# Stem cell research in Brazil: the production of a new field of science

*Rafaela Teixeira Zorzanelli*
Professor, Instituto de Medicina Social/
Universidade do Estado do Rio de Janeiro
Rua São Francisco Xavier, 524, Pavilhão João Lyra Filho,
6º andar, bloco E, sala 07
20550-013 – Rio de Janeiro – RJ – Brazil
rtzorzanelli@hotmail.com

*Angela Vasconi Speroni*
Doctoral candidate, Instituto de Estudos em Saúde Coletiva (Iesc)/
Universidade Federal do Rio de Janeiro (UFRJ)
Avenida Horácio Macedo, s.n., bloco A, sala 7
21941-598 – Rio de Janeiro – RJ – Brazil
angelasperoni@gmail.com

*Rachel Aisengart Menezes*
Professor, Iesc/UFRJ
Avenida Horácio Macedo, s.n., bloco A, sala 7
21941-598 – Rio de Janeiro – RJ – Brazil
raisengartm@terra.com.br

*Annette Leibing*
Professor, Faculty of Nursing/Université de Montréal
CP 6128, succ. Centre-ville
H3C 3J7 – Montréal – Québec – Canada
annette.leibing@umontreal.ca

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Abstract

Based on a review of the literature published in the early twenty-first century by Brazilian researchers, the article offers an overview of stem cell research in Brazil. Three central topics were detected in these papers: (1) the funding of stem cell research in Brazil; (2) preclinical and clinical trials in Brazil; and (3) social anthropological analysis focused on ethical and legal matters. Our review identifies controversial questions in the construction of this scientific field, especially issues involving the media as a disseminator of values and of certain social representations, where new kinds of hope figure large. Within this climate of uncertainty, we find patients and their families energized by the promises of the "medicine of the future."

Keywords: stem cells; cell therapy; regenerative medicine.

Since the twentieth century, genes have been prime biotechnological actors when it comes to producing humans in all their worth because they are considered the repositories of human potential. At the turn of the twenty-first century, stem cell research gained momentum, promising a regenerative medicine that could beat the challenges of illness and aging by furnishing a potentially unlimited source of tissue for transplants (Pereira, 2008). Because these cells can transform into different kinds of tissues – bones, blood, nerves, muscles – expectations grew about possible treatment options aimed at degenerative neurological diseases, cardiovascular illnesses, and spinal cord injuries, among other maladies. Stem cells came to represent a renewable fountain of health and a marketable organic matter that involve intellectual property rights and technological innovation (Waldby, 2002; Rose, 2006). Under the auspices of what is heralded as personalized medicine, hopes and energies are being channeled into "custom-made" therapeutic applications that are genetically and immunologically tailored to a single individual, with the ultimate goal of enhancing the efficacy of stem cell treatment.

This article offers an overview of stem cell research in Brazil, based on a review of the literature published in the early twenty-first century by Brazilian researchers. Our key purpose was to investigate the construction of a new field of science by analyzing scholarly production released by the main researchers involved with this biotechnology in Brazil. Some of the questions that guided our readings of this literature were: What content was emphasized in each publication? What topics were deemed most relevant and which appeared most often?

Stem cells have a tremendous capacity for proliferation and self-renewal (Alves, Muotri, 2014). Scientists divide them into two major groups: embryonic stem cells and adult stem cells (Rehen, Paulsen, 2007). The former, which are obtained from an embryo's cell mass at four or five days after fertilization, can generate a wide variety of cells and tissues. Adult stem cells, on the other hand, come into being in later stages of development and are found in different regions of the body, where they can generate cell subtypes of the tissues from which they derive.

Embryonic stem cell research began in the early 1980s in the United States. The discovery that these cells could transform themselves into various cell types energized the scientific community about possible application in human treatment. However, progress in the field has been limited by ethical and legal barriers to the use of embryos generated for the purpose of assisted reproduction (Diniz, Avelino, 2009).

The transplant of adult stem cells, such as bone marrow, dates to the 1950s. Adult stem cell research advanced following discovery of so-called tissue-specific stem cells, which generate cells for the tissue or organ in which they live. These cells have been identified in the liver, dental pulp, blood vessels, skeletal muscle, pancreas, epithelia of the skin and digestive system, cornea, retina, spinal cord, and brain (Rehen, Paulsen, 2007).

