Michigan Stem Cell Economics Study

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September 15, 2008

The Michigan Prospect

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MICHIGAN PROSPECT

SHAPING OUR STATE'S FUTURE

September 15, 2008

The Michigan Prospect is pleased to publish this report on the economic impact of Michigan's legal restrictions regarding embryonic stem cell research. We believe it makes a valuable contribution to the public policy discussion on this issue.

Once we decided to find an independent health economist to develop this study we confidently commissioned Dr. Allen C. Goodman, Professor of Economics at Wayne State University in Detroit, MI and a renowned health economist, to do the analysis. His impressive work on the economic impact of various health policies and programs commended him to this project.

This publication is a result of Dr. Goodman's work and that of Sam Berger, formerly with the Center for American Progress and now a student at the Yale University School of Law, author of much of the report's background material on the status and importance of embryonic stem cell research in Michigan and the United States today.

We appreciate working on this project with these authors.

Libby Maynard, President

Lynn Jondahl, Executive Director

The Michigan Prospect is a non-profit public policy institute, founded in 1992 to focus attention on state public policy issues. The Prospect has created a structure for public policy education and advocacy, calling upon the resources of both public and private organizations. The Michigan Prospect commissions research on key issues, publishes and distributes issue papers and reports, sponsors conferences and forums, all designed to advance policy ideas. Information about the Michigan Prospect is available at the Website: www.michiganprospect.org.

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Acknowledgements and Attributions

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Dr. Goodman is Professor of Economics at Wayne State University in Detroit, Michigan. This report does not represent, in any way, the opinions of Wayne State University, the State of Michigan, or the host institutions of those who provided information.

Executive Summary

Embryonic stem cell research represents one of the most promising fields for medical researchers seeking cures and treatments for a wide range of diseases and injuries. Embryonic stem cells are unique because they can become any tissue in the human body.

From heart disease and Parkinson's disease to spinal cord injuries and diabetes, embryonic stem cell research holds the key that could potentially unlock the secrets to treatments and cures that long have eluded patients suffering from some or the most devastating diseases. But, in the race to find cures using embryonic stem cell research, Michigan is at a serious disadvantage.

Michigan law effectively bans critical componenets of embryonic stem cell research that leading scientists believe can result in cures and treatments. Leftover embryos from fertility clinics cannot be used for medical research, although those leftover embryos can be thrown away as medical waste. While 45 other states allow the research that is illegal in Michigan and many also provide funding for that research, Michigan – along with Arkansas, Louisiana, South Dakota and North Dakota – severely restricts this important work.

This study is designed to measure the humanitarian and economic costs to Michigan resulting from Michigan's restrictive law on embryonic stem cell research. The study finds:

- ***Potential Benefits for those Suffering from Many Diseases:***

  These diseases include: (1) Type 1 Diabetes and Latent Autoimmune Diabetes in Adults; (2) Parkinson's Disease; (3) Spinal Cord Injury; (4) Acute Myocardial Infarction (heart attack); (5) Stroke; (6) Alzheimer's Disease; (7) Amyotrophic lateral sclerosis (ALS), sometimes called Lou Gehrig's Disease.

- ***Over 770,000 Potential Beneficiaries:***

  Over 770,000 Michigan residents are afflicted with conditions that are potentially amenable to treatments that could be enhanced by stem cell research. These include over 278,000 with stroke conditions, almost 352,000 with heart conditions and almost 100,000 with diabetes.

- ***Potential Cost Savings of Almost $80 Million per Year:***

  Treatment costs for these conditions are over $7.9 billion per year. The potential benefits from stem cell enhanced treatments that reduce these costs by as little as one percent would reduce treatment costs by almost $80 million each year. Over a thirty year period, these cost reductions would sum to $2.379 billion.

- ***Reduction of Spending on Medicaid:***

  In 2004, Michigan's Medicaid programs served 1.8 million beneficiaries, including almost 1.7 million under capitated care. With $7.7 billion in vendor payments, even small percentage reductions could provide major cost savings for the State. Savings of one-half of one percent would save the State $38,500,000 per year. Over a thirty year period, these cost reductions would sum to $1.16 billion.

- ***Increased Numbers of Biotech Jobs:***

  Michigan has almost 50,000 workers in the "biotech" industries. As small as a one percent increase in biotech employment due to stem cell research would lead to:

  - approximately 443 new jobs with a commensurate payroll increase of $32 million per year;
  - another 354 jobs in induced employment, for a total of approximately 797 jobs;
  - increased payroll of $51 million, with proportional impacts on tax receipts.

  A five percent increase in biotech employment would lead to:

  - approximately 2,215 new jobs with a commensurate payroll increase of $159 million per year;
  - another 1,770 jobs in induced employment, for a total of 3,985 jobs;
  - increased payroll of $254 million, with proportional impacts on tax receipts.

- ***Increased Worker Production and Productivity:***

  Stem cell research can lead to increased productivity for the workforce due to improved health. Conservative estimates of annual productivity impacts are:

  - Annual gains from a two percent reduction in absenteeism of $19.2 million. Over a thirty year period, these gains would sum to $576 million;
  - Gains from a one percent reduction in deaths from specified diseases of $8.5 million per year. These gains would sum to $255 million over a thirty year period;
  - Total productivity gains of almost $28 million per year. Total productivity gains, summed over a thirty year period, would be $831 million.

Analytical Methods Used

This report was commissioned by the Michigan Prospect to determine the potential economic impacts of a loosening of Michigan's stem cell law. The focus of the report is to look at the multiple impacts that might result from a change in Michigan's strict stem cell law.

The analysis used involves the techniques of economic evaluation. These involve the use of economic theory to determine appropriate costs and benefits. With one important exception (noted in the report), all costs are presented as annual costs in "real" (inflation adjusted) dollars.

Due to the scope and time constraints of the project, the study team did not engage in original data collection. Much of the analytical data came from federal government sources, either from their original web sites or from other studies available including those for California, Missouri, New Jersey, and New York. All studies are cited where appropriate.

The Principal Investigator and his study team sought to make the analyses as transparent as possible. Reasonable analysts may disagree on assumptions and parameter values that lead to the conclusions presented. Where appropriate, it is useful to test the sensitivity of findings to particular values and their changes.

Scientific and Legislative Background

The Science of Stem Cells

Recent scientific advances have generated tremendous excitement in the burgeoning field of regenerative medicine, which focuses on developing therapies to restore or replace damaged cells and tissues in the human body. Stem cell research has proven to be one of the most promising areas of research, offering the opportunity to revolutionize medical treatment, drug development and biomedical research.

Stem cells have the ability to develop into every type of cell in the body, as well as to replicate themselves for very long periods of time. Thus, stem cells could be used to treat diseases or injuries by replacing the damaged or aged cells with newer, functioning ones, or by repairing the dysfunctional cells. Stem cells could also be used to greatly speed up the process of drug development, allowing researchers to test the effects of drugs on specific human cells in the laboratory, rather than in human subjects. These cells provide a unique opportunity for researchers to study the development of diseases, as well as general human development, which could lead to novel therapies and treatments for a host of diseases.

