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Medico Legal and Ethical Study of Stem Cell Research in India

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Abstract
Stem cells have the ability to produce a large number of specialised cells or tissue by regeneration and differentiation. The cells that regenerate could be known to cure disease or injury. As a result, they are distinguished from other cell types by their ability to replicate themselves. Stem cells offer the potential to develop cell-based therapies. Such type of research could lead to novel and improved treatments for a variety of disorders, including diabetes, spinal cord injuries, Alzheimer's, Parkinson's, and heart disease. Stem cell treatment, also characterized as regenerative medicine, induce the repair mechanism of damaged, diseased, or injured tissue using stem cells and their derivatives. Early-stage embryos are used to obtain human embryonic stem cells. Because human embryonic stem cells are harvested from human embryos, there have been various concerns raised the moral and ethical issues in embryonic stem cell research. On the other hand, reprogramming of somatic cells to make induced pluripotent stem cells, avoids the moral and ethical issues that come with embryonic stem cell research. In human stem cell research in addition to moral issues, informed consent to donate materials, critical downstream research, premature clinical trials and oversight all issues occur. To ensure that stem cell research is carried out in an ethically acceptable way, these ethical and policy issues must be discussed along with scientific challenges. This article examines these challenges and how they are addressed in India are explained.

Keywords: Stem cell, regenerative medicine, induced pluripotent cells, clinical trial, India.

1. Introduction:

A stem cell is a type of cell that has the ability to divide (self-replicate) indefinitely, often throughout an organism's lifetime. Stem cells can differentiate (give rise to) the many various cell types that form the organism if given the appropriate conditions or inputs. That is, stem cells have the ability to mature into adult cells with distinct structures and functions, such as heart cells, skin cells, or brain cells.[i]

As a reason, stem cells have the potential to function as regenerative therapy for damaged cells. The field of "regenerative medicine" is where a lot of research is currently being done to see whether stem cells may be used to treat diseases and injuries.[ii] In the development of regenerative medicine stem cell research (SCR) plays a key role.

Though stem cell research (SCR) is one of the most exciting areas of the life science today, it has created lot of controversies and raised various ethical and moral issues on the use of embryonic/foetal stem cells in research.[iii] The arguments against using these cells centre around the fact that their production involves destroying human embryos and, therefore, human life. As a consequence, the ethical debate now focuses on defining the stage at which life is considered to begin, and therefore from what point the embryo should be protected.[iv] Another ethical aspect of human embryonic stem cells (hESCs) is the donor and recipient's safety and informed consent for oocyte procurement and stem cell products, respectively. Ethicists are concerned about the appropriate conduct, fairness, and marketing of research in order to minimise ethical difficulties, stress, suffering and pain. And for those various guidelines for ethical conducts have been made by professional groups.[v] Yet adult stem cells (ASCs) avoid ethical issues associated with hESCs, still hESCs are more effective than adult stem cells for the following major issues, adult stem cells are present in very minute quantity in adult tissues; difficulty in identification, isolation, maintenance in laboratory.[vi]

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The discovery of Induced pluripotent stem cells (iPSCs) raised the possibility that hESCs research would no longer be necessary, thereby circumventing the ethical issues present in embryonic research. To date, this has not been the case: the stem cell field continues to rely on both hESCs and iPSCs research to progress the understanding of pluripotency and its potential applications.[vii] In stem cell research broader ethical questions include tissue ownership, informed consent when donating cells for stem cell banking, patient safety and data protection, and access to treatments.[viii]

In India, the political and legal guidelines have always promoted research on stem cells whether using hESCc or ASCc. The various government departments, ministries, private research institutions and Research and Development (R&D) companies in various public research institutions, hospitals and private industry are supportive in stem cells research.[ix] Despite of that rapidly increase of unethical practices in India, stem cell research has given rise much discussion in India within science, law and politics as well as philosophical and ethics. [x]

1.1 Types of stem cell

SCR is classified into embryonic stem cells, adult stem cells, cord blood stem cells and induced pluripotent stem cells as per the sources.

