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LESSONS LEARNED: U.S. EMBRYONIC STEM CELL POLICIES

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In 2004 and 2006, the James A. Baker III Institute for Public Policy held conferences to discuss U.S. human embryonic stem cell policies titled "Stem Cells: Saving Lives or Crossing Lines." The following report draws on discussions among presenters from both conferences. The policy recommendations contained in this report are those of the Science and Technology Policy Program at the Baker Institute and may not reflect the views of the conference participants.

The new field of regenerative medicine has been progressing dramatically due, primarily, to the innovation and advances in stem cell research that have occurred in the past decade. Scientists and patient advocates are excited by the potential to use embryonic stem cells to replace diseased or damaged cells in the body and to treat or cure debilitating diseases and injuries such as diabetes, Parkinson's, and spinal cord damage. Before stem cells are ready for cures, however, further research needs to be done to better understand how these cells work and how they can be used. This research requires the use of both adult and embryonic stem cells (ESC).

By executive order, President George W. Bush limited the federal funding of human ESC research to the few registered lines created before August 9, 2001. The policy prohibited federally-funded research on creating, producing, or using newer ESCs. In the years since the implementation of this policy, research on human ESCs has stagnated in the United States. This is due to significantly fewer cell lines being available than originally thought (in 2001 it was believed there were over 60 lines, when in actuality, only 21 were available), contamination of cell lines with mouse cells and proteins, and a lack of genetic diversity within the lines. Without diversity, ESCs are unable to match a broad population of patients and will therefore have limited therapeutic potential. In addition, the federal government has failed to regulate research arising from private or corporate funds set aside for stem cell research.

While the United States restricts human ESC research, other countries including the United Kingdom, China, and Singapore are aggressively moving forward with their own stem cell research initiatives. Without changes to the current policy, significant intellectual capital, as well as investment capital, will be transferred from the United States to other nations that have more open research policies.

Beyond the issues of competitiveness, human ESC research policy must address ethical concerns. Proponents of such research should be cognizant of its associated ethical issues. Similarly, those who question the appropriateness, even the morality of such research, should be aware of the potential benefits that could result from such new medical

knowledge. Any future progress will require further understanding from all perspectives of the debate.

In 2004, the Science and Technology Policy Program at the James A. Baker III Institute for Public Policy established a conference series, called "Stem Cells: Saving Lives or Crossing Lines," to examine the complexities of human ESC research policy. The first conference, held November 20–21, 2004, was sponsored by the Richard Lounsbery Foundation along with the University of Texas M.D. Anderson Cancer Center, the University of Texas Health Science Center at Houston, and Baylor College of Medicine. The objectives of the conference were to discuss the advances in research, the underlying ethical and policy issues, and the benefits and risks of possible therapeutic applications.

The second conference, "Lessons Learned," was held March 6, 2006, at the Baker Institute. This conference was co-sponsored by the Science and Technology Section of the British Consulate General–Houston, the University of Texas M.D. Anderson Cancer Center, and the University of Texas Medical Branch in Galveston. It focused on state initiatives for increasing ESC research in the United States, with particular interest on the state of Texas.

A third conference, titled "Avenues for Advancement," will take place October 24, 2006, at the Carnegie Institution of Washington, a co-organizer of the event. Co-sponsored by the Texas Tech Health Science Center, the University of Texas M.D. Anderson Cancer Center, the University of Texas Health Science Center at Houston, and the University of Texas Medical Branch in Galveston, it focuses on international stem cell initiatives and models of regulation.

Through the series, the aim at the Baker Institute is to raise public awareness of the fact that, for the first time in modern history, the United States could lose its leadership role in biomedical research. This paper reviews some of the discussions initiated during the first two conferences, highlighting areas in United States and Texas that are moving forward and recommending ways to improve and promote research.

