

The Case Against Federal Funding of Human Embryonic Stem Cell Research

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The use of federal funds for human embryonic stem cell research is unwarranted. Beyond the substantial legal and ethical dilemmas inherent in such research, the scientific evidence shows that adult stem cells have vast biomedical potential to cure conditions such as diabetes, Parkinson's disease, heart disease, and other degenerative diseases. This biomedical potential is as great as, or greater than, the potential offered by human embryonic stem cell research. Simply stated, adult stem cell research is a preferable alternative for regenerative medicine and cell-based therapies because it does not pose the medical, legal, and ethical problems associated with human embryonic stem cell research.

In its September 1999 report on stem cell research, the National Bioethics Advisory Commission (NBAC) stated:

In our judgment, the derivation of stem cells from embryos remaining following infertility treatments is justifiable only if no less morally problematic alternatives are available for advancing the research....The claim that there are alternatives to using stem cells derived from embryos is not, at the present time, supported scientifically. *We recognize, however, that this is a matter that must be revisited continually as the science advances.*¹
(emphasis added)

At that time there was only scant evidence for viable alternatives to embryonic stem (ES) cells for therapeutic use. A plethora of subsequent publications, however, provide ample evidence that non-embryonic stem cells (postnatal stem cells, including those from adult tissues, umbilical cord blood, and placenta, herein termed "adult stem cells") can fulfill all of our needs with regard to degenerative diseases. Indeed, the literature is now replete with citations showing the ability of adult stem cells to treat not only animal models of disease but also human diseases. In contrast,

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there is still only sparse and circumstantial evidence that ES cells can ever make good on any of the extravagant promises that have been made for them.

Several alleged shortcomings related to the biomedical potential of adult stem cells have been put forth. These allegations include that adult stem cells (1) have not been found in all tissues and are not pluripotent (i.e. cannot develop into cells and tissues of all three primary germ layers found early in development—ectoderm, mesoderm, and endoderm—from which all the cells of the body arise), and cannot form functional tissues; (2) are limited in number and difficult to isolate and grow in culture; (3) will be limited for use in treatments by risks of duplicating genetic error, and (4) will have limited applications for clinical treatments compared with ES cells. However, recent scientific developments indicate that these alleged shortcomings of adult stem cells either are illusory or can be overcome. In fact, an impressive volume of scientific literature attests to the fact that human adult stem cells—unlike ES cells—are currently being used successfully in humans to combat many of the very diseases that ES cells only prospectively promise to treat. Animal research indicates that more therapeutic applications of adult stem cells will follow.

Finally, the potential biomedical application of human ES cells faces risks unique to ES cells, including the tendency toward tumor formation, as well as gene expression instability. ES cells also face the very real potential of immune rejection, while use of a patient's own adult stem cells is free from this problem. Consequently, adult stem cells have several advantages over ES cells in their practical therapeutic application for tissue regeneration.

Thus, contrary to suggestions by supporters of human ES cell research, federal funding of such research is not a necessary or even a wise use of limited federal research dollars. Adult stem cell research is more promising, is demonstrably more successful at producing beneficial treatments actually used today, and does not present the significant problems and uncertainties (to say nothing of the ethical and legal problems) posed by human ES cell research.

I. ADULT STEM CELLS ARE PRESENT IN MANY (IF NOT ALL) TISSUES, ARE PLURIPOTENT, AND CAN FORM FUNCTIONAL TISSUES

Adult stem cells have not yet been found in every organ. However, they have been found in many tissues, including brain, muscle, retina, pancreas, bone marrow, peripheral blood, cornea, blood vessels, skin, liver, umbilical cord, placenta, and even fat.² Indeed, researchers have found that human adult neural stem cells can even be isolated from cadavers.³

More importantly, adult stem cells can regenerate healthy tissue and transform from one cell type into another. For example, plentiful stem cells from fat have been transformed into cartilage, muscle, and bone. Readily accessible bone marrow and blood stem cells have been transformed into muscle, heart, neural cells, liver, bone, cartilage, and other tissues. Adult neural stem cells have been reprogrammed to form skeletal muscle, blood, and all neural types. Stem cells from muscle can be coaxed into forming muscle, bone, and cartilage. And even adult stem cells from skin can form neurons, smooth muscle, and fat.⁴

Adult stem cells thus show pluripotency. In fact, published research indicates that adult neural and bone marrow stem cells may be able to generate all adult tissues.⁵ Clarke et al. suggest that “stem cells in different adult tissues may...have a developmental repertoire close to that of [embryonic stem] cells.”⁶ The recent rapid pace of discovery, combined with the ability to form many, if not all, adult tissues, suggests that adult stem cells will ultimately be found in, or found to be capable of transforming into, every significant tissue type.