A large part of investments in stem cell research are currently directed to finding ways of making pluripotent cells. In 2012, the Japanese scientist Shinya Yamanaka and the British scientist John Gurden shared the Nobel Prize for Medicine. Yamanaka was the first researcher to obtain pluripotent stem cells without using embryos. He and his team successfully reprogrammed skin cells from mice and introduced pluripotency-associated factors, creating induced pluripotent stem (iPS) cells. With this technique, cells taken from a

patient can be transformed into an embryonic cell-like state and can then differentiate into various types of tissue. The reprogrammed cells are then transplanted to the same patient, a medical intervention that researchers refer to as "personalized medicine" (Rehen, 29 abr. 2011; Pereira, 2013).

The discovery of iPS cells changed the landscape in this field of research because it opened up the possibility of using innovative alternatives to overcome the roadblocks to successful treatment using embryonic stem cells (Rehen, 29 abr. 2011). The first of these roadblocks is represented by the ethical and legal challenges to obtaining embryonic stem cells, which are isolated from the embryos that would be discarded by in-vitro fertilization clinics. The second obstacle is the risk of post-transplant rejection. Since iPS cells are generated from a patient's own tissues, the chance of their being mistaken for invasive cells is greatly reduced. Current iPS cell research also plays a role in drug testing, since it allows the early signs of some diseases to be studied in the laboratory.

Stem cell research can be divided into three levels: basic, preclinical, and clinical. Basic research entails the identification of cells and their mechanisms and potential. Preclinical trials involve safety and efficacy testing with animals. Clinical trials use human subjects to test safety and compatibility. Researchers call attention to the challenges of moving from the realm of basic research to effective treatment. Proponents of stem cell therapy wager that this regenerative technology will prove successful in addressing a number of issues, such as aging, injury, and chronic degenerative disease.

At the same time, our analysis of the scholarship published by Brazilian researchers detected controversies within this emerging field of biotechnology, especially regarding the tension between promises and reality, findings and expectations. Within this climate of uncertainty, we find patients and their families driven to new hope by the promises of the "medicine of the future."

The theoretical questions guiding this review derive from the social study of the biosciences and life sciences. Of particular relevance is our dialogue with authors like Nikolas Rose and Carlos Novas, who analyze the historical and cultural processes underpinning the construction of a new biopolitical arena and the production of new representations of the body, life, and health.

## Methodology and analysis

In order to map publications in the field of cell therapy, we undertook a bibliographic survey of articles by Brazilian researchers that were published in the Scielo database in Portuguese and English in the first decade of this century, using the keywords "células-tronco" and "stem cells." We then conducted a qualitative study using content analysis methodology. While this tool does not answer the whole range of questions about the latest Brazilian scholarship in the field, it enables the identification of general features, differences, similarities, and peculiarities.

We identified 68 such articles published in Brazilian and foreign journals that are indexed by Qualis Periódicos/Capes. They dated from 2002 to 2010, with a notable increase in the number of articles published starting in 2008, as shown in Table 1:

**Table 1: Bibliographic survey of the Scielo database showing number of articles per year**

| Year | 2002 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| Number of articles | 1 | 6 | 5 | 5 | 6 | 11 | 19 | 15 |

Source: compiled by the authors.

The rise in the number of scientific articles published on the topic starting in 2008 can be correlated with two factors, which will be described in later sections of this paper: approval of Brazil's Biosecurity Law (and revocation of the Direct Action of Unconstitutionality, or Ação de Inconstitucionalidade) and the establishment of Cell Therapy Centers (Centros de Terapia Celular) and the National Cell Therapy Network (Rede Nacional de Terapia Celular) in Brazil, all of which took place that year.

For the purposes of this article, we included recently published papers, books, and documents on the topic. Of the 68 analyzed articles, 58 appeared in Brazilian and ten in foreign journals, as shown in Table 2.

Our survey included one article published in 2004 in the journal *Ciência Hoje* by an eminent researcher in the cell therapy field in Brazil. While this journal is not indexed by Qualis Periódicos/Capes, it is an important science communication source for the lay public and is recognized for its high standards. Its articles are submitted for outside peer review and focus primarily on Brazilian scholarship in its respective fields of investigation.

