The "14-Day Rule" for In Vitro Human Embryo Research Requires Urgent Revision: A Comprehensive Analysis from Scientific, Ethical, and Policy Perspectives (Postprint)

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Abstract

For a long time, the "14-day rule" adhered to by the international scientific community in the field of in vitro human embryo research—limiting the duration of in vitro human embryo research to within 14 days post-fertilization—has constituted the most important ethical regulation in this research domain. With advances in embryo culture technology, this ethical rule has encountered unprecedented challenges. In 2021, the International Society for Stem Cell Research (ISSCR) recommended conditionally relaxing this limitation in its "Guidelines for Stem Cell Research and Clinical Translation," thereby reopening discussions within the scientific community regarding the "14-day rule."This article takes the "14-day rule" as its point of departure, systematically examining the historical background and contemporary challenges of ethical governance in human embryo research; it analyzes key ethical issues concerning the moral status, dignity, and legal status of human embryos; comprehensively surveys the perspectives and attitudes of stakeholders across various sectors; and, based on this combined assessment, clearly proposes policy recommendations and specific measures for the prudent and appropriate extension of the "14-day rule."

Full Text

The 14-day Rule for In Vitro Human Embryo Research Requires Adjustment: A Comprehensive Analysis from Scientific, Ethical, and Policy Perspectives

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Abstract

For a long time, the international scientific community has followed the "14-day rule" in the field of in vitro human embryo research, which limits the cultivation of human embryos to within 14 days post-fertilization. This is the most important ethical rule in this research field. With the advancement of embryo culture technology, this ethical rule has faced unprecedented challenges. In 2021, the International Society for Stem Cell Research (ISSCR) recommended conditionally relaxing this limit in its *Guidelines for Stem Cell Research and Clinical Translation*, prompting the scientific community to reopen discussions on the "14-day rule." This article uses the "14-day rule" as an entry point to systematically review the historical background and practical challenges of ethical regulation in human embryo research, analyzes key ethical issues surrounding the moral status, dignity, and legal status of human embryos, comprehensively examines the perspectives and attitudes of various stakeholders, and based on this assessment, proposes policy recommendations and specific measures for prudently and appropriately extending the "14-day rule."

Keywords: in vitro human embryo research, ethical regulation, 14-day rule, Warnock Report

1. The Proposal, Development, and Current Status of the "14-day Rule"

The "14-day rule" for in vitro human embryo research has exerted broad and profound influence worldwide since its proposal and is considered an internationally consensus-based ethical rule in the life sciences and medical fields. Due to the unique nature of human embryos as research subjects and experimental materials, ethical and moral controversies regarding clinical operations in basic human embryo research have persisted since the birth of the first test-tube baby. Currently, the scientific community generally adheres to the "14-day rule" proposed by the UK' s Warnock Committee in 1984, which stipulates that human embryos cultured in vitro must not exceed 14 days post-fertilization. In recent years, rapid developments in biotechnology have made research on human embryos beyond 14 days in vitro possible [2,3]. The feasibility of such technology

and its significant scientific importance have prompted the scientific community to reopen discussions on the "14-day rule."

1.1 Background In 1978, the birth of Louise Brown in the UK brought hope for fertility treatment to infertile patients while simultaneously raising concerns about how human embryo research might impact ethical relationships and social morality. In response, the UK established the Committee of Inquiry into Human Fertilisation and Embryology in 1982, known as the Warnock Committee, to conduct in-depth research on the development status and ethical issues of assisted reproductive technology and embryo research. The committee published its report in 1984, *Report of the Committee of Inquiry into Human Fertilisation and Embryology*, later known as the *Warnock Report* [4], which became the foundation and starting point for ethical regulation and related legislative work in human embryo research.