Popular discussion has tended to distinguish stem cells into two types: adult stem cells and embryonic stem cells. Adult stem cells are multipotent (meaning they can develop into a limited number of cells), are able to divide for a shorter period of time, and are derived from the cells of human beings. Embryonic stem cells are pluripotent (meaning they can develop into any of the cells in the human body), are able to divide for

extended periods of time, and are derived from early stage embryos, undifferentiated clumps of a hundred or so cells no bigger than the head of a pin.

Scientists also can derive embryonic stem cells through a process known as somatic cell nuclear transfer (SCNT). The nucleus of an adult somatic cell, such as a skin cell, is placed in an enucleated egg, which is then stimulated to divide as if a sperm and egg had fused, although conception has not occurred. This procedure allows researchers to create stem cell lines that match a person's DNA, so that they can study specific diseases as well as decrease the chance that the patient's immune system will reject clinical treatments using the cells.

As the science has advanced, researchers have come to believe that the dichotomy between embryonic and adult stem cells does not fully capture the range of stem cells; rather, stem cells are a continuum of cell types stretching from pluripotent stem cells to multipotent stem cells.[1] Stem cells are akin to a medical tool kit, with different stem cells likely to be useful to treat different injuries or diseases depending on the cells' different characteristics. Many researchers are turning away from SCNT and pursuing other avenues that can yield a better understanding of inherited human diseases, such as reprogrammed adult cells, or induced pluripotent stem cells (IPS).

For example, scientists at Wake Forest University recently have discovered stem cells in amniotic fluid that show the potential to develop into more cell types than adult stem cells, but less than embryonic stem cells.[2] Researchers at the University of Michigan

[1] Weiss, Rick. "Scientists See Potential in Amniotic Stem Cells," *Washington Post*. January 8, 2007.
[2] Swaminathan, Nikhil. "New Source of Stem Cells: Amniotic Fluid," *Scientific American*. January 7, 2007.

have done further work that demonstrates that fetal stem cells are distinctly different from adult or embryonic stem cells.[3]

Scientists also have developed additional means of deriving stem cells that appear to be pluripotent or near-pluripotent. Researchers at Advanced Cell Technology in Massachusetts have developed a means of deriving pluripotent stem cells from a single biopsied cell from the embryo, leaving the rest of the embryo intact.[4] Scientists at Lifeline Cell Technology in Wisconsin have claimed to produce pluripotent stem cells through parthenogenesis, in which an unfertilized egg is stimulated to begin to develop as if it were an embryo.[5] And three teams of researchers from the U.S. and Japan were able to reprogram adult mouse cells to behave like embryonic stem cells.[6]

All of these advances represent significant steps forward, and demonstrate the great promise of the field. None, however, will replace embryonic stem cell research. Single cell biopsy needs further work to improve the safety and efficacy of the technique, and there are worries that it does not truly solve the ethical issues surrounding embryonic stem cell research, but merely creates new ones. Parthenogenesis can only produce pluripotent stem cells genetically matched to women, and there are worries that the cells themselves will be genetically abnormal and unusable in humans. Adult cell reprogramming – also called induced pluripotent stem (IPS) cells - has been demonstrated but the process used to modify the cells introduces viruses that can cause cancer. As a result, IPS cells at this time are useful for laboratory research but not human treatment.

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[3] "Gene That Regulates Blood-forming Fetal Stem Cells Identified," *Science Daily*. July 27, 2007.
[4] Wade, Nicholas. "New Stem Cell Method Avoids Destroying Embryos," *New York Times*. August 23, 2006.
[5] "Stem cells developed from unfertilized eggs," *Associated Press*. June 28, 2007
[6] Wade, Nichols. "Biologists Make Skin Cells Work Like Stem Cells," *New York Times*. June 6, 2007.

Researchers have extensive experience deriving and manipulating embryonic stem cells, and continue to show its medical potential. Scientists have used these stem cells in lab animals to treat paralysis,[7] reduce vision loss,[8] and reverse some of the symptoms of Parkinson's disease.[9] And new research suggests that scientists have found embryonic stem cells in rodents that are more similar to cells in humans, thus speeding the transition from animal models to human cures.[10]

Advances also have been made using human embryonic stem cells, as researchers have coaxed them to become cardiovascular precursor cells that could lead to treatments for heart diseases,[11] T-cells that could lead to a cure for AIDS,[12] and insulin-secreting cells that could be used to treat diabetes.[13] And scientists are planning to use embryonic stem cells to treat common forms of blindness in patients in the next five years.[14]

Furthermore, research into embryonic stem cells is crucial for the advancement of other types of stem cell research, as it provides powerful insights into stem cell development at their earliest stages. Research into all of these types of stem cells should be pursued vigorously, not only because they are interconnected, but also because, as Dr. Story Landis, the Chair of the National Institutes of Health Stem Cell Taskforce, said, "science works best when scientists can pursue all avenues of research. If the cure for

[7] "Stem Cells Help Paralyzed Rats Walk," *CBS News*. June 20, 2006.
[8] Weiss, Rick. "Stem Cell Experiments Slow Vision Loss in Rats," *Washington Post*. September 21, 2006.
[9] Weiss, Rick. "Stem Cell Work Shows Promise and Risks," *Washington Post*, October 23, 2006.
[10] "'Missing link' stem cells may speed race for cures," *Reuters*. June 27, 2007.
[11] Aldhous, Peter. "Heart stem cells discovered by three teams," *New Scientist*. November 22, 2006.
[12] "Researchers Develop T-cells From Human Embryonic Stem Cells, Raising Hopes For A Gene Therapy to Combat AIDS," *Science Daily*. July 5, 2006.
[13] "Geron says embryonic stem cells produce insulin," *Reuters*. May, 17, 2007.
[14] "Scientists aim to kill blindness with stem cells," *Reuters*. June 5, 2007.

Parkinson's disease or juvenile diabetes lay behind one of four doors, wouldn't you want the option to open all four doors at once instead of one door?"[15]

Stem Cell Research Laws

Despite the promise of embryonic stem cell research, Michigan has some of the most restrictive laws in the country. Michigan is one of only five states that outlaw SCNT research which is legal under federal law. The other four states are Arkansas, Louisiana, North Dakota and South Dakota. Michigan law (Michigan Compiled Law 333.2685) also bans research that destroys an embryo if it does not have therapeutic value for that embryo. Violation of this ban is a felony punishable by up to five years in prison. Michigan scientists are thus prevented from developing new human embryonic stem cell lines by any means, leaving them access only to a limited number of federal stem cell lines or ones from other states that can prove difficult and costly to obtain or unsuitable for particular research purposes.

Other states have responded to the potential gains from stem cell research by robustly supporting it. Nearby, Illinois and Wisconsin not only allow researchers to derive their own lines, but also have devoted funding specifically to support the research in order to attract researchers and investors to the state - $14.7 million in Illinois and $386.5 million in Wisconsin.[16] California is by far the largest state supporter of stem cell research, having designated $3 billion for the research, including funding for research on SCNT. These states have been joined by New Jersey, New York, Connecticut,

[15] Weiss, Rick. "Stem Cell Policy Hampering Research, NIH Official Says," *Washington Post*. January 20, 2007.
[16] Moreno, Jonathan, Sam Berger and Alix Rogers. "Divided We Fail," *Center for American Progress*. April 12, 2007.