Table 2 shows a marked prevalence of articles published in the *Revista Brasileira de Hematologia e Hemoterapia*. Of these 25 papers, 14 were from 2009 and eight from 2010, both of which were years when the journal published special supplements on stem cell research and treatment. Most of these articles present reports and outlooks on therapy using stem cells from bone marrow and umbilical cord blood to treat heart, ophthalmological, and rheumatic diseases, autoimmune disorders, diabetes, and leukemia. The prevalence of papers by physicians from the fields of hematology and hemotherapy can be correlated with the fact that stem cell treatment is currently limited to transplants of hematopoietic cells, that is, the cells that are responsible for the formation and maturation of blood components. The scientific community considers all other types of cell therapy experimental at present, and these are restricted to clinical trials on patients.

Examination of these 68 articles showed that 33 were reviews of the literature from the field of cell therapy; 18 involved experimental research conducted in Brazil (preclinical and clinical trials); 11 presented social anthropological analyses of the topic; and seven were editorials.

Of the seven editorials, four appeared in the *Revista Brasileira de Hematologia e Hemoterapia*; two of these four offer expanded discussions of the advent of cell therapy as the "medicine of the future" (Ruiz, 2005; Ruiz, Bydlowski, Seber, 2009).

Our analysis of these articles found three central concerns in addressing the topic: (1) the funding of stem cell research in Brazil; (2) preclinical and clinical trials conducted in Brazil, especially papers about the Multicenter Randomized Trial of Cell Therapy in Cardiopathies, or MiHeart Study (Estudo Multicêntrico Randomizado de Terapia Celular em Cardiopatias) (Tura et al., 2007); and (3) social anthropological analysis of the cell therapy field, focusing

on ethical and legal debates surrounding the application of this innovative technology. Because these concerns dominated the articles under analysis, they also guided our survey.

**Table 2: Bibliographic survey of the Scielo database showing number of articles per journal**

| Journal | Number of articles |
|---|---|
| *Arquivo Brasileiro de Cardiologia* | 3 |
| *American Journal of Pathology* | 1 |
| *Acta Paulista de Enfermagem* | 2 |
| *Arquivos de Neuro-psiquiatria* | 3 |
| *Arquivo Brasileiro de Cardiologia* | 4 |
| *Brazilian Journal of Medical and Biological Research* | 1 |
| *Circulation* | 1 |
| *Ciência e Saúde Coletiva* | 5 |
| *Estudos Avançados* | 4 |
| *Interdisciplinary Perspectives on Infectious Diseases* | 2 |
| *Interface* | 1 |
| *Journal of Infectious Diseases* | 1 |
| *Mana* | 2 |
| *Progress in Cardiovascular Disease* | 1 |
| *Religião e Sociedade* | 1 |
| *Revista Brasileira de Ciências Sociais* | 1 |
| *Revista Brasileira de Hematologia e Hemoterapia* | 25 |
| *Revista Brasileira de Reumatologia* | 2 |
| *Revista da Associação Médica Brasileira* | 1 |
| *Revista de Saúde Pública* | 2 |
| *Revista Brasileira de Cirurgia Cardiovascular* | 1 |
| *Revista do Hospital de Clínicas de Porto Alegre e Faculdade de Medicina da UFRGR* | 1 |
| *São Paulo Medical Journal* | 1 |
| *Stem Cell Reviews* | 1 |
| *Trials* | 1 |

Source: compiled by the authors.

## The funding of stem cell research in Brazil

Population aging and the consequent increase in degenerative ailments constitute the prime culprit behind rising social costs, which are pushing up healthcare expenditures. It was within this climate of discord that regenerative medicine – with its goal of using stem cell treatment to increase our ability to regenerate damaged tissue – entered the limelight.

> The search for methods to repair the biological problems caused by injuries, illness, or aging has been driven by the discovery of stem cells that are able to self-replicate and differentiate into various cell types, opening the way for their use in repairing damaged tissues and organs (Soares, Santos, 2008, p.17).

Stem cell research began in Brazil in 2001, when the Ministry of Science and Technology created the Millenium Institute for Tissue Bioengineering (Instituto Milênio de Bioengenharia

Tecidual). The institute was set up to academically and technologically strengthen Brazilian institutions in the production of innovative treatment approaches that use cell technology to repair organs and tissues. As pointed out by Luna (2012), the establishment of this institute inaugurated a process of forging a transdisciplinary network focused both on coordinated work involving laboratories, professionals, and researchers from a range of specialties and also on the inflow of material and other resources like funding, equipment, and labor, all with the ultimate goal of fostering innovation.