Creating Stem Cell Policies

Creating sound ESC policy is complicated as a consequence of the ethical and religious concerns surrounding the creation and use of human embryos in research. As discussed in the previous Baker Institute Policy Report *Stem Cells: Saving Lives or Crossing Lines*[1], there are many competing views on the use and destruction of embryos to create ESC lines. Proponents support ESC research for its potential to unlock the secrets of human development and often believe there is a moral imperative to do this research because it could lead to the cures of debilitating diseases and injuries plaguing society. Opponents of ESC research often subscribe to the notion that life begins at fertilization; therefore, all uses of embryos for research are immoral because it ends life. Still others point out that the use of human eggs would lead to the objectification of women, since women undergoing the difficult egg-removal procedure receive high levels of compensation, many surpassing $10,000.

With these differing and sometimes diametrically opposing views, establishing a sound ESC policy is extremely problematic. When living in a society with such diverse and entrenched opinions on ESC research, it is a difficult task to formulate an effective policy that reflects the plurality of society's view on the subject.

There are two general approaches to formulating ESC research policy: implementing what was determined to be the morally correct policy or producing a compromise policy that does not completely permit or ban research.[2] In the first option, a country would develop policy based on an analysis of the benefits or harms of this research. This was the model used to determine regulation by Austria, Costa Rica, and Ireland, all of which prohibit ESC

research and Belgium, Israel, and the United Kingdom, which permit it. The advantages are that the society believes it is doing the right thing and the policy is uniform, covering both private and public research.

The disadvantage of this approach is the difficulty of determining what the moral right is. While the United Kingdom and Ireland are close neighbors, they adopted opposite policies when addressing embryonic research. Moreover, the policy is based on a vote, leaving one party with a victory, while the other side feels its opinion has been disregarded.

The thoughtful study and discussion undertaken by the United Kingdom is a worthwhile model to review when evaluating this approach. In the United Kingdom, discussions about the use of embryos in research predated the creation of human ESC lines in 1998. The debate has been ongoing since 1978, when the first *in vitro* fertilization (IVF) baby was born in England, and resulted in the Human Fertilisation and Embryology Act in 1990. In the act, the Human Fertilisation and Embryology Authority (HFEA) was created as an independent nongovernmental body with a lay majority. HFEA controls and regulates IVF and embryo research. It grants licenses for "necessary and desirable" research, but only using donated surplus embryos during the first 14 days postfertilization. At 14 days postfertilization, the human embryo has the beginning signs of brain and neural development.

In 2001, additional legislation in the United Kingdom was passed to officially ban reproductive cloning and provide HFEA the ability to grant licenses for research on embryos if the intention of the research is to increase knowledge about development or disease. HFEA requires all researchers to deposit samples of ESC lines in the UK Stem Cell Bank, thereby restricting the need to create new lines because lines are freely shared with other researchers.

U.S. Stem Cell Policy

In contrast to the United Kingdom and Ireland, American society is deeply divided with regard to embryonic research. Polls from Research!America have consistently found approximately 60 percent of Americans support federal funding of ESC research with a vocal minority who consistently opposes any changes in the current policy.[3] Developing public policy for this contentious issue using an approach that determines the moral right has proven difficult and divisive.

A more effective option for the United States might involve a compromise that appeases both perspectives. This would allow—and perhaps publicly fund—some research, while prohibiting other forms to accommodate the moral sensitivities of as many communities within our society as possible. A compromise approach would avoid settling the moral stance and minimize people's concern about not being heard.

A comparative examination of compromises that have led to ESC regulation is useful when formulating U.S. policy. Denmark, Spain, and France decided that ESCs could be derived only from surplus IVF eggs that had neither been implanted nor preserved for later use. Another compromise was reached by the Clinton administration in 2000. Under this policy, the National Institutes of Health (NIH) could not fund the creation of human ESC lines in which embryos would be destroyed, but it could fund research on ESC lines created using nonfederal funds. Implementation of this policy, however, was blocked by the changing of administrations in 2001. A third kind of compromise was the decision by Germany. Research, both public and private, could be done only using ESCs derived before December 2001. All three compromises have attempted to draw a line allowing some research to proceed while acknowledging the ethical sensitivities associated with the use of human embryos.

