



MASTER_LAST UPDATED 04 February 2014. Washington University School of Medicine in St. Louis Bernard Becker Medical Library.
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THE BECKER LIST: IMPACT INDICATORS

The Becker Medical Library Model for Assessment of Research Impact model is a list of indicators to document evidence of biomedical research impact. The indicators are organized under the following pathways:

- Advancement of Knowledge
- Clinical Implementation
- Community Benefit
- Legislation and Policy
- Economic Benefit

The list is updated on a regular basis.

Please refer to the [Assessing the Impact of Research](https://becker.wustl.edu/impact-assessment) (<https://becker.wustl.edu/impact-assessment>) website for further guidance.



RESEARCH OUTPUTS AND ACTIVITIES	Research Outputs and Activities are products and/or activities resulting from basic or clinical biomedical research.
Indicators	Examples
Biological Materials	Biological material identified or developed as a result of the research study.
Books or Book Chapters	Books or book chapters resulting from the research study.
Collaborations	<p>Collaborative relationships resulting from the research study. Collaborative relationships can be classified in a number of ways:</p> <ul style="list-style-type: none"> • Type of collaboration? <ul style="list-style-type: none"> ○ Number of collaborations ○ Number of departments or disciplines represented ○ Number of institutions represented ○ Duration • Type of partner? <ul style="list-style-type: none"> ○ Community ○ Private/Foundation ○ Industry ○ University ○ Government • Geographic location of the partner? <ul style="list-style-type: none"> ○ Domestic (within the United States). ○ International (outside the United States). • Type of partnership? <ul style="list-style-type: none"> ○ Multidisciplinary (Researchers from different disciplines work independently on a research study to address a research issue). ○ Transdisciplinary (Researchers from different disciplines collaborate on a research study using a shared framework to address a research issue). ○ Interdisciplinary (Researchers from different disciplines collaborate on a project using their discipline-specific perspective to address a research issue). <p>[See: Stokols D, et al. The science of team science: overview of the field and introduction to the supplement. Am J Prev Med. 2008 Aug;35(2 Suppl):S77-89.]</p>



RESEARCH OUTPUTS AND ACTIVITIES	Research Outputs and Activities are products and/or activities resulting from basic or clinical biomedical research.
Indicators	Examples
Conferences or Meetings or Symposia or Lectures	Conference papers resulting from the research study. Conference posters resulting from the research study. Panel discussions resulting from the research study. Presentations submitted by members of a research study in response to a Call for Papers issued by organizers of a meeting or conference. Presentations given by members of a research study in response to a written invitation issued by organizers of a meeting or conference. Lecture provided by research investigators. Supplemental materials provided by research investigators. Meetings or symposia are organized and held by research investigators.
Data (public or restricted)	Research data generated by the research study. Research data is deposited into a shared repository. Metadata from research data is shared with other parties. Supplemental materials are deposited into a shared repository.
Databases or Repositories	Database or repository resulting from the research study.
Diagnostic Techniques and Procedures	Diagnostic application for identification of a disease, disorder or condition developed as a result of the research study. Screening tool for identification of a disease, disorder or condition developed as a result of the research study.
Funding	Research study invited to submit a funding application from a funding body. Research study secures funding.
Gray Literature Materials	Non peer-reviewed journal articles or report or other publication resulting from the research study. Trade publications resulting from the research study. Supplemental materials that supplement a publication (published or unpublished). Slides, videos or other materials resulting from the research study.



RESEARCH OUTPUTS AND ACTIVITIES	Research Outputs and Activities are products and/or activities resulting from basic or clinical biomedical research.
Indicators	Examples
Invention Disclosures	Invention disclosures reported to the university/organization as a result of the research study. License agreements or patents may be executed for inventions deemed to be of potential commercial value. Examples of inventions are: <ul style="list-style-type: none"> • Diagnostic product • Therapeutic product • Measurement instrument • Computer software
License Agreements	License agreement executed for invention or intellectual property generated by the research study.
Measurement Instruments	Measurement instrument developed as a result of the research study.
Media Releases, Appearances or Interviews	News releases issued by the research study or affiliate organization. Media appearances or interviews involving the research investigators. Research study is profiled in a publication published by the institution.
Medical Devices	Medical device or prototype developed as a result of the research study.
Mobile Applications	Mobile application developed by the research study.
Outreach Efforts	Research investigators invited to provide a presentation based on research findings to the public. Research investigators invited to provide a presentation at a non-professional conference. Research investigators meet with policy-makers and other stakeholders to review research findings. Number of attendees at outreach visits. Other types of outreach activities.
Patents	Patent executed for invention generated by the research study.
Peer-Reviewed Journal Articles	Peer-reviewed journal articles resulting from the research study.
Pharmaceutical Preparations	Potential new drug identified as a result of the research study.
Research Methodologies	Algorithm resulting from the research study. Conceptual framework resulting from the research study. Scientific analysis method resulting from the research study. New approach for researching a disease, disorder or condition resulting from the research study. Novel use of technology resulting from the research study. Theoretical construct resulting from the research study.