Massachusetts and Maryland in providing public funding for embryonic stem cell research. And both Massachusetts and New Jersey are considering spending significantly more as well.

Not all states have chosen to support stem cell research monetarily, but they have still relaxed previous limitations. In 2006, Missouri passed a constitutional amendment that would ensure that any stem cell research that is permissible under federal law is also legal in Missouri. Also, Iowa recently passed a law that lifted its ban on SCNT, while maintaining a ban on human reproductive cloning.

State activity has been spurred, in part, by inaction at the federal level. Federal policy currently restricts federally funded stem cell scientists to research using only 21 stem cell lines that were derived before August 9, 2001. These lines are contaminated by the mouse feeder cells used to grow them and are developing mutations as they age. Both of these limitations compromise their scientific usefulness.

In the intervening eight years since this federal decree, scientists have used new methods creating stem cell lines that are much better for research. In fact, some of these lines have proven three times as popular as the older lines, even though they are ineligible for federal funding.[17] In congressional testimony, Dr. Elias Zerhouni, Director of the National Institutes of Health, said that, "American science will be better served [and] the nation will be better served if we allow our scientists to have access to more stem cell lines."[18]

Seeing the importance of updating stem cell policy to keep pace with the science, both Republican and Democratic Congresses passed the Stem Cell Research

[17] Lauerman, John and Rob Waters. "Harvard Stem Cells Favored Over Those Produced With U.S. Funds," *Bloomberg*. July 13, 2006.
[18] Bridges, Andrew. "Bush's Own NIH Chief Opposes Stem Cell Ban," *Associated Press.* March 19, 2007.

Enhancement Act, which would have allowed scientists to use newer, ethically derived stem cell lines. President Bush vetoed the legislation both times, leaving federally funded scientists limited in their ability to conduct research.

Policy Options

The current legislative climate presents Michigan with two distinct policy options. The first is to loosen its restrictive laws, which has been suggested by Gov. Granholm and members of the state legislature such as State Representative Andrew Meisner who, along with 23 co-sponsors, introduced HB 4616 which would permit embryonic stem cell research under certain circumstances. The second option is for Michigan not only to modernize its laws, but also to provide state funding for the research. Because only a few states have supported stem cell research, a commitment of even $15 million could demonstrate tremendous state support for the science.

Of course, there are difficulties in pursuing public funding, not only in ushering such a proposal through the political process, but also in finding sufficient resources. Given the restrictive nature of Michigan's laws and the presence in the State of a number of top level stem cell researchers, simply updating the laws would have a significantly positive effect on research in Michigan. Thus, the rest of this paper will only consider the economic and health implications of the first proposal. It is to be assumed, however, that the benefits would be greater given even a modest public investment.

Humanitarian Benefits

A. Diseases included in this study

In order to determine which diseases would be included in the study, the research team reviewed contemporary literature regarding embryonic stem cell research and carried on phone and email conversations with experts in the field. We are especially grateful for the generous counsel of Dr. Sean J. Morrison, Ph.D, University of Michigan, Associate Professor of Cell and Developmental Biology and Director of the University of Michigan Center for Stem Cell Biology.

Based on our consultations with these scientists the research team has identified possible disease targets to include in this study.

1. ***Type 1 diabetes and LADA (Latent Autoimmune Diabetes in Adults):*** This is a good potential use of stem cell research.
2. ***Parkinson's disease****:* This is a good potential use of stem cell research.
3. ***Spinal cord injury:*** It is reasonable to include spinal cord injury, though the data so far are limited. Study data do not project cures from embryonic stem cells, but rather modest gains in function. i.e. patients might gain bladder control, or more function in their arms.
4. ***Heart attack (also referred to as acute myocardial infarction or AMI):*** It is reasonable to include these conditions although data currently are limited.
5. ***Stroke:*** This is a questionable candidate for stem cell therapies. We have not been made aware of data that credibly suggest that stroke might be treated with embryonic stem cells.

6. ***Alzheimer's disease:*** Although it is not realistic to treat Alzheimer's with cellular therapies derived from embryonic stem cells, it is reasonable to think that new drugs may be developed as a result of screening using embryonic stem cells with Alzheimer's-causing genetic defects. We are not proposing that Alzheimer's Disease will be cured with cell transplants, but rather that the use of human embryonic stem (hES) cells to generate human brain cells with Alzheimer's disease in the laboratory will speed drug discovery.
7. ***Amyotrophic lateral sclerosis (ALS):*** As is the case with Alzheimer's disease, screening using hES cells to generate human brain cells with ALS in the laboratory will speed drug discovery.
8. ***Bone marrow transplants:*** It is reasonable to project that a subset of bone marrow transplants may be done in the future with cells derived from hES cells. Currently, there are many patients that do not achieve good matches or who do not find donors at all. These patients often die with current technology for performing bone marrow/cord blood/mobilized peripheral blood transplants. Therefore, it is reasonable for us to analyze only that subset of patients that do not currently find a donor that is a good match.

In choosing to utilize a conservative approach to potential advances that could result from embryonic stem cell research in Michigan, we believe that achieving even a small fraction of this research potential is critically important.

B. Number of Cases and Treatment Costs

Having identified common diseases/conditions most likely to be treated as a result of embryonic stem cell research, our next task is to identify the number of individuals directly affected, as well as the families who are effected. This task seeks to estimate treatment costs for the patients and their insurers. It is potentially the most data-intensive task, and it involves compiling both nationally representative data as well as adjustments for conditions that may be unique to Michigan.

Table 1 updates methods that were also considered by researchers in California[19] and in Missouri[20] to determine numbers of potential cases, and treatment costs. These methods looked at prevalence rates either for the total population, or for those of working age in the population (ages 18 – 64). These methods were adjusted for Michigan cohort sizes.

[19] Baker, Laurence, Deal, Bruce, "Economic Impact Analysis: Proposition 71 California Stem Cell Research and Cures Initiative," September 14, 2004

[20] Haslag, Joseph H. and Long, Brian K. The Missouri Stem Cell Research and Cures Initiative: An Economic and Health Care Analysis, August, 2006

Table 1 – Prevalence of Selected Conditions in Michigan – 2006

Condition		Prevalence Total Population	Estimated Number Afflicted	Prevalence Ages 18 - 64	Estimated Number Afflicted
Total Population			10,112,620		6,157,574
Parkinson's		0.0033	33,372	0.0016	9,852
Stroke		0.0275	278,097	0.0129	79,433
Heart Attack		0.0348	351,919	0.0168	103,447
Spinal Cord Injury		0.0011	11,124	0.0011	6,773
Type 1 Diabetes	age < 19	0.0021	5,672		
	age > 18	0.0127	94,127	0.0127	78,201
Total			774,311		277,707

The table focuses on Parkinson's disease, Stroke, Spinal Cord Injury, and Type 1 Diabetes. Stroke (with over 278,000 estimated cases) and heart attack (with almost 352,000 cases) constitute the largest numbers, and diabetes shows almost 100,000 cases. For the entire Michigan population, the estimated numbers of potential beneficiaries resulting from embryonic stem cell research that would address these diseases and conditions are 774,311, or over 7 percent of the total population.