1.1.1 Human Embryonic stem cells (hESCs)- hESCs are the "mother" of all other cell types in the body, and it comes from the blastocyst stage of the human embryo. These cells have the ability to transform into a variety of different tissues in the human body.[xi]

1.1.2 Adult stem cells (ASCs)- ASCs are distributed throughout the body, and their role to repair the organ or tissue inside which they exist at any time during one's life.[xii]

1.1.3 Cord blood- Umbilical cord blood (UCB) collected from the umbilical cord differs from the peripheral blood in its properties. It is one of the most abundant sources of hematopoietic stem cells, which have the properties of self-renewal as well as the ability to differentiate into myeloid and lymphoid cell lineages.[xiii]

1.1.4 Induced pluripotent stem cells (iPSCs)- iPSCs have characteristics similar to embryonic stem cells, are another ground-breaking technology in stem cell research. These iPSCs were developed by reprogramming somatic cells into the pluripotent stem cells in the presence of the transcription factor SOKM (Sox2, Oct4, Klf4 and c-Myc).[xiv]

2. Medical Prospective

Currently, several stem cell therapies are possible with the development of stem cell research. There are several reports that have reviewed the outcome of the use of different types of stem cells in various clinical trials. [xv] A few examples of stem cell research cover spinal cord injury[xvi], glaucoma[xvii], cardiovascular disease[xviii], diabetes[xix,] liver injuries[xx], corneal disease[xxi], osteoarthritis[xxii], graft-versus-host disease[xxiii] and more recently therapeutic strategies for the management of COVID-19 patients.[xxiv] Stem cell research has the potential to improve and accelerate drug screening, drug discovery, and pre-clinical toxicological assessment of new drugs.[xxv]

3. Challenges in stem cell research

In the realm of medical research that involves biological material and humans as subjects, it is critical to explore ethical, philosophical, and religious perspectives in order to formulate rules and establish regulations that respect the dignity and fundamental human rights of individuals. [xxvi]

3.1 The source of human embryonic stem cell line

Discussions about the human embryo are frequently framed in terms of the embryo's moral status. An important distinction arises between those who regard the embryo as a person with all the protections accorded to fellow members of the human community and those who regard the embryo as deserving respect as a potential human being but not the same respect accorded to persons.[xxvii]

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While the ethics behind the use of two sources 'surplus embryos'[1], and 'research embryos'[2], are advocated on the basis that surplus embryos are not intentionally created, but are readily available for use by scientists, and research embryos are specifically created by scientists to conduct study.[xxviii] The majority of authors argue that using embryos in the derivation of human embryonic stem cells, rather than discarding them, has the potential to improve human lives.[xxix]

There is no end of discussion on the moral status of embryo consequently regardless of moral and legal embryo status, the creation of the primitive streak has been urged as a key cut-off point in embryo research.[xxx] The 14-day limit is found in several international scientific and medical society guidelines, for example the International Society for Stem Cell Research (ISSCR)[3], included a 14-day limit on human embryo research.[xxxi]

3.2 Religious perspectives on the embryo research

The ethical viewpoints of Buddhist, Hindu leaders supports the donation of leftover IVF embryos for embryonic stem cell research, on the basis of noble cause of saving lives, alleviating suffering and other noble intentions of research. Islamic discussions also point in the same direction. While Catholicism firmly opposes ESCR, regardless of the source of embryos, they believe in holiness of life that begins in an embryo at the time of fertilization.[xxxii] According to Judaism, a foetus is "like water" before the 40th day after conception and only then does it begin to develop into a person. Therefore, research using embryos to help save life is permissible.[xxxiii]

3.3 Biologic challenges

Aside from ethical problems relate to source of embryonic stem cells, the greatest obstacle to clinical use of hESCs-based therapy is safety concerns. The pluripotency that allows hESCs to create hundreds of distinct cell types also makes them challenging to manage after in vivo transplantation. Teratomas, tumours that possess all three germ layers, may arise if undifferentiated hESCs are implanted.[xxxiv] Other challenges are the recognition and proper isolation of stem cells from a patient's tissues and major obstacle to successful stem cell transplantation is immunological rejection.[xxxv]

4. Regulation in India

In India the Guidelines for Stem Cell Research and Therapy in 2007[xxxvi] was a first step to provide guidance and facilitate human stem cell research while limiting exploitation of vulnerable individuals by the government, which were revised after public consultations in 2013[xxxvii] and 2017 again. The most recent National Guidelines for Stem Cell Research (NGSCR 2017) [xxxviii] were released by the Indian Council of Medical Research (ICMR), in collaboration with the Department of Biotechnology (DBT). To regulate stem cell research, a National Apex Committee for Stem Cell Research (NAC-SCRT) has been established, to oversee research activities, and putting into place guidelines for basic and clinical research at the National Level. NGSCR 2017 mandate registration of Institutional Committee for Stem Cell Research (ICSCR) and Institutional Ethics Committee (IEC), with National Apex Committee for Stem Cell Research and Therapy (NAC-SCRT) and Central Drugs Standard Control Organization (CDSCO), respectively. The guideline considered ASCs and UCB stem cell research in permissible categories whereas reproductive cloning in prohibited category.[xxxix] Stem cells and their derivatives are categorised as 'Investigational New Drug (IND)' or 'Investigational New Entity (INE)' once used for clinical purposes, according to the Drugs and Cosmetics Act 1940.[xl] The only exception is the use of haematopoietic (blood-forming) stem cells to treat blood diseases which is considered as proven therapy.