The *Warnock Report*, based on respect for diverse values, conducted extensive surveys among scientists, medical workers, ethicists, and the public, and elaborated on various ethical viewpoints. At that time, opponents of human embryo research held the view of embryonic potential, arguing that human embryos should be regarded as persons or potential persons, should not be used as materials for scientific experiments, and could not be disposed of without informed consent. They believed that using human embryos for research would interfere with the creation of human life and might excessively intervene in human reproduction. From this perspective, moral principles were considered more important than scientific interests. In contrast, supporters of human embryo research refuted the embryonic potential argument, contending that embryos do not have the capacity to develop into persons when not implanted in a human uterus. They argued that using human embryos for research could promote the development of life sciences and medicine and provide scientific evidence for treating various diseases. Moreover, the scientific knowledge gained from human embryo research is irreplaceable in many cases compared to animal embryo studies. After considering these opposing viewpoints, the *Warnock Report* recommended conducting thorough ethical argumentation, public communication, and policy research to establish specialized laws, regulations, and oversight mechanisms.

1.2 The *Warnock Report*'s Initiation of Human Embryo Research Policy and Legislation To balance these conflicting perspectives, the *Warnock Report* sought to identify a time node that could fully respect the demands of all parties, after which embryo development would be terminated. From a utilitarian perspective, ethical considerations are determined by benefits and harms, pleasure and pain, with pain perception considered an ethical basis for setting the time node. The time node could be set a few days before the initial occurrence of functional activity in the central nervous system (22–23 days post-fertilization) to ensure embryo development is terminated before pain perception can occur. Other viewpoints on the time node were also proposed and

debated. For example, the Royal College of Obstetricians and Gynaecologists (RCOG) suggested that human embryos should not develop beyond the starting point of early neural development (17 days post-fertilization); the British Medical Association (BMA) favored setting the time node at 14 days; and the Medical Research Council (MRC) and the Royal College of Physicians (RCP) recommended setting it at the end of the implantation stage.

Opponents of human embryo research focused on the argument that every embryo is a potential human, with an important reference point for developmental potential being the appearance of the primitive streak, which occurs around two weeks of human embryo development. Ultimately, the *Warnock Report* used the appearance of the primitive streak as a key scientific reference and established 14 days as the ideal endpoint for human embryo research, prohibiting any further research on human embryos beyond this time—the now-famous "14-day rule."

Under this policy objective, the "14-day rule" cleverly avoided controversial ontological questions and shifted focus to more practical decision-making solutions, holding significant ethical governance importance. Based on the *Warnock Report*, the UK government solicited two rounds of public opinion and enacted the *Human Fertilisation and Embryology Act* in 1990. This act detailed regulations on the creation, use, storage, and disposal of human embryos and explicitly required that human embryo research in the UK must be approved by the Human Fertilisation and Embryology Authority (HFEA). The "14-day rule" also influenced regulations and legislation in other countries. In 1994, the rule was endorsed by the NIH Human Embryo Research Panel [4]. To date, the "14-day rule" has been written into laws or policy guidelines in many countries, including Sweden, Belgium, France, Australia, the Netherlands, Spain, and South Korea, while guidelines in the United States, China, India, Japan, and Israel also explicitly include the rule [5]. As a public policy tool, the "14-day rule" has achieved tremendous success, exerting sustained, long-term, and important influence in global life sciences and medical fields.

1.3 Advances in Life Science Frontiers Driving New Discussions on the "14-day Rule" Gastrulation is the most important event in early human embryo development, involving the exit from pluripotency, differentiation of the three germ layers, and early organogenesis, establishing the blueprint for future embryonic development. Abnormalities in this developmental stage are closely associated with miscarriage, pregnancy loss, and developmental origin diseases such as congenital heart disease. To prevent and treat these diseases, it is necessary to return to the study of fundamental biological events such as gastrulation. As the renowned British developmental biologist Lewis Wolpert once said, "The most important time in your life is not birth, marriage, or death, but gastrulation." Indeed, gastrulation is one of the most critical developmental events in post-implantation early embryos, laying the foundation for embryonic axis formation, three germ layer specification, and early organogenesis. During this

period, the specification and migration of human primordial germ cells, as well as the development of extraembryonic tissues such as the yolk sac and placenta, occur simultaneously. Because early human embryos lack distinct morphology, sample collection, observation, and research are extremely difficult, making this developmental stage known as the "black box" of embryonic development.