From that point on, research groups and teams from universities and public and private hospitals – including the Oswaldo Cruz Foundation, the National Cardiology Institute (Instituto Nacional de Cardiologia), the National Cancer Institute (Instituto Nacional do Câncer), and the National Institute of Traumatology and Orthopedics (Instituto Nacional de Traumatologia e Ortopedia) – joined forces in the development of what is now known as regenerative medicine.

In 2004, Brazil's Ministry of Health offered grant money to help support the MiHeart Study. This initiative, which converged with efforts by the Millenium Institute for Tissue Bioengineering and with the potential of international cell therapy research, reflected the impetus of Brazilian scientists' interest in conducting clinical trials in Brazil.

One factor worth highlighting is the approval by the Brazilian Congress of the Biosecurity Law in March 2005 (Brasil, 28 mar. 2005), which authorized the use of human embryonic stem cells for research purposes. A suit was filed that same year to contest the decision. In 2008, Brazil's Federal Supreme Court ultimately ruled in favor of continued research, which was to be restricted to the use of embryoes that had been frozen for three years and were to be discarded by IVF clinics.

> A worldwide call for embryonic stem cell research has put pressure on governments, and the Brazilian Congress recently ruled on the matter. A few months ago, Brazil's Ministry of Sciences and Technology and its Ministry of Health also opened lines of credit for research in the area of cardiology that includes clinical and preclinical trials for incurable diseases (Ruiz, 2005, p.4).

In 2005, the National Council for Scientific and Technological Development (CNPq) and the Ministry of Health made more than BRL 10,000,000 in grant money available to support the creation and strengthening of groups that research innovative cell therapy treatment. According to ministry data (Brasil, 2010), 47% of the 45 projects approved for funding involved basic research; 29%, preclinical trials; and 24%, clinical trials. In terms of cell type, 87% of the projects investigated adult stem cells and 13%, embryonic.

In 2008, the Ministry of Health – once again in partnership with the CNPq – released further funding for cell research projects in Brazil. Grants were awarded to 52 projects exploring the therapeutic potential of embryonic stem cells, induced pluripotent stem cells, and/or adult stem cells in treating neurological, liver, kidney, and pulmonary diseases; autoimmune disorders; hearing and visual impairments; damaged bones, muscles, skin, and peripheral nerves; and other conditions. Of the total approved proposals, 32 entailed preclinical trials; 17, basic research; and three, clinical trials.

A further landmark in the development of this field in Brazil was a another 2008 initiative by the Ministry of Health, this one sponsoring a call for proposals to set up Cell Technology

Centers to produce various kinds of human stem cells. The initiative was undertaken in partnership with the Brazilian Innovation Agency (Financiadora de Estudos e Projetos, Finep) and the Brazilian Development Bank (Banco Nacional de Desenvolvimento Econômico e Social, BNDES).

The drive to firmly establish this field of research prompted the 2008 creation of the National Stem Cell Therapy Network, an initiative of the Ministry of Health's Department of Science and Technology, with the support of the Pan American Health Organization (PAHO) and the World Health Organization (WHO). The network currently comprises eight Cell Technology Centers located in five Brazilian states, in addition to 52 laboratories selected by the CNPq. The establishment of these centers is part of a project to strengthen links between basic research and preclinical and clinical trials by organizing a common space where scientists and physicians, ideas and products, can circulate and interact.

The energy of researchers, along with incentive from official bodies in support of investigations in the area, are determinant in advancing research that may benefit the public through progress in regenerative medicine. Yet this is still a nascent field of studies. Further research, laws, regulations, and public policies are needed, as is greater debate among researchers, scientists, physicians, and the public at large. Stem cell therapy is not yet part of the clinically approved arsenal of treatment options, since the scientific community still considers it to be experimental. The use of stem cells remains limited to clinical trials, except in the case of bone marrow transplants. However, this fact is not enough to quell expectations that, in the medium term, the results of clinical trials may translate into treatments that are capable of addressing a variety of ailments and are accessible at healthcare facilities.

The production of new materials urges the enactment of new regulations along with the definition of ethical parameters, in a scenario where there is no international consensus. Given the current cost of conducting clinical trials, especially with personalized cells, another challenge is presented by economic and social considerations, which are related to the principle of universal access to health care stipulated under Brazil's Unified Health System (Sistema Único de Saúde, SUS).