[1] leftover embryos from infertility treatments
[2] embryos created specifically for research purposes
[3] The ISSCR is the world's largest professional society for stem cell researchers, dedicated to promote stem cell research to enhance scientific understanding, treatments, and cures that improve human health.

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CDSCO Ministry of Health and Family Welfare Notification, April 4, 2018, GSR 334(E)) categorize certain stem cell interventions as a drug according to it, stem cell and stem- cell based products derived from substantial, or more than minimal, manipulation would be considered a drug. The ICMR has expressed its concerns to the CDSCO and stressed that minimally manipulated stem cells must also be included under the category of a new drug as it may give a way to flourish unproven stem cell practice to practitioner in India (Scroll.in, 2018).[xli] Where the New Drugs and Clinical Rules, 2019[xlii] were notified which included 'stem cell derived products' without creating any exemptions for 'minimally manipulated stem cells'. Yet again concern is New Drugs and ClinicalTrial Rules, 2019 do not define stem cell-derived products at all.

Despite these benefits of stem cell research for remedy of all ill, it is very hot topic of debate in India. Many years ago, the council set ethical criteria for medical research "But legislation to enforce guidelines and introduce penalties for violation is pending," said Vasantha Muthuswamy, the council's deputy director general. Several clinical studies have been done in India without regulatory authorisation during the last decade by both public and private doctors.[xliii]

In order to curb the unethical practices, the ICMR has recently released a scientific document, "Evidence Based Status of Stem Cell Therapy for Human Diseases" for creating awareness and understanding regarding experimental use of stem cells under the purview of clinical trial.[xliv] This demonstrates how stem cell regulatory organizations in India are always assessing ethical and scientific elements of SCR and taking the necessary steps to educate the public about it.

5. International legal aspect

The United Kingdom (UK) was the first country to regulate artificial reproduction and embryo research, 'Human Fertilization and Embryology Act'[xlv]. Different countries address stem cell research regulation in different ways. In several ways, this reflects the disparities in sentiments regarding the human embryo held by people all around the world. Similar viewpoints are frequently replicated in the laws of these countries, not always though. For example, UK where there is a strong belief that the human embryo is not developed enough to enjoy such protections, both the creation and importing of embryos for research purposes are permitted (and the production of cloned and hybrid embryos). Embryo creation is prohibited in some nations that express moral concern about this type of research, but their importation and use are permitted; examples include Germany and Italy.[xlvi] Human embryo research is permitted in Australia, Canada, Japan, the Netherlands, Spain, South Korea, and Taiwan, but only on embryos created via IVF and donated for research.[xlvii] Although China and India do not have law, their national hESC recommendations specify a 14-day restriction.[xlviii, xlix]

Whereas some countries stem cell policies do not include a 14-day limit, allowing unethical practices to flourish. For example, Japan and South Korea. The Act on Regulation of Human Cloning Techniques in Japan does not specify a 14-day limit, but the Ministry of Education, Culture, Sports, Science and Technology's national recommendations do.[l, li]

It is apparent that developed nations have strengthened their stem cell research regulations to ensure sound research procedures/processes that encourage ethical research methods for the benefit/protection of their citizens. In contrast, the lack of regulation in underdeveloped countries differs sharply with the regulatory systems in developed nations, contributing to the proliferation of experimental stem cell therapy.