The current U.S. policy also is a compromise. President Bush determined that federal funds could

be used only on research using ESCs derived before August 9, 2001, regardless of the source of the lines. ESC lines created after August 2001 are not eligible for federal funding, but they can be eligible for private or state funds. Despite these efforts, the federal compromise has exacerbated the controversy and is unpopular with some Americans as evident by the continued debate over it.

By choosing to support research using nongovernmental funds and allowing very limited federally funded research, the U.S. government has acknowledged that ESC research is highly valuable, but it has severely hindered research progress by forcing researchers to use relatively primitive lines. Science is marked by continuous changes. When researchers first derived ESC, they used the knowledge they possessed at that point in time. Since 2001, there have been great advances in the preparation of ESCs, which make many uses of the older lines obsolete, especially those involving cell-based therapies or regenerative medicine. Current federal policy on this matter could be analogous to the federal government refusing to fund research in computer processors for technology developed after the 1970s, severely hindering the United States' progress in the computer industry.

The controversy over the current federal policy suggests that a new compromise is warranted. Polls from organizations such as Research!America and the Genetics and Public Policy Center at Johns Hopkins University show that Americans support ESC research.[4] For example, Research!America found that 58 percent of those polled supported embryonic stem cell research and 57 percent support federal funding, while a report from the Genetics and Public Policy Center suggests that 67 percent of Americans support embryonic stem cell research. Current federal policy does not reflect this majority opinion on this subject.

In the five years since this policy was implemented, numerous bills have been submitted in Congress either to increase the number of ESC lines eligible for federal funding or to ban all human cloning research—including private research. This also would outlaw somatic cell nuclear transfer (SCNT) to create ESC lines. SCNT is the process where the nucleus, containing the chromosomal DNA, of a human egg is removed and replaced with the nucleus from a somatic cell (any cell other than an egg or sperm cell) and often is referred to as therapeutic cloning. Although this technique has not been perfected in humans, it was used to create the first cloned mammal, Dolly the sheep, in 1997. The technique of SCNT is appealing to scientists because it allows for the creation of disease-specific ESC lines to study how diseases develop. SCNT also might be used to develop patient-specific cell lines and tissues for therapy.

The most recent bill to gain momentum was sponsored by Representatives Michael Castle (R-DE) and Diane DeGette (D-CO). This bill—HB 810—would allow all ESC lines created using surplus IVF eggs to be eligible for NIH funding no matter when the cells were derived. In May 2005, the U.S. House of Representatives passed the bill in a 238 to 194 vote. This was the first time a bill was passed in the House that would increase the number of human ESC lines available for public funding. The Senate version of the bill—S 471—sponsored by Senator Arlene Specter (R-PA), came up for a vote on July 18, 2006, passing 63 to 37. On July 19th, President Bush vetoed the bill and Congress did not have enough votes to override it.

If this legislation had become law, it would have provided a new compromise for ESC research in the United States. The bill, similar to the compromise regulation found in several countries—including Canada, Denmark, Spain, and France—would have increased substantially the number of ESC lines available for federally-funded research. It also would have eliminated many of the issues scientists have with the ESC lines currently available. In the past few years, scientists have been able to grow ESCs without the use of mouse cells and protein, elimi-

nating the contamination issues found in current federally approved lines. Furthermore, the newer lines could have increased the genetic diversity of the research. Within the currently available lines, diversity is extremely limited, making therapeutic treatments for a broad number of patients questionable. However, the legislation limited research to the use of IVF embryos; therefore, diversity still would be limited to those families who can afford IVF, which is an expensive procedure.

Although this legislation would have increased the number of ESC lines, thereby increasing research opportunities, it would not have allowed for federal funding to create embryos for the purposes of creating ESC lines or use SCNT. By limiting the use of SCNT, scientists are prevented from creating disease-specific cell lines.