The Technical Chamber on Cell Therapies (Câmara Técnica de Terapias Celulares) was created in 2012 with the purpose of standardizing practices, information, and regulations (Brasil, 13 dez. 2012). The chamber was to be comprised of representatives of the Ministry of Health, the Brazilian Health Surveillance Agency (Agência Nacional de Vigilância Sanitária, Anvisa), the National Commission for Ethical Research on Humans (Comissão Nacional de Ética em Pesquisa com Seres Humanos), the federal boards of medicine and dentistry, and two patient associations. It followed the model of the European Union, which in 2008 had established a similar committee, known as EuroStemCell Connect.

## Preclinical and clinical trials in Brazil

In 2004, the Ministry of Health released grant funds for the development of a MiHeart Study. The project entails four independent clinical trials involving different kinds of cardiopathies, which are being carried out at four separate locations: acute myocardial infarction, at the Federal University of Rio de Janeiro (Universidade Federal do Rio de

Janeiro, UFRJ); chronic ischemic heart disease, at São Paulo's Heart Institute (Instituto do Coração); dilated cardiomyopathy, at the National Cardiology Institute (Instituto Nacional de Cardiologia) in Rio de Janeiro; and Chagas cardiomyopathy, at the Oswaldo Cruz Foundation in Bahia. All four trials are multicenter, randomized, double blind, and placebo controlled (Tura et al., 2007), which means that the experiments are conducted at two or more research centers using a common protocol and that neither research subjects nor researchers know who has been randomly selected to receive the experimental treatment and who is receiving a placebo.

Stem cell therapy targetting cardiovascular disease has been investigated in Brazil using animal models as well as in human clinical trials.

> Heart disease has a remarkable epidemiological impact and has been the leading cause of death in the world since the middle of the past decade and is projected to remain so through 2030. Public and private bodies from various countries thus consider investments in lines of stem cell research and clinical trials to be strategic (Schettert, 2008, p.15).

> Cell therapies have targeted heart disease ever since the outset of research, especially because it is the world's leading cause of death. For this reason, it is believed that cell therapies in this realm have advanced the farthest and have good chances of being introduced to healthcare services, as long as better-controlled studies are conducted to prove treatment efficacy (Lima, Soares, Santos, 2009, p.88).

Research results have suggested that bone marrow stem cells may be somewhat efficacious in treating ischemic heart disease and may also have potential as a treatment for other cardiopathies. Brazilian researchers have prime motives for investigating the chronic form of Chagas's disease, for which the only available treatment option is a heart transplant (Soares, Santos, 2008).

> The major focuses in heart disease in Brazil are Chagas cardiomyopathy and ischemic heart disease. [These diseases] place an extremely heavy socioeconomic burden on the country's healthcare system (Lima, Soares, Santos, 2009, p.88).

> Chagas cardiomyopathy is one of the leading causes of heart failure in Latin America, and its clinical presentation greatly resembles other forms of dilated cardiomyopathy. ... The model of Chagas's disease is especially attractive for the use of stem cell therapy (Vilas-Boas et al., 2004, p.182).

The research team of Soares and Santos (2008) reported on a pioneer clinical trial conducted in the city of Salvador, Bahia, which involved thirty patients suffering from heart failure caused by Chagas's disease. Their findings showed an absence of any adverse effects, which indicates that the procedure is safe. Rossi and Borojevic (2009) emphasize that while a meta-analysis of the results published in the literature suggests improved heart function, this improvement is slight. Moreover, in some cases no changes were shown. The authors stress that new research is necessary to clarify these discrepant results.

The study by Mastropietro et al. (2010) stands out among the analyzed articles based on empirical studies because its findings have an important bearing on the psychosocial conditions of the patients receiving stem cell transplants. Tools used in socioeconomic

evaluation and interviews about post-transplant recovery detected links between income, work, and quality of life for patients submitted to stem cell transplants. Results showed that patients whose income was greater than the equivalent of two times the monthly minimum wage presented higher mental health indexes and overall quality of life scores and also felt more capable of performing activities of daily living. The authors report that poverty lowers quality of life, demeans the feeling that one is competent in one's personal life, and challenges psychological adjustment, all of which can boost inherent transplant risks. They suggest that doctors involved with this type of therapy take these psychosocial variables into account.