Contrary to the impression created by advocates of human ES cell research, the results for adult stem cells are far more promising than any obtained for ES cells, including the ability to form functional tissues in the body. The case for diverting scarce research dollars away from more promising avenues of research into human ES cell research in order to “cure” diabetes or Parkinson’s disease is weak indeed.

II. ADULT STEM CELLS ARE PRESENT IN ADEQUATE SUPPLY AND CAN BE EASILY ISOLATED AND GROWN IN CULTURE

To be sure, adult stem cells are present in finite amounts throughout the body, but the supply of human adult stem cells immediately available is much larger than previously thought, and adult stem cell numbers can be expanded greatly in culture. Adult stem cells have the ability to rapidly and significantly proliferate so that sufficient amounts can be produced for clinical applications.⁷ Indeed, animal studies indicate that a single adult stem cell is sufficient to repopulate adult bone marrow, generate nerves, and participate in repair of a variety of tissues throughout the body.⁸ In fact, evidence now exists that human adult stem cells can be expanded indefinitely in culture.⁹

Arguments for federal funding of human ES cell research thus rely on an outdated understanding that markedly underestimates the number of adult stem cells present in an adult human and the efficiency with which those cells can be reproduced.

III. TREATMENTS USING ADULT STEM CELLS WILL NOT BE PROHIBITED BY RISKS OF DUPLICATING GENETIC ERROR

It has been asserted that adult stem cells are likely to be ineffective at combating genetic diseases because the patient's own stem cells would contain the same genetic error, making those cells inappropriate for transplantation. Evidence from clinical studies to date belies this assertion. The first successful human gene therapy used "remedied" adult stem cells to cure severe combined immunodeficiency syndrome (the "boy in the bubble" syndrome).¹⁰ In some cases the correction of the genetic defect may not be necessary to effect a cure with adult stem cells. For example, patients with systemic lupus have been treated with their own bone marrow stem cells that repaired organ damage previously considered permanent. This repair occurred without correcting any genetic defect present in the bone marrow cells.¹¹ Thus, a patient's genetic deficiency does not preclude the use of his or her own stem cells for therapeutic purposes. In fact, the use of one's own stem cells is medically preferable to use of ES cells, which carries with it a severe risk of host rejection and tumor formation.

ES cells are in fact the ones that will suffer from a risk of accumulating defects and DNA abnormalities. ES cells face the risk of mutation with every successive generation in culture; "[c]ells derived from stem cells that have replicated through many generations will have accumulated mutations and be susceptible to cancer or have decreased viability."¹² Therefore, an ES cell line grown in a lab for successive generations has an equal or greater chance of exhibiting undesirable characteristics compared to adult stem cells harvested from a patient for autologous (same-patient) transplantation.

Moreover, a recent study points to potentially significant problems with using ES cells for therapeutic treatments.¹³ For mice cloned from mouse ES cells, even apparently healthy animals had abnormalities that would be difficult to detect but could lead to disastrous disorders later in life. The abnormalities could be traced back to the ES cells themselves. The gene expression of the ES cells "was found to be extremely unstable," even in the culture dish.¹⁴ This instability suggests that using ES cells to treat health disorders may not work nearly as well as some have suggested, and would likely limit any use of ES cells in clinical treatments.

IV. ADULT STEM CELLS HAVE BEEN USED IN MANY CLINICAL TRIALS WITH GREAT SUCCESS AND HAVE BEEN USED SUCCESSFULLY IN TREATMENT OF NUMEROUS ANIMAL MODELS OF DISEASE

By contrast, adult stem cells have already been used in a variety of

clinical applications with considerable success. Such applications include treatments for various cancers,¹⁵ autoimmune diseases (such as multiple sclerosis, systemic lupus, and rheumatoid arthritis¹⁶), immunodeficiencies, anemias,¹⁷ stroke,¹⁸ and cartilage and bone diseases.¹⁹ Adult stem cells have also been used to regenerate corneas, restoring sight to previously blind patients,²⁰ and to treat cardiac damage.²¹ Simply stated, adult stem cells are already successful at treating a wide array of human diseases, presently providing results only promised by advocates of ES cell research.