RESEARCH OUTPUTS AND ACTIVITIES	Research Outputs and Activities are products and/or activities resulting from basic or clinical biomedical research.
Indicators	Examples
Social Media Applications	Social media accounts (Twitter, blogs, Facebook, etc.) utilized by the research study to disseminate results about the research study. Research investigators create a You Tube video about the research study. Research investigators create a Wikipedia or other wiki entry based on the research study.
Software Applications	Software resulting from the research study (alpha or beta).
Trainees or Scholars	Trainees or scholars involved in the research study.
Training Materials	Training materials developed as a result of the research study. Best practices guidance document developed as a result of the research study.
Website of Research Study	Website developed for the research study.



ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Books or Book Chapters	<p>Book or book chapters generated by the research study is noted in a bibliography.</p> <p>Number of libraries that own the book generated by the research study.</p> <p>Book is used as a textbook for higher education.</p> <p>Subsequent editions of the book or book chapters.</p> <p>Book is reviewed by a scholarly journal.</p> <p>Translations of the book.</p> <p>Book awarded prizes such as the PROSE Award or noted by an organization as having made a significant contribution to a field.</p> <p>Book noted on a publisher’s best-seller list.</p> <p>Book or book chapter cited in subsequent publications.</p> <p>Book publicly recommended on Google+.</p> <p>Author invited to present on the topic related to the book or book chapter.</p>
Change in Understanding and Awareness	<p>Research study findings represent a paradigm shift in a field.</p> <p>Research study findings lead to change in understanding a problem.</p> <p>Research study findings expand the knowledge in a field.</p> <p>Research study findings lead to a new approach to disease, disorder or condition.</p>
Citations to Publications	<p>Publications generated by the research study are cited in a subsequent reference including journal articles, books, book chapters, gray literature, dissertations, patents, web sources, and/or data records.</p> <ul style="list-style-type: none"> • Number of first generation citations. • Number of second generation citations. • Countries represented by citations. • Institutions represented by citations. • Languages represented by citations. • Subject foci represented by citations. • Funding acknowledgements represented by citations. • Other research studies represented by citations. <p>See Publication Metrics for related examples.</p>
Classical Articles	Publication generated by the research study is cited or noted as being a classical article in a field of study.



ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Conferences	<p>Conference theme is organized around the topic related to the research study.</p> <p>Conference panel is created around the topic related to the research study.</p> <p>Research study findings are cited in a presentation.</p>
Collaborations/Partnerships	<p>Research study collaborations that continue after completion of a research study within the university or outside of the university.</p> <p>Research study results in new collaborative relationship after completion of a research study within the university or outside of the university.</p> <p>Research study members are invited to collaborate on a new research study within the university or outside of the university.</p> <p>Collaborative relationships can be classified in a number of ways:</p> <ul style="list-style-type: none"> • Type of collaboration? <ul style="list-style-type: none"> ○ Number of collaborations ○ Number of departments or disciplines represented ○ Number of institutions represented ○ Duration • Type of partner? <ul style="list-style-type: none"> ○ Community ○ Private/Foundation ○ Industry ○ University ○ Government • Geographic location of the partner? <ul style="list-style-type: none"> ○ Domestic (within the United States). ○ International (outside the United States). • Type of partnership? <ul style="list-style-type: none"> ○ Multidisciplinary (Researchers from different disciplines work independently on a research study to address a research issue). ○ Transdisciplinary (Researchers from different disciplines collaborate on a research study using a shared framework to address a research issue). ○ Interdisciplinary (Researchers from different disciplines collaborate on a project using their discipline-specific perspective to address a research issue).



ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Consensus Development Conferences	Research study cited in a Consensus Development Conference.
Curriculum Guidelines/Materials	Curriculum guideline refers to the research study as being significant or for use as recommended or background readings for more information. Research study findings are cited in teaching materials.
Data	Research data is deposited into a repository. Research data created by the research study are reused and/or cited by other parties.
Gray Literature	Research study findings are noted in a trade publication, government documents, industry reports, public policy documents or other publications. Research study findings are noted by a funding agency.
Licenses	License is granted to outside parties for use of intellectual property or invention generated by the research study. Examples of licenses include: <ul style="list-style-type: none"> • Evaluation and Option Agreement. • Non-Exclusive License Agreement. • Exclusive License Agreement.
Mass Media	Mass media publication or broadcast refers to the research study. Research investigators are interviewed by the media.
Material Transfer Agreements (MTA)	MTA is granted for transfer of tangible property generated by the research study.
Meta-Analyses	Research study is cited in a meta-analysis.
Institute or Center	New institute or center is formalized as a result of a research study.
Partnership/Collaboration	New partnership or collaboration formed as a result of a research study.
Research Direction	Research study findings lead to new direction and/or area of research.
Research Field or Discipline	Research study findings lead to new field of research or discipline.
Outreach Efforts	Research study investigators receive feedback as a result of an outreach effort.



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ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Pharmaceutical Preparations	Potential new drug shows benefit during pre-clinical development trials. Investigational New Drug (IND) application accepted by FDA.
Proof of Concept (POC)	An experimental scientific method or innovation demonstrates feasibility in a pilot study.
Publication Metrics	<p>Publication generated by the research study accessed/viewed online. (Publications include journal articles, books, book chapters, slides, software, conference papers, data sets, videos, supplemental materials, etc.).</p> <p>Publication generated by the research study downloaded.</p> <p>Publication generated by the research study is assigned a ranking factor by a reviewer based on significance of the research study.</p> <p>Publication generated by the research study is awarded a “Best Paper” award by a publisher.</p> <p>Publication generated by the research study is reviewed by Facultyof1000.</p> <p>Publication generated by the research study is noted as a Breakthrough of the Year in AAA Science Magazine.</p> <p>Publication generated by the research study is noted as a Top Scientific Discovery in Wired.</p> <p>Publication generated by the research study is noted in “Data and Rankings” in Science Watch.</p> <p>Author/s in publication generated by the research study is noted in “Data and Rankings” in Science Watch.</p> <p>Publication generated by the research study is noted as a SciVerse ScienceDirect Top 25.</p> <p>Publication generated by the research study is noted as a Hot Paper in Essential Science Indicators.</p> <p>Publication generated by the research study is noted as a Core Paper in Essential Science Indicators.</p> <p>Publication generated by the research study is noted as a Highly Cited Paper in Essential Science Indicators.</p> <p>Research study itself is referred to in a publication without a reference.</p>
Reprint Requests	Requests for reprints (print or electronic) for journal articles generated by the research study.
Requests for Information	Physicians, policy makers or consumers contact research study investigators for more information on research findings.
Research Methodologies	<p>Research methodologies developed by the research study are used by others. Examples include:</p> <ul style="list-style-type: none"> • Scientific analysis method. • Conceptual framework. • Algorithm.
Research Practice	Research study leads to change in bench or clinical research practices.



ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Research Studies/Ancillary	Ancillary research study generated as a result of the research study. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.
Research Studies/New	New research study generated as a result of the research study. New pilot award generated as a result of research study findings. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.
Research Studies/Renewed	Research study is renewed. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.
Reviews	Research study cited in a review.
Social Media Applications	Publication generated by the research study is referred to or cited in a blog, tweet, wiki, or other non-traditional mode of dissemination. (Publications include journal articles, books, book chapters, slides, software, conference papers, data sets, videos, supplemental materials, etc.). Publication generated by the research study accessed/viewed online. Publication generated by the research study downloaded. Publication generated by the research study is bookmarked by online reference managers. Comments, notes, recommendations and/or rankings are added by readers to a publication generated by a research study. Video about the research study is viewed or recommended by others. Wiki entry (based on the research study) is publicly edited.
Software Applications	Software applications developed by the research study are used by others.
Subject Headings/Thesauri	New subject heading or thesauri term or phrase resulting or related to the research study is established.
Systematic Reviews	Research study is cited in a systematic review.