6. Conclusion

Stem Cell Research in India will be of great advantage, as therapies generated in India would cost less than treatments industrialized in developed countries due to India's low R&D cost and process engineering advantages.[lii] But as stem cell science moves from the laboratory to the clinic and the experimental treatment of patients, in India it does so in a governance vacuum. [liii] Though India taking steps in this direction and promoting stem cell research in country but there is gap in the regulation as well

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Country	Regulation	Comment
Austria	Reproductive Medicine Act (1992, amended 2001, 2004, 2008, 2009, 2010, 2014, 2015, 2018)	Prohibition using cells capable of development for purposes other than medically assisted procreation.
Brazil	Biosafety Law (2005, amended 2007)	Prohibition of "genetic engineering on human germ cells, human zygotes or human embryos" but do not address a development limit or other restrictions on human embryo research.
India	National Guidelines for Stem Cell Research 2013(updated in 2017)	Establishment of new hESC lines from spare, supernumerary embryos is permissible
Italy	Rules on medically assisted procreation (2004)	Research on human embryos is banned.
Russia	Federal Law on Biomedical Cell Products,	Prohibition on the use of human embryos
Switzerland	2003 Federal Act on research involving embryonic stem cells	7-day limit, prohibition on the creation of research embryo, creation of a clone, chimera, or hybrid but permit use of surplus embryos for the derivation of embryonic stem cells
Canada	Assisted Human Reproduction Act (2014) Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (2014);	Permissible derivation of embryonic stem cell lines from left over embryos., prohibition on the creation of chimeras or hybrids.
Spain	Biomedical Research Law (2007, amended 2011) Techniques of Assisted Human Reproduction Law (2006, amended 2007, 2011, 2015)	prohibits creating human pre-embryos and embryos for research purposes, but it does permit SCNT.
United Kingdom	1990 Human Fertilisation and Embryology Act, amended in 2009 2001 Human Reproductive Cloning Act 2004 Human Tissue Act	Approved SCR on human embryo isolated from supernumerary embryo, permits human embryo research prior to 14 days, the embryos can also be created for research purposes.
Germany	Embryo Protection Act (1990, amended 2011) Stem Cell Act (2002, amended 2017)	The use of embryos for research is heavily restricted

as monitoring process which is mainly responsible for the rapidly increasing unproven stem cell therapy in India.[liv] Legislation and policies may turn out to be effective in minimizing the marketing of immature and unproven SC research (often with unidentified risks and side effects) to unaware patients by scientists and physicians.[lv]

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DOI-10.55183/amjr.2022.vo3.lsi.01.011

References:

[i] Chagastelles P. C., and Nardi N. B, (2011): Biology of stem cells: an overview. Kidney international supplements, 1(3), pp 63–67.
[ii] Eve D.J., Marty P.J., McDermott R.J., Klasko S.K., Sanberg P.R,(2008): Stem Cell Research and Health Education. American Journal of Health Education,39(3), pp 167-179.
[iii] Sharma A. (2006): Stem cell research in India: Emerging scenario and policy concerns. Asian Biotechnology and Development Review, 8, pp 43-53.
[iv] Pompe S, Bader M., and Tannert C. (2005): Stem-cell research: the state of the art. Future regulations of embryonic-stem-cell research will be influenced more by economic interests and cultural history than by ethical concerns. EMBO Report, 6(4), pp 297-300.
v Sugarman J. (2008): Ethical issues in stem cell research and treatment. Cell Research, 18, S176.
[vi] Basu P. (2016): Ethical Issues Concerning Experimentation on Embryos and Foetuses: an Overview. PhD. University of Calcutta
[vii] Smith A., and Blackburn C., (2012): do-we-still-need-research-human-embryonic-stem cells, Available at:https://www.eurostemcell.org/do-we-still-need-research-human-embryonic-stem-cells, Accessed on 4 February 2022.
[viii] Hug K., and Hermeren G., (2011). Do we still need human embryonic stem cells for stem cell-based therapies? Epistemic and ethical aspects. Stem Cell Review, 7, pp 761-74.
[ix] Sharma A., Gokulchandran N., Sane H., and Badhe P., (2014): Stem Cell Therapy in Neurological Disorders, 2nd edition, pp 29 – 46, NeuroGen Publications, Mumbai.
[x] Chaturvedi R.K., Tripathy C.B., Varma A., and Chaturvedi P.K., (2010): Scientific, legal & ethical issues in stem cells research in India. Medico-Legal Update, 10, pp. 69-72.
[xi] Sharma A. (2006)
[xii] Stem cell: research trends and Perspective on the evolving International Landscape (2013): A joint report by Elsevier, EuroStemCell and Kyoto University's Institute for Integrated Cell-Material Sciences (iCeMS)
[xiii] Sachdeva A., et al. (2018):Umbilical Cord Blood Banking: Consensus Statement of the Indian Academy of Pediatrics. Indian Pediatrics, 55, pp 489–494.
xiv Takahashi K., and Yamanaka S. (2006). Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. Cell, 126(4), pp 663-76.
[xv] Kabat M., Bobkov I., Kumar S., and Grumet M., (2020): Trends in mesenchymal stem cell clinical trials 2004-2018: Is efficacy optimal in a narrow dose range? Stem Cells Translational Medicine 9, pp 17-27.
[xvi] Shroff G., and Gupta R., (2015): Human embryonic stem cells in the treatment of patients with spinal cord Injury. Annals of Neurosciences, 22 (4), pp. 208–216.
[xvii] Zhou S. et al. (2015). Differentiation of human embryonic stem cells into cone photoreceptors through simultaneous inhibition of BMP, TGFβ and Wnt signaling. Development, 142 (19), pp. 3294-306.
[xviii] Shiba Y. et al. (2012): Human ES-cell-derived cardiomyocytes electrically couple and suppress arrhythmias in injured hearts. Nature, 489 (7415), pp. 322–325.
[xix] Bruin J.E. et al. (2015): Treating diet-induced diabetes and obesity with human embryonic stem cell-derived pancreatic progenitor cells and antidiabetic drugs. Stem Cell Reports. 4 (4), pp. 605–620.
[xx] Avior Y. et al. (2015): Microbial-derived lithocholic acid and vitamin K2 drive the metabolic maturation of pluripotent stem cells-derived and fetal hepatocytes. Hepatology, 62 (1), pp. 265–278
[xxi] Mahla RS. (2016): Stem Cells Applications in Regenerative Medicine and Disease