The emergence of embryo in vitro culture technology has provided opportunities to study gastrulation. Research teams from the University of Cambridge and Rockefeller University have both demonstrated the possibility of culturing human embryos in vitro for more than 14 days [2,3]. Chinese scientists have also conducted a series of cutting-edge studies on human embryo in vitro culture. For example, Tang Fuchou's team at Peking University [6] analyzed the early molecular regulatory mechanisms through long-term human embryo in vitro culture, while Li Tianqing and Ji Weizhi's team at Kunming University of Science and Technology [7] developed a new 3D culture model that highly simulates human embryonic development in vivo. These studies have allowed preliminary insights into the mysteries of gastrulation, but to comply with the "14-day rule," these experiments were stopped on day 14 post-fertilization, leaving many scientific questions unresolved.

Research on human embryos beyond 14 days in vitro could elucidate a series of important developmental events: (1) the developmental dynamics and mechanisms of gastrulation, body axis formation, and germ layer specification, which initiates the differentiation of the three germ layers and is a landmark event in pregnancy closely related to future life development; (2) the formation mechanisms of early tissues and organs, where three germ layer cells further differentiate to form early organs during late gastrulation; and (3) the origin and migration of human primordial germ cells, which play key roles in reproduction and maintaining population reproductive health, though their origin, specification mechanisms, exact location before migration, and migration pathways remain unclear.

Under the current "14-day rule," these three key scientific questions will be difficult to study in depth. Abnormalities in early post-implantation human embryo development, particularly in gastrulation, body axis formation, three germ layer differentiation, and early organogenesis, often lead to embryonic arrest, early miscarriage, and postnatal defects such as congenital heart disease, neural tube defects, cerebral palsy, and spinal dysplasia. Abnormal development of primordial germ cells can cause infertility. Therefore, in-depth exploration of human embryo development beyond 14 days will benefit the resolution of these problems. Additionally, studying three germ layer differentiation, interactions between different cell lineages during embryonic development, and early organ formation and development can provide important references for evaluating current embryoid models, organoid models, and pluripotent stem cell differentiation models, thereby improving related technical methods and obtaining more embryo-like models. These results will further promote and enrich understanding of embryonic development, providing a foundation for clinically screening

more effective targeted drugs, developing better diagnostic and treatment measures, and manufacturing artificial organs.

Chinese scientists have achieved in vitro culture of non-human primate embryos to days 20 and 25 [8–11], enabling further study of gastrulation and early organogenesis regulatory mechanisms. However, differences between human and monkey early development should not be ignored. For example, monkey embryos implant on the surface of the endometrium, while human embryos (and ape embryos) implant within the endometrium—a process related to intrauterine growth restriction diseases. The regulatory patterns of cellular pluripotency in monkey embryo development also differ from those in humans. These issues can only be resolved through direct study of human embryos.

When the "14-day rule" was formulated in the 1980s, no laboratory could culture human embryos in vitro for more than five days, giving scientists some exploration space. Current scientific research, particularly in primates, shows that China has taken a leading position in this field, fully demonstrating the feasibility of extending in vitro human embryo culture time. The tension between scientific development and urgent human health needs has highlighted the gap between ethical regulation and scientific advancement, prompting heated discussions on extending the "14-day rule" and necessitating a re-examination and discussion of ethical rules under new technological conditions.

2. Key Ethical Issues in Human Embryo Research

To relax the restrictions of the "14-day rule," it is necessary to re-examine key ethical issues in human embryo research, incorporate new scientific discoveries into ethical arguments, and provide ethical justification for policy adjustments. Ethical issues in human embryo research focus on three aspects: the moral status, dignity, and legal status of human embryos, which have generated a series of ethical debates including whether human embryos have moral status and what kind, when they should be granted moral status, whether they possess dignity, and what legal status they should be accorded.