> It is not just quality of life that is strongly associated with family income; so too are the feeling of personal competence and the achievement of better psychological adjustment. This finding suggests that greater attention should be paid to socioeconomic factors. To reduce the impact of these factors, input is needed from the multi-professional team comprising physicians, nurses, occupational therapists, psychologists, social workers, physical therapists, dentists, and family and community support (Mastropietro et al., 2010, p.103).

According to data from the Ministry of Health, the MiHeart Study received the highest level of funding for any clinical trial in Brazil, that is, more than BRL 13,000,000. In terms of patient numbers (1,200) and institutions involved (66), this is the world's largest funded research project on cell therapy for cardiopathies. The breadth of the study, which runs the length of the country from north to south, also contributes to making Brazil's stem cell research more visible on the international stage.

While cardiopathies are at the fore in stem cell research in Brazil, other illnesses also receive academic attention and dedication, such as neurological diseases (Teive et al., 2008; Muotri, 2010), autoimmune disorders (Voltarelli, 2002), diabetes (Voltarelli et al., 2009), ophthalmological problems (Siqueira, 2009), and pulmonary diseases (Ribeiro-Paes et al., 2009), among others.

In an article published in 2004, Radovan Borojevic (2004, p.39), an eminent researcher in the field, points to the contrast between promises and expectations about the results of clinical trials and actual reality. The author called attention to the role that the media play in spreading hope:

> Public exposure might be desirable, since mobilizing opinion can influence priorities when it comes to producing knowledge, training human resources, transferring scientific knowledge for medical application, and improving people's quality of life. It can also be dangerous, by sparking exaggerated, unjustified hope; fueling disproportionate expectations; and mobilizing society to follow paths that are not always right or go along with proposals that are not always honest.

A number of authors have underscored the intense, growing social mobilization stemming from the dissemination and promotion of premature information on stem cell research. One example is the burgeoning movement known as stem cell tourism, in which patients cross intercontinental borders in the pursuit of new experimental treatment options (Lindvall, Hyun, 2009; Knowles, 2010). Researchers in the field are concerned over a steadily rising trade in new biotechnologies in countries that have little or no government regulations, like China, Singapore, Russia, India, Turkey, Germany, and Mexico.

Brazil's leading scientists have rigorously declared that except in cases of bone marrow transplants with stem cells, most procedures are experimental and their risks still unknown (Rehen, 29 jul. 2011; Pereira, 2013). According to Brazilian researchers, studies that are in the phase of application to human subjects still represent the cutting edge but, nevertheless, this does not curtail enthusiasm or expectations about progress with this innovative technology.

> With the goal and desire of diminishing suffering and, when possible, forestalling death, medicine discovers new proposals for therapeutic procedures at innovative moments in the evolution of science. What hope for those who need to cure their disease, diminish their pain, return to a normal life! What hope for those who want to overcome the limits of time, aging, lost quality of life, and inexorable physical death! Cell therapies are in fashion. They promise, at least in part, to provide solutions to these challenges (Borojevic, 2004, p.37).

Pointing out the value of using stem cells in Brazilian public health, Pereira (2008) highlights the milestone reached in 2001, when the National Cancer Institute created Brazil's first public umbilical cord blood bank for cell therapy purposes. Pereira defends the importance of cord blood banks in ensuring samples that preserve the diversified nature of Brazilians.

## Social anthropological analyses of the field of cell therapy

Of the 68 articles chosen, 11 explore various topics from the perspective of social anthropology. Diniz and Avelino (2009) offer a comparative analysis of government regulations on embryonic stem cell research in a number of countries. Based on an analysis of official sources available on the internet, the authors identify an international trend to recognize the ethical legitimacy of scientific research with embryonic stem cells through legal frameworks, as has been the case in Brazil, the United Kingdom, Spain, Finland, France, Denmark, and Sweden. A unique feature of Brazil's Biosecurity Law is that it stipulates that embryonic research should preferably involve nonviable embryos. Conversely, in most of the countries surveyed, no distinction is made between viable and nonviable frozen embryos.

An article by Segre (2004), published before enactment of Brazil's Biosecurity Law, discusses the need to redefine the moment that life begins in order to develop assisted reproductive technologies. He criticizes the "obscurantist authoritarianism" (p.259) of sectors of society that use religious arguments to hamper scientific progress and jeopardize the chances of improving quality of life for the many who might benefit from embryonic stem cell research.