Although disease-specific ESC lines can be created for some diseases without using SCNT, others cannot. An ESC line for cystic fibrosis has been derived by Stephen Minger, senior lecturer and director of the Stem Cell Biology Laboratory at King's College London. First, fertilized eggs intended for IVF were screened for a genetic mutation that is known to cause cystic fibrosis using preimplantation genetic diagnosis (PGD). A fertilized egg that contained mutations on both copies of this gene was then donated to Minger and used to create an ESC line. While cystic fibrosis-specific ESC lines can be developed, many diseases such as Alzheimer's, diabetes, and Parkinson's do not have a known genetic mutation. It is the goal of researchers to use a somatic cell—e.g., a skin cell from a patient suffering from Parkinson's disease—to create an ESC line that would show researchers how the cell progressed from a normal to a diseased state. Furthermore, scientists could, in principle, create cells and tissues that are compatible with the original donor's immune system and could be used for therapies. Many researchers around the world are working to perfect this process, but have had limited success due to the misleading results from Woo Suk Hwang.[5]

Other legislation has been introduced to promote alternative methods for creating ESC lines that do not destroy embryos, but these techniques are relatively new, and their ability to be replicated and used for therapeutic application remains unclear. Scientists recommend leaving the maximum number of options open for experimentation, allowing the best method to be found by research and not by policy.

While researchers and advocates would prefer that federal funding include the creation of embryos for research—but not reproductive—purposes, this seems unlikely in the current political climate. The current attempts in Congress to expand research to include new ESC lines derived from surplus IVF eggs would be a positive move forward and a compromise that could appease both sides and minimize the concern many have that their views are being disregarded.

State Initiatives

As federal legislation stalls, states are starting to move ahead with their own legislation. Some states have chosen to advance stem cell research internally with initiatives and funding of their own. These include millions to billions of dollars for research within their states. Other states have gone in the opposite direction, banning all publicly and privately funded human cloning including SCNT (or therapeutic cloning), and a few states even have banned research on embryos, prohibiting the derivation and research on ESCs. In addition, some legislation was left vague, leaving the definition of a human being unresolved and, therefore, has had unintended consequences.

Six states currently ban SCNT or therapeutic cloning: Arkansas, Indiana, Iowa, Michigan, North Dakota, and South Dakota.[6] Virginia's legislation potentially bans SCNT because there was no definition of a human being. Furthermore, Michigan also bans the derivation of ESC lines and South Dakota forbids any research on embryos regardless of the source. There are five states that not only pro-

mote but fund research: California, Connecticut, Illinois, Maryland, and New Jersey (see table I). Governors are even trying to compete with each other to recruit businesses to their states. Governor Rod Blagojevich of Illinois invited researchers from Missouri, where there still is ongoing debate about ESC research policy, to move to his state.[7]

State Initiatives for Stem Cell Research

California	2004	$3 billion over 10 years
Connecticut[8]	2005	$100 million
Illinois[9]	2006	$10 million (Governor's Office)
Maryland[10]	2007	$15 million
New Jersey[11]	2004	$9.5 million
	2005	$10.5 million

The most aggressive initiative is the landmark legislation in California, Proposition 71: the California Stem Cell Research and Cures Act, which created the California Institute of Regenerative Medicine (CIRM).[12] CIRM is a state organization that is responsible for granting and overseeing research focusing on adult and embryonic stem cells, especially research that is unlikely to get federal funding. The legislation, passed in 2004, allows bonds to be sold in the amount of $3 billion over 10 years for stem cell research. This amounts to a budget of approximately $300 million a year, far exceeding the $38 million the federal government (NIH) committed to ESC research in 2006, and it is competitive with national initiatives such as the United Kingdom's national stem cell initiative.

While a few states have passed legislation defining their ESC policy, more than 25 states—including Texas—do not have legislation specifically permitting or prohibiting ESC research or cloning. Although six additional states had previous legislation regarding embryonic research applying to ESC research, none of them have legislation on cloning. Even in states with a defined policy, new legislation is submitted each year addressing ESC research and cloning. In 2004, there were approximately 60 bills on stem cell research policy.[13] In 2005, this number increased to approximately 180, and in the first four months of 2006, there already were almost 100 bills in state legislatures. As of May 2006, 27 states had bills pending in their legislatures.