For those between the ages of 19 to 64 years, the numbers obviously are smaller. Of this target population of a little over 6.1 million people, the numbers of people with stroke (79,433), heart attack (103,447) and diabetes (78,201) don't vary greatly. The

total of 277,707 potential beneficiaries when considering all 5 conditions analyzed is over 4 percent of those in that working age population range.

Table 2 presents treatment costs and potential treatment savings. The costs were taken from the Missouri study[21] and inflated to 2006 dollars (representing the last full year's data). Table 2 shows costs per person varying from almost $5,000 for Parkinson's Disease to over $50,000 for spinal cord injuries. The highest total costs (over $4 billion) are for heart attacks, with costs of over $2 billion for stroke and over $1 billion for Type 1 diabetes.

Table 2 - Cost per Person Afflicted in Michigan - Current Dollars

Condition	Cost/Person	Number Afflicted	Total Cost
Parkinson's	$4,803	33,372	$160,268,699
Stroke	$7,269	278,097	$2,021,487,456
Heart Attack	$11,654	351,919	$4,101,324,575
Spinal Cord Injury	$54,963	11,124	$611,407,279
Type 1 Diabetes	$10,399	99,799	$1,037,818,100
Total		774,311	$7,932,306,119

The potential cost savings attributable to stem cell research are speculative, and they would almost certainly not accrue equally to all those afflicted with a particular condition, nor across all conditions. If one were to apply a 1 percent cost reduction to these numbers, it would indicate benefits in the form of reduced treatment costs of approximately $79.3 million. Over a thirty year period, these cost reductions would sum

[21] Ibid.

to $2.379 billion. Savings of even half that level would amount to $39.7 million annually, or $1.190 billion over a thirty year period.

C. Medicaid Savings for Michigan

One of the fundamental health care financial impacts facing any state relates to its participation in the federal Medicaid program. Medicaid is a program operated by the states with matching federal dollars. It primarily provides health care coverage to lowest income people.

Medicaid, referring to Title XIX of the Social Security Act, is a federal-state matching entitlement program that pays for medical assistance for certain vulnerable and needy individuals and families with low incomes and resources. This program is the largest source of funding for medical and health-related services for America's poorest people. In 2003 Medicaid provided health care assistance to more than 41 million persons. Total Medicaid expenditures in the fiscal year 2003 were $223 billion.

Gruber (2002) notes that Medicaid incorporates four public insurance programs into one. The first provides coverage of most medical expenses for low-income women and children. This function absorbs only about one-quarter of Medicaid program dollars but encompasses two-thirds of Medicaid enrollees. The second program provides public insurance for the portions of medical expenditures not covered by Medicare for the low-income elderly. The third program covers most medical expenses for low-income persons with disabilities. The fourth program pays the nursing home expenditures for many of the institutionalized elderly. The last three programs apply to only one-third of the beneficiaries but use three-quarters of the entire Medicaid dollars.

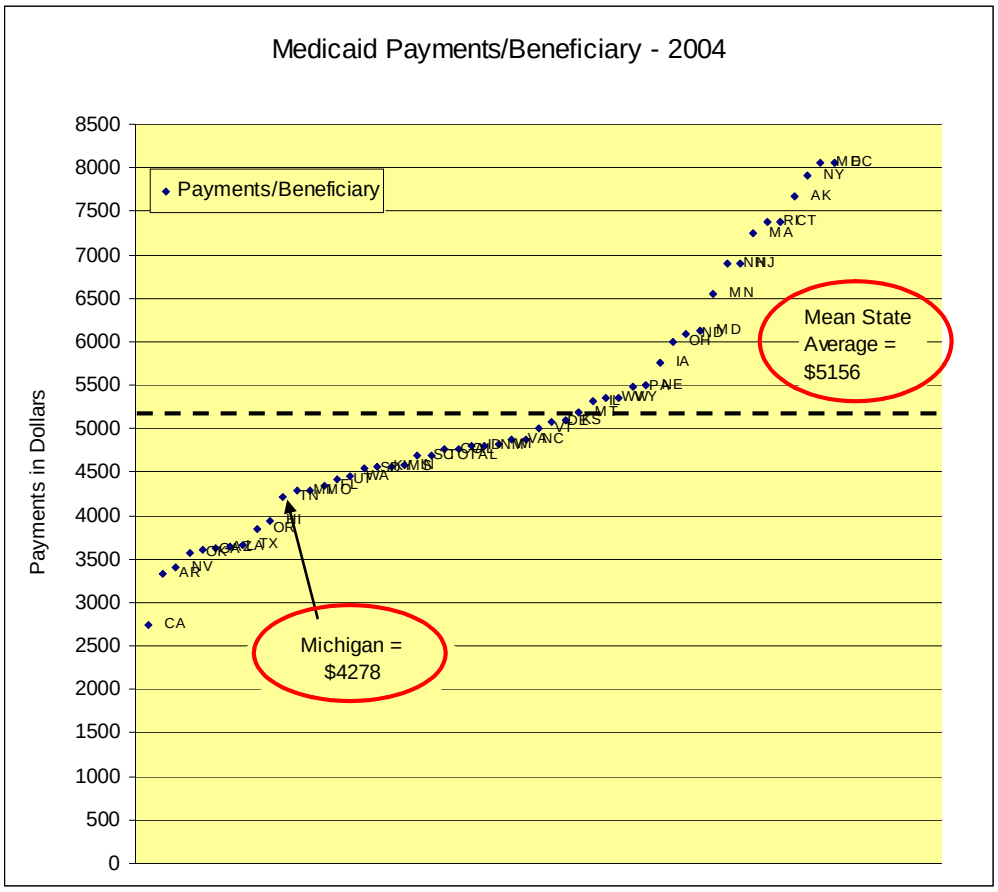
Within broad national guidelines set forth in federal statutes, regulations, and policies, each state: (1) establishes its own eligibility standards; (2) determines the type, amount, duration, and scope of services; (3) sets the rate of payment for services; and (4) administers its own program. Medicaid policies for eligibility, services, and payment vary considerably even among similar-sized and/or adjacent states, and the services provided by one state may differ considerably in amount, duration, or scope from services provided in a neighboring state. Further discussion of Chart 1 (below) will validate this observation.

Medicaid is a cost-sharing partnership between the federal government and the states. The federal government pays a share of the medical assistance expenditures under each state's Medicaid program. That share, known as the Federal Medical Assistance Percentage (FMAP), is determined annually by a formula that compares the state's average per-capita income level with the national income average. States with higher per-capita income levels are reimbursed smaller shares of their costs. By law, the FMAP cannot be lower than 50 percent or higher than 83 percent. In 2007, Michigan's FMAP is 56.38%; in other words, for every state dollar spent for Medicaid programs, the state brings in $1.29 in federal funds.

Charts 1 through 4 provide information on Michigan's Medicaid program in 2004, the most recent year for which comparative stage data are available. Chart 1 places Michigan's Medicaid program in the context of the other states. In 2004, Michigan's Medicaid paid a bit less than $4,300 per beneficiary, compared to a mean payment (among state plans) of $5,156.