> For this reason, I believe we should not fear [technologies for using embryonic stem cells in research] a priori but rather carefully monitor their application. ... The possibility of treating diseases like leukemia, Parkinson's, and Alzheimer's, as well as being able to grow organs that can be used in transplants, is a heartening prospect toward improving quality and length of life for many people (Segre, 2004, p.260).

On the other hand, Gallian (2005) points to arguments regarding the commotion caused by research with embryonic stem cells. The author calls attention to the challenges of achieving successful treatment in research on animals and also suggests that research often

reflects a blind enthusiasm triggered by coverage of the "Dolly event" (p.255). As Gallian sees it, the euphoria incited by the media is unjustified. The first beneficiaries of the legal authorization of this research in Brazil were assisted reproduction clinics, which have stocks of frozen embryos. So behind the scenes of this showy spectacle promised by stem cells, a razzle-dazzle of technical terms is used to justify scientific progress.

Cesarino (2007) addresses the topic from a legal perspective, comparing the British and Brazilian debates and laws governing embryonic research and assisted reproduction. She stresses the fact that the passage of laws in Britain was preceded and followed by a heated ethical debate. In Brazil, approval was a response to pressure from those interested in the approval of these two biotechnologies.

During the period under analysis, Luna (2007a, 2007b, 2008, 2010) published a number of articles on the topic of stem cells. In "A personalização do embrião humano" (Luna, 2007a), she analyzes representations of the human embryo and fetus present in the discourse of professionals involved in assisted reproduction and also in texts published by the media around the time of the events surrounding legislative approval of Brazil's Biosecurity Law. Interviewee narratives underscored the physical markers for assigning personhood to an embryo. Luna noted the existence and use of both religious and scientific arguments, especially to bolster the legitimacy of each group's positions.

In another article, Luna (2008) addresses religious aspects in the medical context of stem cell research. Since the majority of the Brazilian population is currently Catholic, the author explored whether the two groups of interviewees – researchers and patients – adhered to the interpretation of the Vatican, which opposes any manipulation of the embryo because it is considered a human life. In both groups, the vast majority supported the use of embryos pursuant to the terms of the Biosecurity Law: "No direct linear correlation was found between religious affiliation and opinion regarding embryonic stem cell research; the interviewees who were against or undecided about this manipulation [included both those who declared themselves to be] non-practicing Catholics [as well as those who] stated they had no religious affiliation" (p.174).

Of the social cultural texts that were analyzed, special note should be taken of the article by Oliveira Junior (2009), which presents philosophical arguments, religious beliefs, and bioethical principles. The religious backdrop to the article is evident in a number of passages, such as:

> The grandeur of this act, where a human being can successfully capture and sequentially transfer [genes], constitutes a demonstration of the infinite wisdom of the Creator. ... But to perfect the human being even further, the Creator placed virgin cells – veritable soldiers in the reserves, authentic spare tires – in the bone marrow, available at any time (Oliveira Junior, 2009, p.161).

Oliveira Junior (2009) defends embryonic stem cell research as long as ethical and legal principles are respected, such as, for example, the signature of a free, informed consent. He believes this would make it possible to follow a "path crowned by success through regenerative medicine" (p.163).

Fernandes (2008) begins with the idea that the field of stem cell research presents a relevant debate regarding the realm of bioethics. He questions ownership of the material donated

to IVF clinics and argues that human stem cells should not be patented. In his opinion, protecting property rights is not helpful in promoting social well-being and might hamper access to possible results and treatments. Fernandes presents as an appropriate alternative the creation of a worldwide fund for the development of research, especially with embryonic stem cells, which would be a way of avoiding patenting and other means of private ownership. Scientists would gain recognition as the authors of their work and for the social value of their contributions.

## Controversies

Our analyses identified certain controversial matters within this field of research, especially because embryonic stem cell research has become the object of moral debate. Certain aspects of these controversies deserve highlighting, such as the release of cell research findings by the lay media.

As noted by Luna (2012), stem cells have been in the public limelight because their use is associated with "promises of curing" diseases for which no efficacious treatment currently exists. In this context, the media wields great influence through its frequent coverage of the positive results of experimental stem cell treatment of humans.