Regulation

For those states that have chosen to permit and, in some cases, fund ESC research, new questions on regulation have emerged: Should a state use the existing oversight committees such as the institutional review board (IRB) within an institution? Should a state create a new oversight committee as suggested by the National Academies (National Academy of Science, National Academy of Engineering, and Institute of Medicine)? Should the oversight include both public and private research? Should a state create a statewide oversight committee?[14]

The model of regulation that CIRM chose is described as a mini-NIH model with public money but decentralized research.[15] CIRM has created a statewide oversight committee known as the Independent Citizens Oversight Committee (ICOC), headquartered in San Francisco. By decentralizing research, money is not focused on specific institutions but given to researchers throughout the state. CIRM estimates $295 million a year will be used to fund non-NIH research, laboratory space, policy groups, and ICOC.

Since April 10, 2006, 16 institutions in California have received a total of $12.1 million—close to one-third of the federal budget for ESC research.[16] This is only 18 months after the passage of Proposition 71. Although CIRM intended to have a shorter timetable, this is an exceptionally short length of time to start a granting and oversight organization, especially considering the legal challenges to its funding sources. Court cases challenging its constitutionality were ruled in favor of CIRM in April 2006, but the case is being appealed.

Other states have chosen different oversight methods. New Jersey decided to create a system

with centralized research, where funding goes to create and maintain the Stem Cell Institute of New Jersey, although the state did fund a series of grants through a Stem Cell Grants program.[17] Connecticut combined these approaches by creating a statewide oversight committee and a review committee to work with the Department of Public Health to select grants.[18] The oversight committee has a scientist majority, and the review committee is comprised only of scientists. In addition, the state uses existing IRBs to review and approve all research. Illinois opted to follow the model and guidelines set forth by the National Academies in their 2005 report, requiring institutions—and not the state—to create new ESC research oversight (ESCRO) committees.[19]

Currently, national regulation has been addressed outside of the federal government by the National Academies—independent organizations chartered by Congress to advise the government on issues related to science, engineering, and health. In 2004, the National Academies charged a committee to create a series of guidelines and recommendations for human ESC research in the United States in an effort to resolve the current system of fragmented regulation and policy. A year later, the National Academies released the report *Guidelines for Human Embryonic Stem Cell Research*, which outlines recommendations for the responsible practice of human ESC research.[20] These guidelines not only cover oversight but also informed consent, standards of clinical care, compliance, and stem cell banking. Furthermore, the report recommended the establishment of a national body, which the National Academies created in May 2006 to periodically assess the guidelines and provide a forum for public discussion.

Texas Policy

Similar to policy-making bodies elsewhere in the nation, the Texas Legislature has continued to debate ESC research. In 2005, the 79th Texas Legislature introduced 11 bills favoring ESC research and SCNT (therapeutic cloning) and three bills proposing SCNT bans.[21] HB 864, sponsored by Texas State Representative Phil King (R-Weatherford), put forward a ban on cloning and somatic cell nuclear transfer, which includes both reproductive and therapeutic cloning. HB 1929, sponsored by Texas State Representative Beverly Woolley (R-Houston), would have permitted human embryonic stem cell research and SCNT. It also proposed a medical advisory committee to guide research in Texas that would have included the executive commissioner of Texas Health and Human Services, scientists, medical ethicists, and members of religious organizations. HB 3076, sponsored by Texas State Representative Elliot Naishtat (D-Austin), would have established a stem cell research program and provided for issuances of bonds to support the program.

With the promise of a gubernatorial veto of any bill funding ESC research or permitting therapeutic cloning, many advocates spent their time at the state capital arranging education forums on stem cells for legislators to keep the three unfavorable bills from passing. It was no surprise that none of the 11 bills favoring ESC research passed.

Stem Cell Research in Texas

While federal and Texas state ESC research policies are not complete, institutions within the state are moving forward with programs and collaborations on stem cell research. The following describes a few initiatives in Houston, Dallas, and San Antonio involving collaborations both within the state and outside Texas to solve some of the mysteries of stem cells.