All comparisons must be done carefully. A state plan may have a low per beneficiary total because it covers large numbers of low-cost beneficiaries, or because it does not provide generous payments to those that it does cover. The important information in this chart, however, is that Michigan's payments were at least 10% lower than averages for all state plans.

Chart 1 – Medicaid Payments/Beneficiary – 2004

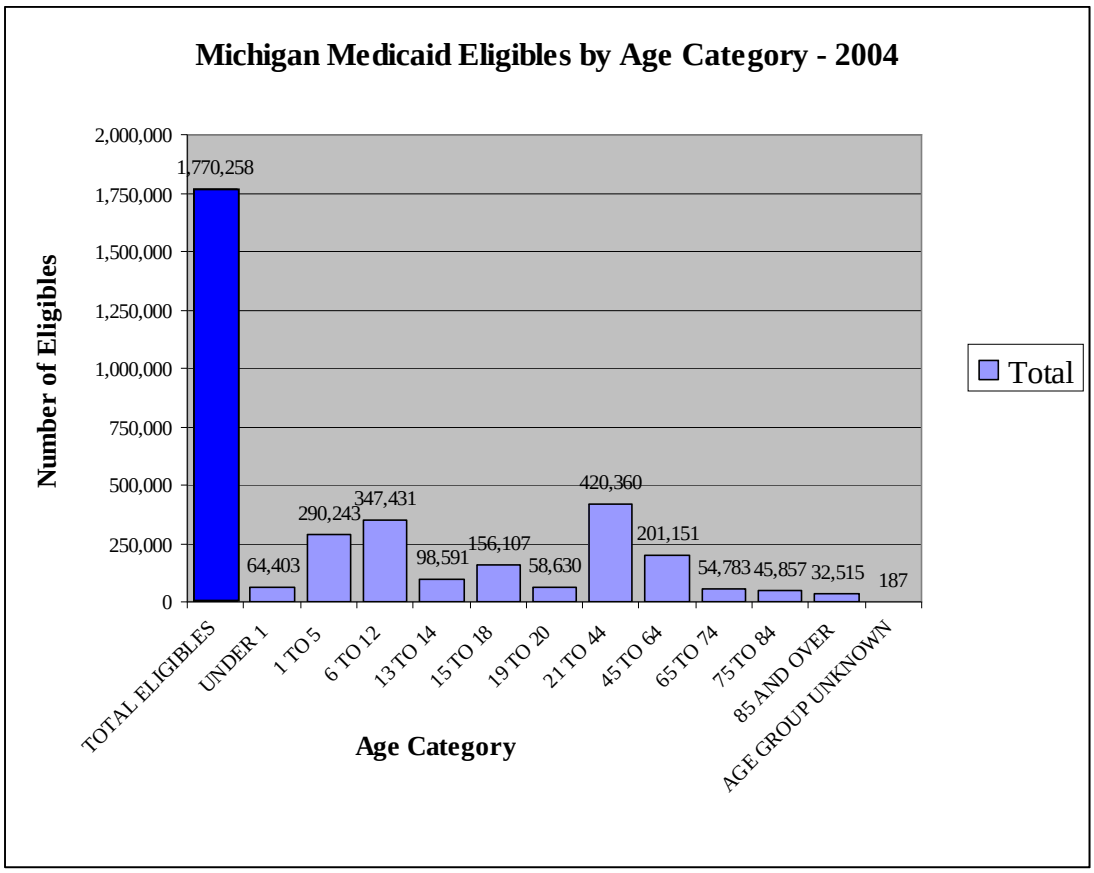


Source: Fiscal Year 2004 National MSIS Tables – Table 01

http://www.cms.hhs.gov/home/rsds.asp

Chart 2 shows Michigan's Medicaid eligibles by age category. Well over half of the eligibles are children under the age of 18. These data (and those for the beneficiaries, since eligibles are not identical to beneficiaries) will be used to impute treatment numbers and costs for those in the Medicaid program.

Chart 2 – Medicaid Eligibles by Age Category – 2004

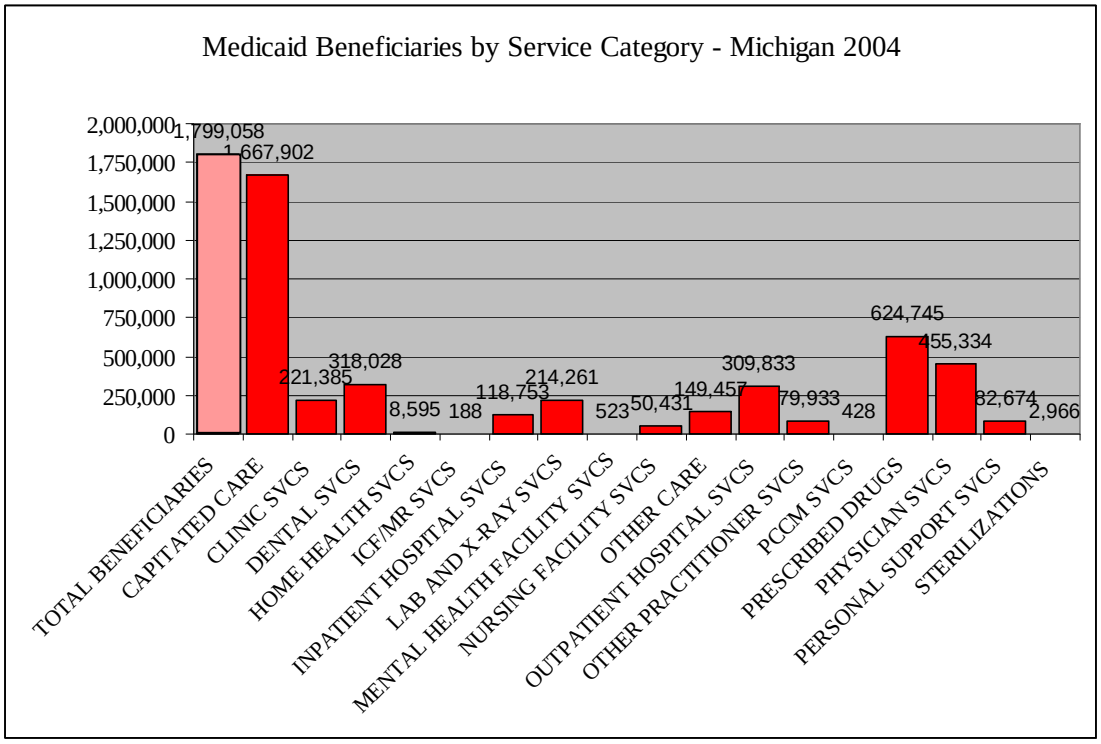


Source: Fiscal Year 2004 National MSIS Tables – Table 05

http://www.cms.hhs.gov/home/rsds.asp

Chart 3 looks at Medicaid beneficiaries by service category. Note that the numbers in the individual categories add up to more than the total of 1.799 million, presumably because because some receive multiple Medicaid services.