Available online on: www.anveshaejournal.com e-ISSN 2582-6719
DOI-10.55183/amjr.2022.vo3.lsi.01.011

Therapeutics. International Journal of Cell Biology, 6940283. doi: 10.1155/2016/6940283.

[xxii] Yubo M., et al (2017): Clinical efficacy and safety of mesenchymal stem cell transplantation for osteoarthritis treatment: A meta-analysis. PLoS One ;12: e0175449.

[xxiii] Zhao L., et al (2019): The role of mesenchymal stem cells in hematopoietic stem cell transplantation: Prevention and treatment of graft-versus-host disease. Stem Cell Research and Therapy ,10, pp 182.

[xxiv] Leng Z., et al., (2020): Transplantation of ACE2-mesenchymal stem cells improves the outcome of patients with COVID-19 pneumonia. Aging Disease, 11, pp 216-28.

[xxv] Stem cell: research trends and Perspective on the evolving International Landscape (2013)

[xxvi] Frazzetto G. (2004): Embryos, cells and God. EMBO reports, 5 (6), pp 553-555.

[xxvii] Ethics Committee Report (2002): Donating spare embryos for embryonic stem-cell research, Ethics Committee Report, Fertility and Sterlity,78 (5), pp 957-960.

[xxviii] S Sivaraman, M. A. F., and Noor, S. N. M., (2014): Ethics of embryonic stem cell research according to Buddhist, Hindu, Catholic, and Islamic religions: Perspective from Malaysia. Asian Biomedicine,8(1), pp 43-52.

[xxix] Manninen, B.A. (2007): Respecting Human Embryos Within Stem Cell Research: Seeking Harmony. Metaphilosophy, 38, pp 226-244.

[xxx] Corrigan O., et al. (2006): Ethical Legal and Social Issues in Stem Cell Research and Therapy. A briefing paper from Cambridge Genetics Knowledge Park, pp 1-31.

[xxxi] ISSCR (International Society for Stem Cell Research). Guidelines for Stem Cell Research and Clinical Translation (2016). Accessed at: https://www.isscr.org/policy/guidelines-for-stem-cell-research-and-clinical-translation, Accessed on 26 February 2022.

[xxxii] S Sivaraman, M. A. F., and Noor, S. N. M., (2014)

[xxxiii]Silber SJ., (2010). Judaism and reproductive technology. Cancer Treatment Research,156, pp 471-80.

[xxxiv] Volarevic, V., et al., (2018). Ethical and Safety Issues of Stem Cell-Based Therapy. International journal of medical sciences, 15(1), pp 36–45.

[xxxv] Zakrzewski, W. et al. (2019). Stem cells: past, present, and future. Stem Cell Research Therapy, 10 (68).

[xxxvi] Indian Council of Medical Research. (2007). Guidelines for Stem Cell Research and Therapy, Accessed at: http://www.icmr.nic.in/stem_cell/stem_cell_guidelines_2007. pdf. Accessed on 24 Feb 2022.