ADVANCEMENT OF KNOWLEDGE	Advancement of Knowledge represents research outputs and/or activities that contribute to the scholarly record.
Indicators	Evidence
Trainees/Scholars	For some research studies, trainees or scholars are involved with research. Examples of outcomes related to the training/education received are: <ul style="list-style-type: none"> • Trainees or scholars receive advanced degrees. • Trainees or scholars continue research at different institutions. • Trainees or scholars receive grant award funding for research. • Trainees or scholars engage in translational research.
Training Materials	Training materials created by the research study are used or adapted by others.
Website of Research Study/ Usage	Some investigators have websites devoted to a research study. Examples of metrics related to the website include: <ul style="list-style-type: none"> • Number of page views. • Number of unique and returning visitors. • Origin of site visitors by country. • Time spent on site. • Requests from the public for more information. • Requests from health care providers and researchers for more information. • Other web-based metrics.

CLINICAL IMPLEMENTATION	Clinical Implementation is the adoption of research outputs and/or activities in clinical applications.
Indicators	Evidence
Biological Materials	Biological material application generated by the research study shows benefit during clinical trials. Biological material application generated by the research study registered/licensed with FDA. Biological material application generated by the research study used by health care providers and/or consumers.
Clinical Decision Aids	Research study cited in a clinical decision aid. Research study findings are synthesized in consumer health materials.
Clinical Trial Outcomes	Research study efforts results in recruitment and retention of clinical trial participants. Clinical Trial is successful (Phase I, II, III, or IV).
Clinical/Practice Guidelines	Research study cited in a guideline issued by a government agency. Research study cited in a guideline issued by a specialty organization related to the field of study. Research study cited in a guideline issued by a non-government organization. Research study cited in a clinical point-of-care resource.



CLINICAL IMPLEMENTATION	Clinical Implementation is the adoption of research outputs and/or activities in clinical applications.
Indicators	Evidence
Clinically Effective Practice	Research study findings result in a clinically effective approach in the management and treatment of a disease, disorder or condition. Clinicians in the field report change in delivery of healthcare based on findings of research study.
Coding	HCPCS code implemented as a result of the research study. ICD code implemented as a result of the research study. CPT code implemented as a result of the research study.
Continuing Education Materials	Research study findings cited in continuing education materials.
Diagnostic Techniques and Procedures	Research study findings result in a diagnostic application for identification of a disease, disorder or condition. Research study findings result in a screening tool for identification of a disease, disorder or condition.
Disease Prevention/Eradication	Research study findings lead to identification of measures for disease prevention. Research study findings lead to eradication of a disease.
Enhancement of Resources	Research study findings result in enhancement of existing resources and expertise.
Laboratory Techniques and Procedures	Research study findings result in new laboratory methods or procedures.
Measurement Instruments	Measurement instrument generated by the research study is used. <ul style="list-style-type: none"> • Requestor status, individual or organization. • Purpose. • Translations, if applicable. • Adaptations, if applicable.
Medical Devices	Clinical trial study testing of a medical device generated by the research study. Clinical data generated in support of marketing a medical device, 510(k); Investigational Device Exemption, IDE; or Premarket Approval, (PMA) generated by the research study. Medical device generated by the research study shows benefit during clinical trials. Medical device generated by the research study registered/licensed with FDA. Medical device generated by the research study used by health care providers and/or consumers.
Mobile Applications	Mobile application is developed by the research study is used by health care providers and/or consumers.



CLINICAL IMPLEMENTATION	Clinical Implementation is the adoption of research outputs and/or activities in clinical applications.
Indicators	Evidence
Pharmaceutical Preparations	Drug generated by the research study shows benefit during clinical trials. Drug generated by the research study registered/licensed with FDA. Drug generated by the research study is listed on a drug formulary list. Drug generated by the research study listed on the WHO Model List of Essential Medicines. Drug generated by the research study is prescribed by health care providers.
Quality Measure Guidelines	Research study cited in a guideline issued by a government agency. Research study cited in a guideline issued by a specialty organization related to the field of study. Research study cited in a guideline issued by a non-government organization.
Quality of Life	Research findings result in a treatment or intervention that is judged as being clinically effective. Patients self-report increase in quality of life.
Reporting Requirements	Research study identifies new parameter leading to surveillance and reporting of a disease, disorder or condition.