Chart 3 – Medicaid Beneficiaries by Service Category – 2004



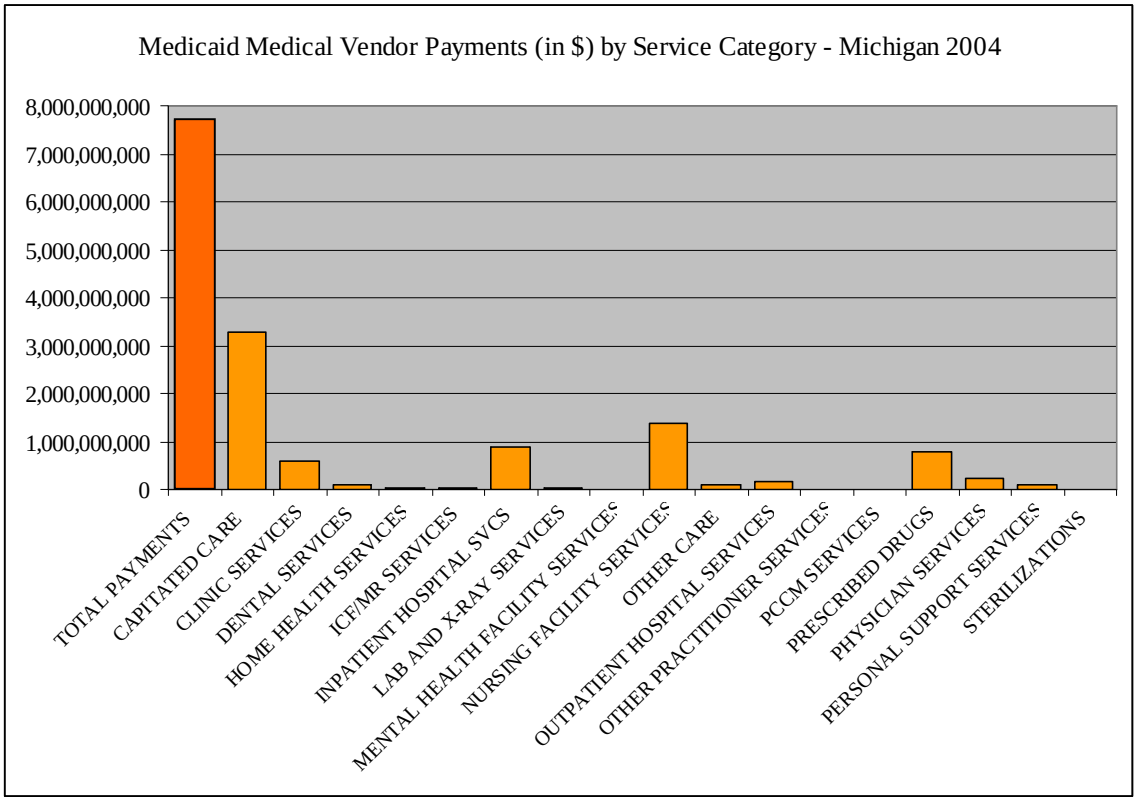
Source: Fiscal Year 2004 National MSIS Tables – Table 10 http://www.cms.hhs.gov/home/rsds.asp

Chart 4 enumerates the $7.7 billion in Medicaid vendor payments in 2004. The two biggest categories, again not unexpected, were payments for capitated care (almost $3.3 billion) and payments for nursing facilities (almost $1.4 billion).

While the capability to perform stem cell research can provide only limited fiscal benefits, the size of the State's Medicaid obligation (well over $3 billion per year) suggests that cost reductions in the fractions of a percentage point offer substantial potential public savings and/or reallocations to other uses.

Savings of one-half of one percent would would save the state $38,500,000 per year. Over a thirty year period, these cost reductions would sum to $1.16 billion.

Chart 4 – Medicaid Medical Vendor Payments (in $) by Service Category – 2004



Source: Fiscal Year 2004 National MSIS Tables – Table 10 http://www.cms.hhs.gov/home/rsds.asp

D. Job Impacts of the Biotech Sector

Although embryonic stem cell research is not explicitly a tool for economic development, one might expect the ability to perform this research to lead to increased research and technology, as well as improved pharmaceutical and medicine manufacturing. This section attempts to quantify such impacts.

Embryonic stem cell research falls under the description of biotechnology. Within the North American Industry Classification System (NAICS), most jobs related to biotech fall under the five-digit classification codes for Research and Development in the Physical, Engineering, and Life Sciences (54171) and Pharmaceutical and Medicine

Manufacturing (32541). These codes also include segments of the pharmaceutical industry.

Definition: NAICS 32541 Pharmaceutical and medicine manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing biological and medicinal products; (2) processing (i.e., grading, grinding, and milling) botanical drugs and herbs; (3) isolating active medicinal principals from botanical drugs and herbs; and (4) manufacturing pharmaceutical products intended for internal and external consumption in such forms as ampoules, tablets, capsules, vials, ointments, powders, solutions, and suspensions.

Definition: 54171 Research and Development in the Physical, Engineering, and Life Sciences

This industry comprises establishments primarily engaged in conducting research and experimental development in the physical, engineering, and life sciences, such as agriculture, electronics, environmental, biology, botany, biotechnology, computers, chemistry, food, fisheries, forests, geology, health, mathematics, medicine, oceanography, pharmacy, physics, veterinary, and other allied subjects.

The most recent detailed data available are for 2002. Table 3 shows 44,298 workers in Michigan with a (then) average payroll per employee of $71,767, or about 8 percent higher than the national average. Approximately 84% are in code 54171, with the remainder in code 32541.

Table 3 – Payroll and Employees in Combined Sectors by State – 2002

32541 Pharmaceutical and medicine manufacturing
54171 Research and Development in the Physical, Engineering, and Life Sciences

	Payroll (000)	Number of Employees	% of US Total	Average Payroll/Employee	Payroll % of National
National	$53,604,609	806,364		$66,477	100.00
California	10,231,394	139,057	17.2%	73,577	110.68
New Jersey	4,773,603	68,204	8.5%	69,990	105.28
New York	3,658,891	69,885	8.7%	52,356	78.76
Illinois	3,260,466	46,615	5.8%	69,945	105.22
Michigan	**3,179,113**	**44,298**	**5.5%**	**71,767**	**107.96**
Massachusetts	2,814,011	38,571	4.8%	72,957	109.75
Pennsylvania	2,264,877	32,748	4.1%	69,161	104.04
Virginia	2,236,548	32,251	4.0%	69,348	104.32
North Carolina	1,900,085	31,511	3.9%	60,299	90.71
Maryland	1,892,511	27,784	3.4%	68,115	102.46
Texas	1,878,093	30,363	3.8%	61,855	93.05
Ohio	1,817,488	26,134	3.2%	69,545	104.62
Indiana	1,322,673	16,550	2.1%	79,920	120.22
Connecticut	1,234,498	16,797	2.1%	73,495	110.56
Colorado	949,566	14,500	1.8%	65,487	98.51
Florida	685,475	13,189	1.6%	51,973	78.18
Missouri	663,370	11,809	1.5%	56,175	84.50
District of Columbia	326,518	5,169	0.6%	63,169	95.02
Delaware	138,356	2,324	0.3%	59,534	89.56
Tennessee	116,411	2,389	0.3%	48,728	73.30

Even a modest 1% increase in employment in these sectors, related to the possibility of currently banned embryonic stem cell research would lead to approximately 443 new jobs in these sectors with a commensurate payroll increase of $32 million per year (as noted in Table 4a).