A recently released article (Almeida, Dal'Col, Massarani, 2013) explores this controversy in Brazilian television journalism, based on a study concerning the release of information on stem cells, stem cell research, and findings. The investigation surveyed news broadcast by the country's most watched non-cable newscast from 2005 to 2008, the period of Brazil's legal debate over the use of embryonic stem cells for research purposes. The authors note that the debate was sharply polarized between those who defended embryonic stem cell research (particularly scientists and researchers) and those who attacked it (most of whom were representatives of religious bodies). At the same time, they point to the prevalence of a tone of enthusiasm sparked by the heralding of health interests, technological progress, and the advancement of science, revealing the complex relations between media, public opinion, and political decisions.

The advent of the internet and expanding access to this resource has democratized information, including data on research lines and the likely therapeutic uses of stem cells (Takeuchi, Tannuri, 2006), as illustrated in these words: "In recent years, cell therapy and adult and embryonic stem cells have dominated the media as well as the hopes of carriers of incurable diseases who have no prospects of finding efficacious treatment through current conventional means" (Ruiz, Bydlowski, Seber, 2009, p.1).

Roza and Bizario (2008) believe that the information that has been broadcast has done little to clarify central concerns in the field of cell therapy and has reinforced the religious and moral biases found in Latin culture. Those who enthusiastically promote cell therapy do not attribute due importance to the fact that many steps are still needed before we arrive at approved, controlled, and accessible therapies. Caught in the midst of this uncertainty are the sick and their families, excited by the promises of the "medicine of the future" and therefore seeking inclusion in experimental clinical trials, while they increasingly lodge their demands through legal channels.

Zatz (2009) calls attention to clinics operating in countries that lack official regulations governing stem cell research and that offer treatments for a variety of conditions, such as Down syndrome, spinal cord injuries, strokes, and even age-related baldness and face wrinkles, a situation that increasingly fuels stem cell tourism. The author stresses that it is hard to define how long it will take for research to move out of the laboratory and into the patient's home, from the realm of basic research to actual treatment. Carvalho et al. (2009) agree with Zatz's statement and emphasize that despite the progress that has been seen in basic science in the last decade, questions remain unanswered, such as those concerning the mechanisms of cell therapy. While studies have been promising so far, there is a substantial need for preclinical trials before it is possible to shift to patient testing.

In the opinion of Zatz (2009), the media could collaborate by publicizing free participation in clinical trials. She argues that the negative results of clinical trials should also be released by scientific journals and on the websites that are consulted by patients in search of information. Disseminating the information that, for most diseases, the clinical applicability of these new forms of treatment still lies in the distant future would be a way of safeguarding the ill, and this includes protecting them from financial and psychological harm.

## Final considerations

Progress in stem cell research worldwide reflects an optimistic wager on regenerative medicine and its promise to repair and renew the body when injured, aging, or ailing. The role of cell therapy is grounded in the possibility of developing innovative ways of achieving renewable health or a health status that is less vulnerable to the predation of time. The body and its organs, tissues, and cells have been transformed into matter that can be steadily improved, bringing various social groups together in disputes over access to healthcare services and experimental treatment. In this context, hope becomes an ingredient in scientific research, politics, and the market.

As pointed out by Novas and Rose (2004), science is a realm where forms of the future are constructed through engagement in scientific research aimed at producing new kinds of therapeutic technology and resources. Hope plays an essential role in reshaping aspirations, ambitions, and desires in tune with the targeted biotechnological goals, and affected individuals increasingly need to deal with uncertain and even contradictory information about complex kinds of therapeutics (Leibing et al., 2016). Promoting and sustaining hope become crucial in caring for people with life-threatening diseases. In this setting, a belief in the improvement of human conditions underpins what we might call a "medical industry of hope" (Leibing, Tournay, 2010; Menezes, 2013).

Novas (2006) emphasizes the various facets of hope at play in contemporary biopolitics. It is not only a matter of what the ill and their families expect to see in terms of the treatment and cure of their diseases. It is also a matter of physician expectations regarding the development of innovative therapeutic resources, of scientists' and researchers' expectations regarding scientific progress and peer recognition, and of the expectations of the pharmaceutical industry and of biotechnology companies regarding their pursuit of profit-generating treatments.

As pointed out by Rose (1989), new authorities are subtlely influencing individual choices, wishes, and behavior. They act on people's hopes and expectations, drawing their attention to attractive images of life and persuasive truths.

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