Stem Cell and Regenerative Medicine—Baylor College of Medicine

The mission of the Stem Cell and Regenerative Medicine (STaR) program at Baylor College of Medicine is to facilitate all types of stem cell research

and enable the translation of such research into clinical applications. Researchers at STaR are working on characterizing stem cells and their growth and development. Their focus is on stem cell biology, developmental biology, and bio-imaging. Collaborations with Rice University provide opportunities to work with biomaterials, bioreactors, and nanotechnology-based instrumentation to further the understanding of stem cell development and tissue generation.

A main research project at STaR is the study of blood vessel formation during development. Scientists are working on engineering a hematopoietic bone, i.e., a vascularized, innervated bone with architecturally correct marrow that sustains hematopoietic stem cells (HSCs).[22] There are several areas under investigation: the cellular steps needed for forming blood vessels, the molecular signals controlling each step, the directing of the process ex vivo (outside the body), and the source of the cells that form the blood vessels.

The University of Texas M.D. Anderson Cancer Center

A major project at the University of Texas M.D. Anderson Cancer Center involves research on HSCs obtained from human umbilical cord blood. Umbilical cords, as well as bone marrow, are excellent sources of HSCs. When transplanted, HSCs are effective in treating several conditions and diseases such as acute leukemia and aplastic anemia. HSCs from cord blood have advantages over bone marrow because the cells are less mature and their transplantation results in a lower chance of rejection or graft-versus-host disease.[23] The University of Texas M.D. Anderson Cancer Center created the Cord Blood Bank to help collect and preserve human umbilical cord blood cells for transplantation and research.

Other research interests at the University of Texas M.D. Anderson Cancer Center involve using mesenchymal stem cells (MSCs) therapeutically. MSCs are multipotent cells capable of self-renewal and differentiation into multiple cell lines. These cells are found in bone marrow and have been shown to help cord blood cells by secreting proteins and creating a rich environment for growth and expansion. In preliminary studies, genetically modified MSCs also can help deliver antitumor drugs, inhibiting specific cancer growths.

The University of Texas Health Science Center at Houston

There are two initiatives for stem cell research sponsored by the University of Texas Health Science Center at Houston: the Stem Cell Center at the Texas Health Institute and the newly created Stem Cell Research Center at the Brown Foundation Institute for Molecular Medicine for the Prevention of Human Disease (IMM). The Stem Cell Center, located at the Texas Heart Institute at St. Luke's Episcopal Hospital, is dedicated to the study of adult stem cells and their role in treating cardiovascular disease. The primary mission of the center is to help patients through the advancement of clinical stem cell research. A major research focus is the use of a patient's HSCs to treat diseases of the heart and circulatory system.

The Stem Cell Research Center, started at IMM in May 2006, is led by Paul Simmons. Simmons's research focuses on improving existing treatments using HSCs, understanding the molecular details of HSCs and MSCs and their environment in the body, and studying other less understood adult stem cells from tissues such as the lung or kidney. The center has plans to recruit additional scientists to drive stem cell research from the bench to the bedside.

The San Antonio Institute for Cellular and Molecular Primatology

The San Antonio Institute for Cellular and Molecular Primatology (SAICMP) is a collaboration of scientists and facilities from institu-

tions within San Antonio. SAICMP's major contributors are students and scientists from the University of Texas at San Antonio, the University of Texas Health Science Center at San Antonio, the Southwest National Primate Research Center, and the Southwest Foundation for Biomedical Research. SAICMP also promotes collaborations with institutions in other parts of Texas and the United States.

The mission of SAICMP is to facilitate cellular and molecular biology research in nonhuman primates with emphasis on research relating to stem cell biology, primate embryology, biogenesis research, regenerative medicine, translational research, and public policy. Nonhuman primates are important models for the complex physiology of the human. By using them, researchers at the SAICMP will have the ability to mimic both simple and complex human diseases for biomedical research. New areas of study include the derivation of ESC lines from baboons, characterization of baboon ESCs, and development of primate models to study the efficacy and safety of assisted reproductive technology, SCNT, and regenerative medicine. Furthermore, SAICMP intends to explore the public policy and ethical considerations with regards to translating methods developed in the nonhuman primates to human clinical medicines.