[xxxvii] Indian Council of Medical Research and Department of Biotechnology (2013): National Guidelines for Stem Cell Research; 2013. Accessed at: https://www.ncbs.res.in/sites/default/files/policies/NGSCR%202013.pdf, Accessed on 31 January 2022.

[xxxviii] Indian Council of Medical Research – Department of Biotechnology. (2017). National Guidelines of Stem Cell Research, Accessed at: https://dbtindia.gov.in/regulations-guidelines/guidelines/national-guidelines-stem-cell-research-%E2%80%93-2017, Accessed on 26 February 2022.

[xxxix] Mittal S. (2013): Stem cell research: The India perspective. Perspective of Clinical Research, 4, pp 105-7.

[xl] Rajarathna T. (2010). advancements in stem cell research: an Indian perspective-ll. Annals of neurosciences, 17(3), pp 110–112.

[xli] Scroll.in, (2018). Medical research council objects to the health ministry easing up on stem cell therapy regulation. Access at: https://scroll.in/pulse/878085/medical-research-council-objects-to-the-health-ministry-easing-up-on-stem-cell-therapy-regulation, Accessed on 28 February 2022.

[xlii] New drugs and clinical trials rules, 2019, ministry of health and family welfare, India. Available at: http://www.egazette.nic.in/WriteReadData/2019/2 00759.pdf. Accessed 19 July 2019. Accessed on 20 July 2020.

[xliii] Mudur G. (2005). India plans to audit clinical trials. BMJ (Clinical research ed.), 331(7524), pp 1044.

[xliv] Indian Council of Medical Research. Evidence Based Status of Stem Cell Therapy for Human Diseases – 2021,

Available online on: www.anveshaejournal.com e-ISSN 2582-6719
DOI-10.55183/amjr.2022.vo3.lsi.01.011

Accessed at:https://main.icmr.nic.in/sites/default/files/upload_documents/Evidence_Based_Status_of_Stem_Cell_Therapy_for_Human_Diseases_v1.pdf , Accessed on 27 February 2022.

[xlv] UK, Human Fertilisation and Embryology Act 1990 (1990, amended 2008) 37 (1990). Accessed at:www.legislation.gov.uk/ukpga/1990/37/contents, Accessed on 15 February 2022.

[xlvi] Stem cell: Science and ethics. (2010). Jan Barfoot, Donald Bruce, Graeme Laurie, Nina Bauer, Janet Paterson and Bownes, Chapter 2. 3rd Edition, Biotechnology and Biological Sciences research Council (BBSRC).

[xlvii] Gopalan N., Mohamed M.S., and Nor S.N.M., (2018): Global Human Embryonic Stem Cell Laws and Policies and Their Influence on Stem Cell Tourism. Biotechnology Law Report, 37(5), pp 255–269.

[xlviii] Indian Council of Medical Research & Department of Biotechnology. (2017): National Guidelines for Stem Cell Research.

[xlix] Ministry of Science and Technology and Ministry of Health, Beijing, China (2003): Ethical guidelines for human embryonic stem cell research. Accessed at: http://most.gov.cn/fggw/zfwj/zfwj2003/200512/t20051214 54948.htmhttp://www.cncbd.org.cn/News/Detail/3376 , Accessed on 20 February 2022.

[l]Japan, Act on Regulation of Human Cloning Techniques (2000) 146 (2000). Accessed at:www.cas.go.jp/jp/seisaku/hourei/data/htc.pdf, Accessed on 20 February 2022.

[li] Ministry of Education, Culture, Sports, Science and Technology, Tokyo, Japan (2009): Guidelines on the Derivation and Distribution of Human Embryonic Stem Cells. Accessed at: www.lifescience.mext.go.jp/files/pdf/n743 00.pdf, Accessed on 20 February 2022.

[lii] Pareira W.C., (2010): Stem cell entrepreneurship-trends and advances-II. Annals of Neurosciences, 17(4), pp. 154-157.

[liii] Padma T. (2006): Unchecked by guidelines, Indian stem cell scientists rush ahead. Nature medicine. 12. 4. 10.1038/nm0106-4b.

[liv] Pandya S.K. (2008): Stem cell transplantation in India: tall claims, questionable ethics. Indian Journal of Medical Ethics, 5(1), pp. 15-17.

[lv] Gopalan N., Mohamed M.S., and Nor S.N.M., (2018).