Table 4a – Economic Impact of a 1% Increase in Biotech Employment

	New Jobs	Payroll/Job	Increased Payroll (x 1,000)
Biotech	443	$71,767	$31,791
Induced	354	$53,825	$19,075
Total	797		$50,866

According to economic development models, job growth in one industry (or, the "direct impact") also generates indirect and induced effects. An analysis for New York State with the IMPLAN model, developed for the federal government, utilizes detailed data on national and local interindustry economic transactions to model the effects of regional economic changes.

The indirect effects reflect the purchase of goods and services by biotech and pharmaceutical firms from other companies within the state, and the income earned by these new job holders that stays within the state can lead to increased consumption spending, which causes other businesses to grow and hire new workers (the "induced effect"). New York's employment multiplier, defined as total impact divided by direct effects, equals 2.01 for the biotech and pharmaceutical industries. Using a more conservative value of 1.80 for Michigan, would yield another 354 jobs, for a total of approximately 797 jobs. Evaluating these jobs at a payroll impact of 75% of the biotech jobs, yields an additional payroll impact of approximately $19 million.

Table 4b – Economic Impact of a 5% Increase in Biotech Employment

	New Jobs	Payroll/Job	Increased Payroll (x 1,000)
Biotech	2,215	$71,767	$ 158,955
Induced	1,770	$53,825	$ 95,375
Total	3,985		$ 254,330

A 5% increase in employment in these sectors, related to the possibility of currently banned embryonic stem cell research would lead to approximately 2,215 new jobs in these sectors with a commensurate payroll increase of $159 million per year (as noted in Table 4b).

Using the parameters and methods described above, we calculate an induced impact of 1,770 jobs, for a total of approximately 3,985 jobs. Evaluating these jobs at a payroll impact of 75% of the biotech jobs, yields an additional payroll impact of approximately $95 million for a total annual impact of approximately $254 million.

E. Productivity Relationships

Economists measure the major impacts of any health related intervention by looking at potential impacts on earnings due to workers' improved "human capital." Improved health may reduce worker absenteeism, allow workers to work more productively (sometimes called "presenteeism"), and at the limit prevent deaths that may take workers out of the labor force. All of these represent gains to the economy.

It should be stated at the outset that the use of human capital measures represents a conservative accounting. It does not put a dollar value on the "feeling better." It values the contributions of those who are unemployed, or those who are retired, as zero. It puts a zero value on children, and it does not account for any type of "pain and suffering" that accrue to loved ones regarding those who are ill or who have died.

This study presents two measures of potential benefits due to the possibility of embryonic stem cell related treatments. The absenteeism measure calculates the number of days per year typically lost to illness. The analysis then investigates the impact of a 2 percent decrease in absenteeism for three different age categories: ages 18 – 24; ages 25 – 44; ages 45 – 64. Each is evaluated at an age-specific average wage, on the assumption that the worker works eight hours per day. The aggregate change indicates potential gains from reduced absenteeism.

The second measure of potential benefits is related to deaths prior to the age of 65. A person's death is like the destruction of a machine. One loses not only the year's production, but a stream of production for the future, by assumption until retirement at age 65.[22] This "present discounted value" of the future production is a totally appropriate annual cost. Our calculations use an interest rate of 4% to calculate the present value (see Folland, Goodman and Stano, 2007, for further discussion). A rate of 3%, which is often used for health economics applications provides an even larger value.

Table 5 provides absenteeism-related gains for acute myocardial infarction (AMI), stroke, diabetes, and Alzheimer's Disease. Not surprisingly the largest impacts for improved health occur at the 45-64 age bracket, with total impacts of over $5.5

[22] A prime example in the literature involves premature deaths due to alcohol-related traffic accidents in which a person's entire productive life is destroyed, leading to a loss, in that year of $1 million or more.

million per year. Impacts for stroke are over $3.65 million per year, and for diabetes, they are almost $10 million per year. Total productivity gains in this accounting are approximately $19.2 million per year. Over a thirty year period, these gains would sum to $576 million.

Table 5 - Productivity Summary Table - Impact of 2% reduction in absenteeism

	Age (18-24)	Age (25-44)	Age (45-64)
AMI Prevalence Rate (% of the population)	0.08	0.39	3.78
Wage Level/hour	$10.94	$19.21	$21.65
Increased Wages	$13,148	$804,947	$4,694,184
Total Increased Wages			$5,512,279
Stroke Prevalence Rate (% of the population)	0.16	0.53	2.58
Wage Level/hour	$10.94	$19.21	$21.65
Increased Wages	$19,174	$1,068,755	$2,563,174
Total Increased Wages			$3,651,102
Diabetes Prevalence Rate (% of the population)	0.84	2.64	10.50
Wage Level/hour	$10.94	$19.21	$21.65
Increased Wages	$142,365	$2,348,652	$7,388,993
Total Increased Wages			$9,880,010
	0.01	0.01	0.06

Alzheimer's Prevalence Rate (% of the population)			
Wage Level/hour	$10.94	$19.21	$21.65
Increased Wages	$342	$74,967	$74,511
Total Increased Wages			$149,820
Total Productivity Gain	$175,028	$4,297,321	$14,720,862
Total Productivity Gains - All Ages			$19,193,211

Table 6 shows how even a one percent decrease in death rates from specific ailments can have major impacts. For AMI, for example, a one percent decrease would lead to reduced output of $436 thousand in one year, but a present discounted value of nearly $4 million. In sum the total impacts of the diseases enumerated involves a potential productivity impact of $8.5 million. These gains would sum to $255 million over a thirty year period.

Table 6 - Gains from a 1% Reduction in Death Rate

	Age (18-24)	Age (25-44)	Age (45-64)	Total
AMI				
Annual	$456	$34,363	$401,685	$436,504
Lifetime	$9,320	$599,347	$3,389,772	$3,998,439
Stroke				
Annual	$0	$4,395	$60,343	$64,738
Lifetime	$0	$76,661	$509,226	$585,886
Diabetes				
Annual	$1,139	$39,557	$207,598	$248,294
Lifetime	$23,301	$689,946	$1,751,889	$2,465,135

Parkinson's				
Annual	$0	$400	$6,304	$6,704
Lifetime	$0	$6,969	$53,203	$60,172
Alzheimer's				
Annual	$0	$0	$9,907	$9,907
Lifetime	$0	$0	$83,604	$83,604
ALS				
Annual	$0	$4,795	$36,926	$41,721
Lifetime	$0	$83,630	$311,617	$395,246
Sickle Cell				
Annual	$0	$5,994	$6,304	$12,298
Lifetime	$0	$104,537	$53,203	$157,740
CF				
Annual	$2,050	$3,197	$450	$5,697
Lifetime	$41,941	$55,753	$3,800	$101,495
Spinal Cord				
Annual	$228	$15,583	$45,482	$61,293
Lifetime	$4,660	$271,797	$383,819	$660,276
All Conditions				
Annual	$3,872	$108,283	$775,000	$887,155
Lifetime	$79,222	$1,888,640	$6,540,132	$8,507,993

It is appropriate to add the totals from Table 5 and Table 6 to get a productivity impact of approximately $27.7 million per year. Total productivity gains, summed over a thirty year period, would be $831 million. As noted above, this is a conservative estimate because it puts a zero value on children, those who are not working, and retirees. The true value may be considerably higher.