The University of Texas Southwestern Medical Center at Dallas

In 2003, the University of Texas Southwestern Medical Center formed a stem cell initiative. The initiative is headed by Eric Olson, chair of the Department of Molecular Biology; Luis Parada, director of the Center for Developmental Biology; and David Garbers, director of the Cecil H. and Ida Green Center for Reproductive Biology Sciences, with more than 25 faculty at the university affiliated with it. The initiative is actively recruiting additional faculty involved in stem cell research and is creating a core instrumentation facility designed specifically for stem cell biologists.

While these Texas state initiatives are impressive, especially considering the restrictive federal policies on ESC and SCNT, changes in federal policy regarding NIH funding and state initiatives to encourage ESC and SCNT research would allow Texas, given its outstanding research capability, to forge ahead as a world leader in this promising medical field.

Conclusion

The federal government's policy to allow limited ESC research by only funding studies using ESCs derived before August 2001 has restricted the efficacy and advancement of stem cell research. Approved lines have limited application, because they are contaminated with animal cells and proteins and also lack the genetic diversity necessary for use in a broad population.

Lack of significant federal involvement also is leaving the decision of ethics to others, as demonstrated in the controversy in South Korea, where not only were data falsified, but women working in the lab were coerced to donate eggs for research.[24] By opting out of the ethical discussion and appropriate regulation, the U.S. government is opening the doors for potentially damaging, sub-standard practices.

Current federal policy has discouraged American researchers' and the biomedical communities' capacity for advancement. Under current federal policy, laboratories where both federal and nonfederal funding takes place must cleanly separate allowable and unallowable activities in such a way that permits the costs to be unambiguously tied to the appropriate funding source. This essentially prohibits the usual efficiencies gained by sharing equipment, personnel, laboratories, and other facilities. This increases the cost of research, because scientists must duplicate everything they need, using nonfederal funds, leaving less money for actual research. Although, in principle, some

sharing is possible, the penalty for misjudging or making a mistake could be the loss of all federal funding.

While federal policy severely limits NIH funding for this area of science, it places no restrictions of any kind on research using private or state funding. There is no national oversight or regulation except for the voluntary measures recommended by the National Academies. In May 2006, the National Academies also formed a committee whose members include bioethicists, scientists, advocates, and lay persons to assess the adequacy of the guidelines the National Academies proposed in their report, *Guidelines for Human Embryonic Stem Cell Research*, a year earlier. This newly created committee allows a place for public input and oversight of ESC research, especially research not funded by the federal government.

The state governments are taking the lead by determining policy within their borders. A few states have banned all research on embryos. Other states—California, Connecticut, Illinois, Maryland, and New Jersey—have established large funding initiatives. But without federal guidelines, these programs have differing regulation and oversight. The federal policy also has encouraged competition between states, as demonstrated by Illinois governor Rod Blagojevich's attempt to woo researchers and pharmaceutical companies away from his neighboring state, Missouri.

Several legislators in the U.S. Congress have started to address the limited federal funding of ESCs. HB 810 proposes an increase in ESC lines available for federal funding by allowing lines derived from donated surplus IVF eggs (similar to legislation in Canada, France, and Denmark) regardless of the date of derivation. While the bill passed both the U.S. House of Representatives and Senate, it was vetoed by the president.

In order to move the debate forward, the role of NIH in shaping ESC research policy is instrumental. Throughout its history NIH has been the primary source of biomedical research funding in our country. It has guided the oversight for even the most controversial research. NIH's participation along side the National Academies in steering ethical guidelines, best research practices, donor consent, and public awareness is greatly needed.

Furthermore, the scientific community has an obvious and valuable role in shaping policy. Scientists are in the unique position to help educate the public and policymakers on what ESC research is and the consequences of restricting it. During the March 2006 stem cell policy conference at the Baker Institute, Kenneth Shine, executive vice chancellor for health affairs at the University of Texas System, argued, "the principle wealth of a nation in the 21st century is knowledge. It's the ability to create new knowledge, to apply it, and to use it for the development of cure for illnesses, prevention of disease, new technologies, and new opportunities based on that knowledge." Scientists have a responsibility to explain to the American people why research is so vital to their health and overall well being and key to economic growth of the nation and why the public should continue to support it.

