the *Cancerpedia: Education* chapter.

D. RESOURCES

Resource needs for research are wide ranging and include appropriate start-up funding, the capacity to secure ongoing funding, facilities and equipment, human resources and an information management infrastructure. The core resource elements required for research are standard; however, various factors may impact the level and configuration of resources required by a specific cancer centre. For example, increased resources may be needed to support a higher volume of research or more specialized research.

5. FUNDING

The cancer centre must secure sufficient funding to support the management and operations of its research program, its specific research units and its research support services. This includes funding for physical facilities and equipment, human resources and an information management infrastructure. The cancer centre may also support investigators who are engaged in research and other activities, such as patient care and teaching.

Funding for cancer research usually comes from multiple sources, which may include the following:

- *National and subnational research funding organizations*: Funding organizations typically award funds through a competitive, peer-review process. These organizations may support a broad range of healthcare research, or focus specifically on cancer.
- *Pharmaceutical, biotechnology and medical device companies*: Companies tend to sponsor and collaborate with cancer centre investigators on clinical trials and research projects that test or further the development of drugs and equipment.
- *Private and public foundations*: Foundations raise funds from donors or through other means (e.g., lotteries) with the express purpose of supporting cancer research and research leadership (e.g., research chairs). These organizations may have a national, subnational or local presence. Large cancer centres are often associated with a dedicated foundation that helps raise funds for internal and collaborative research. For more information, see the *Cancerpedia: Philanthropy* chapter.
- *Universities, hospitals and other organizations*: These organizations provide some funding for research and may help cover indirect costs for research studies (e.g., administrative and support services, additional physical facility costs beyond available core facilities).

Generally, researchers are expected to apply for research funding from one or more of the above sources. Awarded funds cover the costs of conducting research studies and as well as indirect costs. It is important to be transparent about the sources of funding used for research. Disclosing these sources of funding appropriately helps to manage potential conflicts of interest or perception of bias.

Financial management support is essential for a sustainable research operation. Access to financial and budget analysts is important to: ensure the accuracy and timeliness of payments received from funding sources; identify discrepancies in invoices and payments, and advise the appropriate parties to take corrective action; and provide comprehensive financial management and consultation to the principal investigators of clinical trials and various service departments.

6. FACILITIES AND EQUIPMENT

Facility infrastructure for research includes physical space as well as equipment and supplies. The design and layout of research-related facilities must meet the needs of researchers, as well as any quality and safety standards and requirements for cancer research set by the national and subnational regulatory bodies of the jurisdiction in which the cancer centre is located. The scale of the research facility infrastructure will vary depending on the scope of the research program and the extent of its internal and collaborative research projects.

Clinical Space

Clinical trials require adequate clinical space, which can vary greatly depending on the nature of the clinical research. Infrastructure needs must be carefully considered before a clinical trial is activated. Space for clinical trials may be above that required for standard of care treatments. For example, clinical trial protocols frequently stipulate additional clinic visits to monitor subjects, inpatient treatment interventions or overnight hospital stays to enable frequent pharmacokinetic blood sampling. Investigational treatments require additional resources to administer the treatments, which may require a pre-specified observation period for monitoring. There must also be adequate space in pharmacy to manage new investigational products, and adequate access to surgical theatres and radiation machines for surgical and radiation studies. For clinical trials that are testing medical equipment, devices and interventions that cannot be accommodated with available physical facilities, purpose-built space and dedicated supplies may be required.

Research Laboratories

Basic research requires adequate laboratory space along with state-of-the art. Equipment may include highly advanced microscopes, scanners, computer hardware and software for analysis. Animal care facilities may also be required. For more information about laboratory facilities and equipment, see the National Research Council's *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version* and the National Institute of Building Sciences' design recommendations for research facilities.[16,17]

Workspace

Clinical and translational/implementation research requires adequate office space. Similarly, program leadership, research unit directors and managers, research support service staff, technical staff and full-time researchers require office space to conduct work, research development, data gathering and analysis, and population-based research.