COMMUNITY BENEFIT	Community Benefit is the enhancement of well-being to the community as a result of research outputs and/or activities.
Indicators	Evidence
Awareness and Identification of Risk Factors	Research study findings lead to public awareness of risk factors of a disease, disorder, condition or behavior. Research study findings lead to identification of risk factors of a disease, disorder, condition or behavior.
Consumer Health Information	Research study findings result in patient decision materials to assist with healthcare decision-making. Research study findings are cited in materials for patients or the public.
Health Care Quality Access and Evaluation	Research study findings result in increased performance, quality, and consistency in the delivery of health care services.
Health Promotion	Research study findings leads to enhancement of health promotion activities among community members.
Lifestyle Intervention	Research study findings leads to identification of a lifestyle intervention.
Measurement Instruments	Measurement instrument generated by the research study used by consumers.
Partnerships	Research study forms partnership with Community or other group to address a community-based need.
Pharmaceutical Preparations	Drug generated by the research study used by consumers.
Private Healthcare Benefit Plans	Research study cited in private insurance benefit plan in support of coverage.
Public Healthcare Benefit Plans	Research study cited in a public insurance benefit plan in support of coverage.
Standard of Care	Research study findings result in clinically effective approach in the standard of care for a disease, disorder or condition.



LEGISLATION AND POLICY	Legislation and Policy represents codification of research outputs and/or activities into public law, guidelines, standards or policy.
Indicators	Evidence
Committee Participation	Research study members invited to serve on advisory boards. Research study members invited to serve on committees for policy development.
Guidelines	Research study cited in development of guidelines issued by organizations.
Legislation/Regulations	Research study cited in enactment of federal, state or local legislation or regulation.
Policy	Research study cited in enactment of federal, state or local policy. Research study cited in enactment of non-governmental policy. Policy-making organizations report that research findings resulted in change in policy.
Standards	Research study cited in enactment of standards such as American National Standards Institute (ANSI) or the International Standard Organization (ISO).
Testimony/Witness	Testimony based on research outputs and/or activity is presented before a legislative body.

ECONOMIC BENEFIT	Economic Benefit represents economic outcomes as a result of research outputs and/or activities.
Indicators	Evidence
Costs Savings	Research study findings result in reduced costs in the delivery of health care services.
Cost-Effectiveness	Research study findings result in a cost-effective intervention for a disease, condition or disorder.
Disease Prevention/Eradication	Research study findings lead to identification of measures for disease prevention. Research study findings lead to eradication of a disease.
Health Resources	Research study findings result in enhancement of existing resources and expertise.
Quantity and Quality of Life	Research findings result in a treatment or intervention that is judged as being clinically effective. Patients self-report increase in quality of life.
Quality of Healthcare Services	Research study findings result in increased performance, quality, and consistency in the delivery of health care services.



ECONOMIC BENEFIT	Economic Benefit represents economic outcomes as a result of research outputs and/or activities.
Indicators	Evidence
License Agreements	Revenue generated from granting of licensing to outside parties for use of intellectual property or invention generated by the research study. Examples of licenses include: <ul style="list-style-type: none"> • Number of licenses granted. • Requestor status, individual or organization. • Purpose. • Translations, if applicable. • Adaptations, if applicable.
Life Expectancy	Research study findings result in increased life expectancy.
Morbidity and Mortality	Research findings result in reduction of disease burden. Research findings result in reduction of morbidity. Research findings result in reduction of mortality. Research findings results in reduction of prevalence of a disease, disorder or condition. Research findings result in reduction of incidence of a disease, disorder or condition.
Pharmaceutical Preparations	Drug generated by the research study results in a cost-effective means of management of a disease, disorder or condition.
Research Project/Ancillary	Ancillary research study generated as a result of the research study. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.
Research Projects/New	New funded research studies generated as a result of the research study. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.
Research Projects/Renewed	Renewed research studies generated as a result of the research study. <ul style="list-style-type: none"> • Dollar amount of the new research study. • Duration of the new research study. • Type of funding sources. • Full time employees.



ECONOMIC BENEFIT	Economic Benefit represents economic outcomes as a result of research outputs and/or activities.
Indicators	Evidence
Spin-off Company	Spin-off company formed as a result of the research study. <ul style="list-style-type: none"> • Revenue generated. • Duration of spin-off. • Value at termination of spin-off company. • Number of employees hired.
Start-up Company	Start-up company formed as a result of the research study. <ul style="list-style-type: none"> • Revenue generated. • Number of employees hired.