Winston Churchill once said, "You can always count on the Americans to do the right thing—after they've tried everything else." With the current limited federal policy, continuous rancorous public debate, and uneven regulation and oversight of ESC research across the country, the United States has tried almost every option. Now is the time to try a new option—federal oversight and funding of expanded ESC research. This entails expanding federal funding for research on ESC lines created with leftover donated IVF eggs as well as on disease-specific lines created through SCNT. With oversight through NIH and the National Academies, the public could be involved in the policy-making process, and research will progress at a steady rate. Hopefully, in the next few decades, our understanding of debilitating disease and injuries

such as Parkinson's, diabetes, and spinal cord damage will have led to better treatments, therapies, and maybe even cures.

Footnotes

[1] The Baker Institute Policy Report #31, *Stem Cells: Saving Lives or Crossing Lines*, is a summary of the November 2004 conference with the same title. It is available online at www.bakerinstitute.org/Pubs/PubIntro.htm.

[2] Discussion based on a presentation at the March 2006 conference by Baruch Brody titled, "The Role of Ethical and Political Philosophy in Formulating a Policy on Stem Cell Research."

[3] Research!America poll data can be found at www.researchamerica.org/polldata/10statestemcell.htm.

[4] Research!America poll data can be found at www.researchamerica.org/polldata/10statestemcell.htm. Johns Hopkins data can be found at www.dnapolicy.org/pub.reports.php?action=detail&report_id=1.

[5] In December 2005, it was discovered that at least two research papers by Woo Suk Hwang, a researcher from South Korea, on the use of nuclear transfer to create cloned human embryonic stem cell lines were falsified.

[6] Information obtained in June 2006 from the websites *State Human Cloning Laws* and *State Embryonic and Fetal Research Laws* at www.ncsl.org/programs/health/genetics/rt-shcl.htm and www.ncsl.org/programs/health/genetics/embfet.htm.

[7] Based on press report: www.npr.org/templates/story/story.php?storyId=4857918.

[8] Information obtained from the Connecticut website: www.cga.ct.gov/2005/BA/2005SB-00934-R01-BA.htm.

[9] Information obtained from the Illinois Governor's Office website: www.illinois.gov/gov/execorder.cfm?eorder=39.

[10] Information obtained from the Maryland website: http://mlis.state.md.us/2006rs/bills/sb/sb0144t.pdf.

[11] Information obtained from the website *State Embryonic and Fetal Research Laws* at www.ncsl.org/programs/health/genetics/embfet.htm.

[12] Information on CIRM obtained from its website: www.cirm.ca.gov.

[13] Information obtained through the Nation Conference of State Legislatures' Genetics Legislation Database: www.ncsl.org/programs/health/genetics/geneticsDB.cfm.

[14] Discussion based on presentation at the March 2006 conference by Lori Knowles, titled, "Current U.S. Stem Cell Policy: Setting Standards Across the States."

[15] Information on CIRM obtained from its website: www.cirm.ca.gov.

[16] Information on CIRM obtained from its website: www.cirm.ca.gov.

[17] Information obtained from New Jersey website: www.state.nj.us/scitech/stemcell/.

[18] Information obtained from the Connecticut website: www.cga.ct.gov/2005/BA/2005SB-00934-R01-BA.htm.

[19] Information obtained from the Illinois Governor's Office website: www.illinois.gov/gov/execorder.cfm?eorder=39.

[20] The report, *Guidelines to Human Embryonic Stem Cell Research*, can be found at www.nap.edu.

[21] Information obtained through the National Conference of State Legislatures' Genetics Legislation Database: www.ncsl.org/programs/health/genetics/geneticsDB.cfm.

[22] Hematopoietic stem cells are progenitor or pre-blood cells.

[23] Graft-versus-host disease is a common disease that occurs when the immune cells from the donated HSCs attack the host. This can be lethal if left untreated.

[24] At least two women from Woo Suk Hwang's laboratory were identified as having donated eggs for research, which is against all existing ethical guidelines.

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