Meeting rooms and conference rooms or lecture halls are required to support staff meetings, space for monitoring and auditing, and education activities.

Dedicated common rooms should be available to staff and research trainees for nutrition breaks, with secure space (e.g., lockers) for personal belongings.

Storage

Storage facilities must be available to maintain the integrity of biobank samples using appropriate conditions and temperatures, and automated systems that enable accurate and timely access to requested samples. Supplies, such as correlative kits, are frequently provided by a clinical trial sponsor and also require storage. Cancer centres may have biobanks on site or may contract with organizations that maintain biobanks. For more information, see *The Evolution of Biobanking Best Practices*.[18]

All research requires supplies, which can range from basic office supplies to highly-sophisticated laboratory equipment. Adequate space for the storage of supplies and the archiving of clinical records is essential. The storage of source documentation may be subject to regulatory oversight; for example, clinical trial source documentation must be retained for a statutory period of time following the completion of a trial. For more information, see the *Cancerpedia: Physical Facilities and Support Services* chapter.

7. HUMAN RESOURCES

The cancer centre requires a sufficient number of qualified and skilled investigators to conduct research. These individuals may include full-time staff researchers as well as professionals who conduct research and perform other duties (e.g., patient care, education). Technical and support staff are needed to support all aspects of a successful research program. As a cancer centre becomes larger and more complex, other roles may be required, such as specialists in correlative laboratory specimen procurement and processing. It is recommended that all staff report to research directors/managers, rather than investigators, as specialized skills are needed to oversee and manage staff and performance.

All positions should have a job description with clear roles, responsibilities and accountabilities for performance. The research program should liaise with the human resources department to develop job descriptions and matrices that define the various levels and types of research professionals required by the cancer centre. For example, many programs employ a model wherein clinical trials nurses see patients and clinical research staff perform regulatory and data co-ordination activities.

Staff who are part of the cancer centre's research program must have the appropriate expertise and competencies for their roles, as well as appropriate orientation and training.

8. INFORMATION MANAGEMENT

Information management infrastructure is required to:

- Oversee and manage the research program
- Track and monitor research activities
- Assess research outcomes and impact

Research data is captured in research records, patient health records, the hospital registry and molecular databases, and may be shared with population-based cancer registries. Ideally, an electronic patient health record is available to enable the collection and reporting of outcomes data, as well as links to molecular data, as needed. For more information, see the *Cancerpedia: Health Records*, *Cancerpedia: Hospital Registry* and *Cancerpedia: Population-Based Cancer Registries* and *Risk Factor Surveillance* chapters.

E. MANAGEMENT

The head of the research program should be a senior leader who oversees all aspects of research at the centre. This includes establishing processes to strengthen research, setting up internal systems to support research and meeting quality performance standards. In addition, the program must have senior research directors and/or managers to lead and manage major research and support areas. These leads must ensure that all activities advance the organization's research strategy, continuously increase the level of the centre's discovery and impact, and meet all standards and requirements for exemplary research. Given that research is interrelated with care and education, cancer centres should also consider a lead director or manager who is responsible for linking education and research.

F. QUALITY

Cancer centres must regularly evaluate their research activities with respect to their magnitude, productivity and impact. Where possible, performance indicators should reflect research best practices and benchmarks, and be used to manage and improve the centre's research program. A centre may compare its research performance to its peers at the global, national and subnational levels.

The research program must select a manageable number of indicators to track. Table 1 presents examples of quality performance indicators for research.

Table 1: Examples of Quality Performance Indicators for Research

Category	Examples of Quality Performance Indicators
Size of Program	• Number of researchers • Number of research trainees (i.e., fellows, graduate students) • Number of staff • Total research funding received • Number of core research facilities • Research space
Conduct of Clinical Research	• Percentage of patients treated who participate in a clinical trial • Rate of studies with zero accruals • Length of time to open new studies • Number of open trials each year • Number of trials that are opened in a year
Standards and Regulations	• Use of standard operating procedures (e.g., management of clinical trials, collecting biospecimens) • Trending of results of audits
Outputs	• Number of completed research studies • Number of peer-reviewed publications
Impact	• Number of modifications and/or improvements in clinical practice as a result of research