2.1 The Moral Status of Human Embryos Discussions on the moral status of human embryos reveal irreconcilable differences among various viewpoints. Some utilitarians and radicals view human embryos as groups of cells or single organisms lacking self-awareness and other personhood-related traits, as well as basic attributes such as sentience [12], and thus deny embryos moral status. From biological and some religious perspectives, the moral status of human embryos is considered inherent. Represented by "genetic identity theory" and "developmental continuity theory" [13], these views argue that human essence does not change dramatically throughout the process from fertilization to death, with differences between human embryos and human individuals only manifesting in degrees of cell differentiation and gene expression, and therefore moral status should be equivalent to that of humans. In some religious cultures, embryos are given the same importance as human life, and abortion is considered

a serious crime.

Mainstream bioethical views tend not to treat embryonic moral status as an absolute "all-or-nothing" issue but rather as a relatively continuous and dynamic concept, focusing discussion on what degree and when moral status should be granted. To reconcile ethical understanding with scientific development, the ethics and scientific communities have reached a consensus that "biological characteristics" should serve as markers for granting changing moral status to human embryos. Traditional views linked moral status to perceivable biological features such as birth, viability, or fetal movement. With advancing life sciences increasing knowledge about human reproductive development, biological characteristics such as primitive streak appearance [14], brain development [15], and the emergence of sentience [16] have been identified as potential time nodes for granting moral status, supported by arguments from different perspectives. Gradualist perspectives argue that embryonic moral status increases with the emergence of a series of important biological characteristics [17].

The "14-day rule"selects the appearance of the primitive streak as a key criterion. Based on scientific understanding at the time, it was believed that embryos could no longer develop into identical twins after this point and had become unique, stable individuals. However, with scientific progress, a 2006 study found that embryos at 21 days post-fertilization could still produce conjoined twins [18], challenging the argument for determining embryonic moral status based on the biological feature of primitive streak appearance. Overall, the method of granting moral status to human embryos based on biological characteristics should be seen more as a compromise facing different moral viewpoints rather than a philosophical and ethical discussion of moral status itself, giving the "14-day rule" a clearer policy practice meaning, establishing an ethical foundation for its proposal, and achieving a balance among scientists' positions, ethical justifications, and public concerns, making it an operational and practical policy tool that effectively resolves tensions between life science development and ethical governance.

2.2 The Dignity of Human Embryos Dignity is considered the value objective of bioethics and a criterion for analyzing and resolving conflicts of interest and value [19,20]. Debates on human embryo dignity focus on two questions: whether dignity should be granted to human embryos based on their special attributes and to what degree, and whether embryonic dignity should be considered equivalent to human dignity or whether it grows gradually with embryonic development.

Some scholars vehemently oppose human embryo research from a dignity standpoint. American jurist and former presidential bioethics committee member Robert P. George refers to human embryos as "embryonic human beings," arguing they are no less valuable than humans at other developmental stages and should not be destroyed for scientific or other interests [21]. Based on this position, destructive embryo research, embryo freezing, and patents related to

human embryos have all been criticized [22–24], prompting scholars who support scientific development to defend human embryo research. They argue that overemphasizing dignity would seriously hinder life science and technology development. Harvard psychology professor Steven Pinker, in his article "The Stupidity of Dignity," rejected the traditional view of dignity as the foundation of bioethics, considering it a tool for conservatives to suppress biomedical research and treatment [25].

In fact, understanding of human embryo dignity is complex and dynamic, adapting and changing with life science development. For example, Germany initially prohibited human embryonic stem cell research in principle based on considerations of human embryo dignity but began allowing the import and use of human embryonic stem cells derived from surplus embryos in 2002 [26]. In academia, embryo research and gene editing technologies are often questioned as "instrumentalizing" embryos and "blurring" the boundaries between procreation and production, representing a certain degree of damage to embryonic dignity [27,28]. However, some scholars argue these technologies are instead an expression of autonomy [29,30], and that advances in life technology better serve human health and autonomous development.