The Competitive Stem Cell Landscape

While Michigan is forced to turn people away who want to help advance the research because of its restrictive laws, other states are rushing to attract scientists and investors. These states are actively working to attract scientists and biotechnology companies from around the country, by providing funding and the freedom to pursue their research. They understand that there is tremendous prestige, potential for job creation and economic growth associated with becoming a biotechnology hub in the 21st century.

Michigan is in the midst of an area with considerable stem cell activity. Both Wisconsin and Illinois have dedicated public funds to supporting research, and Wisconsin is considered the Midwest hub for the research. These states continue to work to attract researchers by providing tax breaks, removing unnecessary legal restrictions, and providing public funding.

Wisconsin Governor Jim Doyle set aside $5 million to "recruit new stem cell companies to Wisconsin and in the process create thousands of good-paying jobs."[23] Gov. Doyle has also aggressively used patenting rights over existing stem cell lines and techniques held by the Wisconsin Alumni Research Foundation, lines which Michigan

[23] "Governor Doyle Commits $5 million to Recruit Stem Cell Companies," *Office of the Governor – Jim Doyle*. April 25, 2006.

scientists might very well have to use due to current state law, to entice companies to perform their research in his state.[24]

Other states have followed suit in working to attract researchers, particularly from states where the research is restricted or in danger of being restricted. When opponents of stem cell research in Missouri were attempting to ban research on human embryos, similar to the law currently in effect in Michigan, Illinois Governor Rod Blagojevich sent a letter trying to convince Missouri's top scientists to come to Illinois where they would face no such restrictions.[25]

Michigan faces competition not only from nearby states, but also strong state research supporters from the coasts. Even two years ago Michigan was seeing the loss of top scientists to other states, and Dr. Sean Morrison, Director of the University of Michigan's Center for Stem Cell Biology said that, "there are companies that have come out of the University of Michigan and gone to California," because of the restrictive Michigan laws.[26]

Massachusetts Governor Deval Patrick's proposal to spend $1.25 billion on stem cell research includes money to train local workers for jobs in biotechnology, hoping to attract companies by offering an ample supply of capable workers. And New York Governor Eliot Spitzer pushed his $600 million stem cell plan in order to encourage investment in the state's economically depressed upstate region by biotechnology companies.[27]

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[24] "Doyle, WARF announce partnership to lure stem cell companies," *WTN News*. September, 28, 2006.
[25] Vestal, Christine. "Embryonic stem cell research divides the states," *Stateline*, June 21, 2007.
[26] Gustafson, Sven. "Stem cell program losing researchers," *The Oakland Press*. October 17, 2005.
[27] Vestal, Christine, "More govs boost stem cell research," *Stateline*. April 5, 2007.

These states are so eager to support the research both because of its tremendous promise to ease suffering and cure disease, and because of its potential to revitalize economies and attract biotechnology investors to the state. Just as in Michigan, they know that supporting stem cell research could be beneficial for the people of their state not only medically, but economically as well.

A report written by a Stanford University professor and an economic consultant predicted that the California state initiative would generate a sizeable return on the $3 billion investment.[28] Even ignoring the gains directly attributable to public funding for the research, the economic benefits were substantial. The report suggested that income from private investment and research attracted by the demonstration of state support could range from $2.2 billion to $4.4 billion over thirty years. Direct savings to the state government in health care costs from stem cell treatments were modeled as between $3.4 billion and $6.9 billion. And additional savings in healthcare to state businesses, citizens and other payers of health care costs could stretch from $9.2 billion to $18.4 billion.

Similarly impressive results were predicted in a report on the New Jersey stem cell initiative, written by a Professor at the Edward J. Bloustein School of Planning and Public Policy at Rutgers University.[29] They predicted the public funding initiative would create almost 16,000 jobs, expand economic activity by $1 billion over 20 years, and generate $84.7 million in tax revenues. Health care costs could be reduced by $11.3 billion, $813 million could be saved by reducing the number of work days lost to injury or sickness, and almost 18,000 premature deaths could be averted over ten years.

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[28] Baker, Laurence and Bruce Deal, "Economic Impact Analysis: Proposition 71 California Stem Cell Research and Cures Initiative," *Analysis Group*. September 14, 2005.
[29] Seneca, Joseph and Will Irving, "The Econonmic Benefits of the New Jersey Stem Cell Research Initiative," *Office of the Governor*. September, 2005.

But even in states that do not provide public funding, economic benefits could be substantial. A report by Missouri economists suggested that the passing of a 2006 initiative, which would make Missouri law similar to the updated laws suggested by Michigan stem cell advocates, would be of tremendous benefit.[30] They predicted that under conservative projections citizen health care costs could be reduced by $150 million over 10 years, with moderate projections putting the savings at $2.4 billion. The state also would save from $16 million to $780 million in health care costs. If stem cell research allowed 5% of afflicted workers to reenter the workforce it would increase the Gross State Product by $11 billion over 10 years. Meanwhile, the detrimental effect of restrictive laws was readily apparent, as only a 5% reduction in biotechnology research would cost the state $1.65 billion over 25 years.

The Ethics of Stem Cell Research

While economic benefits are certainly important, ethical concerns are, and should be, the determining factor in choosing whether to support stem cell research. Stem cell research brings strongly held values into conflict. Interestingly and importantly, both sides of the value debate over stem cell research underscore their respect for and commitment to the enhancement of life through easing human suffering and respecting human life potential.

The research regulations proposed by supporters of stem cell research acknowledge and incorporate both of these viewpoints. Under proposed federal and

[30] Haslag, Joseph and Brian Long. "The Missouri Stem Cell Research and Cures Initiative: An Economic and Health Care Analysis," *The Missouri Coalition for Lifesaving Cures*. August, 2006.

Michigan state laws all embryonic stem cell lines would have to be derived under the strictest ethical guidelines, ensuring that those donating them had been provided with adequate information about their choice and that no coercion was involved. And research proposals would be strictly scrutinized in order to ensure that the research could only be done using embryonic stem cells and would be of the highest scientific value.

Currently there are over 400,000 excess embryos in *in vitro* fertilization (IVF) clinics around the country, embryos that are slated for destruction and then disposal as medical waste, according to a report in TIME on August 7, 2006. These embryos are collections of about one hundred cells with no human organs or limbs, no ability to feel pain, and no ability to think. For the families that have to make the difficult decisions about what to do with their excess embryos, they have overwhelmingly chosen to support research. According to a recent study, 60 percent of couples with IVF embryos would be willing to donate frozen embryos for stem cell research.[31]

While it is clear that these decisions are difficult, an overwhelming majority of the country and the individuals making these decisions themselves have concluded that donating these embryos is the best means of demonstrating our collective respect for human life.

[31] Kliff, Sarah. "The Donors Have Spoken," *Newsweek web exclusive*. June 20, 2007.

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