The scientific record provides strong evidence for the conclusion that adult stem cells will be applied to treat a host of other human diseases and conditions, based on results in animal models. Adult stem cells have already been used successfully to treat various animal models of human disease, including nerve and spinal cord damage,²² Parkinson's disease,²³ heart damage,²⁴ muscular dystrophy,²⁵ diabetes,²⁶ stroke,²⁷ and liver disease.²⁸ Adult stem cells also appear to possess an ability to target sites of damaged tissue in the body, repairing damage and even attacking tumors.²⁹ As these studies move from animal models to clinical application, adult stem cells will be our best hope for fighting those diseases in the near term.

Contrary to the impression created by ES cell advocates, the biomedical potential of ES cells remains entirely speculative. Such cells have never been successfully used in clinical applications and have had lackluster success in combating animal models of disease. Thus, unlike adult stem cells, the biomedical potential of ES cells is purely speculative and a distant hope. Indeed, in contrast to human adult stem cells, human ES cells have not been successfully coaxed to make pure populations of most tissue types, even for animal models of disease.³⁰ Although ES cells may have great theoretical potential, they have been difficult to control in laboratories. The inability to manage ES cells successfully in the controlled atmosphere of a laboratory does not bode well for success as therapeutic treatments.

Even proponents of ES cell research have noted that ES cells are "tedious to grow," and that "simply keeping human ES cells alive can be a challenge."³¹ Not only is there difficulty in consistently coaxing human ES cells to differentiate into desired cell types, but also, there is the more fundamental problem of keeping ES cells alive. Significantly, ES cells also face a substantial risk of immune rejection.³² In stark contrast, the retransplantation of a patient's own stem cells carries with it no risk of immune rejection since the cells are the patient's own. No effective strategy has been developed to combat the problem of immune rejection of ES cells. Additionally, pluripotent ES cells have a tendency to form tumors.³³ University of Pennsylvania bioethicist Glenn McGee agrees,

noting recently: "The emerging truth in the lab is that pluripotent stem cells are hard to rein in. The potential that they would explode into a cancerous mass after a stem cell transplant might turn out to be the Pandora's box of stem cell research."³⁴

CONCLUSION

Compared with embryonic stem cells, adult stem cells have as great, if not greater, potential for biomedical application without the medical risks or the ethical controversy. The biomedical potential of adult stem cells is enormous. They are already used successfully to treat patients, and animal studies indicate that therapeutic treatments for numerous devastating human diseases are well within the vast therapeutic capabilities of adult stem cells. Studies strongly suggest that adult stem cells can transform into all significant tissue types. This transformative power of adult stem cells has caused one reviewer to remark that "[r]ecent studies have revealed that much of this remarkable developmental potential of embryonic stem cells is retained by small populations of cells within most tissues in the adult."³⁵ One recent review proposes that "rather than referring to a discrete cellular entity, a stem cell most accurately refers to a biological function that can be induced in many distinct types of cells, even differentiated cells."³⁶ The authors liken the circulatory system to a "stem cell highway" in which adult stem cells may migrate from tissue to tissue, taking "on-ramps" and entering tissues to generate appropriate cell types in response to homing and growth signals ("billboards") as required, with all choices reversible.³⁷

Whereas adult stem cells continue to surpass expectations, ES cells have yet to live up to their billing as the new fountain of youth. ES cells are difficult to work with and carry with them significant risks that cast doubt upon their therapeutic viability. The shortcomings of ES cells, contrasted with the capabilities of adult stem cells, indicate that adult stem cells have many advantages as compared with ES cells in practical therapeutic applications.

There can be little doubt at this time that adult stem cells provide equal, if not greater, potential for biomedical application as compared with ES cells. Applying NBAC's own standard, the scientific record indicates that federal funding for human ES cell research is not justifiable. Indeed, less morally problematic alternatives for advancing the research are most definitely available, due to the stunning promise of adult stem cells.³⁸

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