G. ADDITIONAL CONSIDERATIONS

Research is competitive and is characterized by developing individual research programs, competing for limited research funds, being the first at discovery and innovation, publishing research findings in leading journals and being the first to market innovations. Although competitive, many researchers participate in collaborative work that provides other benefits. One benefit of collaboration is that it supports cancer research in countries with fewer resources. Collaborative research can also enable large-scale clinical trials involving multiple sites, providers and patients. The National Cancer Institute's Clinical Trials Cooperative Group Program involves more than 25,000 patients and thousands of clinical investigators in its clinical trials annually. In 2010, the Institute of Medicine made 12 recommendations to improve the network in response to concerns that it was not meeting its potential. Improvements included moving beyond co-operation to integration by reorganizing clinical trial structures and operations into the larger network.[19]

Greater collaboration is essential to the development of common standards and practices that help facilitate further research. For example, the Canadian Tissue Repository Network (CTRNet) fosters translational research by improving access to high-quality tumour biospecimens.[20] CTRNet established common standards to harmonize biospecimen quality and approaches to governance, and implemented a rigorous biobank certification program that includes education and required operational practices.[21] CTRNet lets researchers search for quality-controlled tissue samples from Canada's leading tumour banks in one, central location, and lets biobanks make their biospecimens available for research users.

Finally, collaboration can maximize the use of research talent, funding and resources, and avoid duplication of effort. The International Cancer Research Partnership (ICRP) is an alliance of cancer organizations from Australia, Canada, France, Japan, the Netherlands, the United Kingdom and the United States, working together to enhance global collaboration and strategic co-ordination of research.[5] Member organizations share funding information, facilitate the pooling and evaluation of data across organizations, and have access to a database that identifies grants from more than 100 funding organizations.

H. THE FUTURE

9. CLINICAL TRIALS

Significant improvements in outcomes for multiple cancer types have arisen from an understanding of molecular aberrations within tumours that can be targeted, and through the modulation of the immune system These approaches pose challenges, as trials evaluating interventions in rare subgroups of patients must screen many subjects for a specific marker to find a small number of eligible participants. As a consequence, the number of trials a centre may activate has increased, with the result that centres go through the costly and labour-intensive process of activating more trials with less anticipated accrual per trial. This is likely to become an increasing trend, as research continues to identify new, actionable molecular variants and potential actionable mechanisms of resistance for subsequent lines of therapy. Individual cancer centres, trial sponsors and regulatory authorities can all play a role in facilitating ways to streamline this process and facilitate research of rare cancer subtypes. Novel trial designs are now in practice, such as master protocols, that address multiple questions within a single protocol.[22] This can reduce the number of individual trial protocols and enhance accrual under a single protocol. There are also initiatives to enhance accrual and maximize efficiency, such as just-in-time clinical activation, where a centre activates a trial only when a potentially eligible patient has been identified. Novel trial designs and logistics will likely continue to facilitate the evaluation of new treatments in rare subtypes of diseases.

10. BIG DATA AND TECHNOLOGY

The rising prevalence of electronic patient health records and mobile, internet-enabled devices means that an increasing amount of patient data is being collected for potential study, including real time data. Often referred to as "big data", this pool of information continues to grow and evolve from sources such as administrative and claims data, routine population statistics, surveillance data, health records information, research data and registries. The potential for big data in research is high; however, the "high-volume, high-velocity and/or high-variety" of big data can also create challenges related to data storage, processing and management.[8,23,24] Excellent data stewardship and analytics are required to ensure that the datasets used for research are accessible, non-duplicative, complete and valid.

Moving forward, artificial intelligence may play an increasing role in research by allowing for algorithm-based testing and simulation of clinical decisions and other research-based scenarios.[25,26]

For more information about data sources and management, see the Cancerpedia: Equipment and Technology, Cancerpedia: Hospital Registry and *Cancerpedia: Population-Based Cancer Registries* and *Risk Factor Surveillance* chapters.

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