If we return dignity discussions to Kant' s moral philosophy system, humans are the carriers of dignity, and what truly grants humans dignity is humanity within personhood [31]. Kant believed humanity is related to rationality, and whether one possesses rationality is the core criterion for being human, with a rational being being the basic condition for human dignity. The biological basis related to rational consciousness mainly derives from the brain' s nervous system. Based on life science understanding in the 1980s when the "14-day rule" was proposed, nervous system establishment was believed to occur 17–22 days post-fertilization. In recent years, scientists have gained more precise scientific understanding, finding that early neural developmental marker genes and differentiated neural cell-related marker genes are not detected or are expressed at very low levels in 16–19-day human embryos, indicating that neural differentiation has not yet begun [32], while functional neural connections form after day 42 post-fertilization. These scientific facts provide new references for ethical examination of embryonic dignity issues, necessitating reconsideration of existing rules.

2.3 The Legal Status of Human Embryos The legal status of human embryos is more complex in practice. Legal status typically refers to the qualification of legal subjects to enjoy rights and assume obligations. The UK generally grants human embryos a special status between civil subjects and civil objects, prohibiting the market circulation of frozen embryos [33]; China' s current laws have not yet made explicit provisions on this matter. In fact, technologies such as "in vitro fertilization" and "test-tube babies" have helped numerous groups achieve reproductive desires by artificially altering natural reproductive pathways, but the resulting legal disputes have been endless, such as the Rios

couple' s frozen embryo and inheritance rights case in the United States, China' s 2013 "Yixing Frozen Embryo Case," and the 2021 case of a widowed wife suing a hospital.

There are three main doctrines regarding the legal status of human embryos: (1) The "subject theory" holds that embryos should have the status of rights-holders in law, a position accepted by many countries' laws. The Rios couple left two frozen embryos and substantial assets after dying in a plane accident during IVF treatment. After extensive discussion, the Victorian Legislative Council ultimately decided to have the embryos implanted in a surrogate mother to inherit the assets upon reaching adulthood, reflecting the embryo' s status as a legal subject. (2) The "object theory" holds that embryos can only be the object of rights and obligations of legal relationship subjects, as they may not necessarily be bearers of rights and obligations. However, this could lead to arbitrary creation and disposal of embryos and even potential commercialization [34]. For example, some US states grant embryo donors complete autonomy, with Michigan and Florida allowing embryos to be created "solely for therapeutic purposes" and classifying them as property [35]. (3) The "compromise theory" views embryos as a transition between person and object, a special entity with life potential. Due to their life potential and symbolic meaning, embryos are given greater respect than other human tissues, yet they have not developed personhood characteristics, and their intrinsic potential may not be realized. This approach avoids the compulsion of the "subject theory" and the commodification of the "object theory" but creates difficulties in boundary delineation.

The legal status issue of human embryos is a further concretization of moral status and dignity issues and has never reached effective consensus.

3. Current Discussions on Extending the "14-day Rule" Among Various Parties

Currently, some scientific organizations and scholars from different professional backgrounds have engaged in intense discussions on extending the "14-day rule." Supporters argue from the necessity and benefits of research on human embryos beyond 14 days, stating that extension would help traverse the "black box period" of human development, promote understanding of primitive streak development and early organ formation, and increase knowledge about pregnancy loss and birth defects [36]. Research on human embryos beyond 14 days in vitro will help further grasp information about early human embryonic development, benefiting disease treatment and the health of future human generations . Additionally, many existing embryos remain from IVF treatments, and extending the limit could enable them to play beneficial roles. Some scholars suggest that in the short term, research should be conducted under the supervisory methods for human embryo work recommended by the ISSCR, with time limits set based on nervous system development and heartbeat [5,36]. Some bioethicists believe the "14-day rule" should be adjusted in light of technological development and social cognition changes but require international coordination and consensus

[37,38].

Opponents of extension question the accuracy of in vitro human embryo research or defend their position from a moral slippery slope perspective. The artificial culture environment differs from the female uterus, and embryos cultured for long periods in this environment may not accurately reflect reality [36]. Meanwhile, extending the "14-day rule" might lead to continuously expanding research time windows, even until fetal birth, creating a moral slippery slope effect and destroying public trust in such research [39].

Therefore, to effectively reconcile the contradiction between scientific research needs and social ethical requirements, a prudent attitude should always be maintained, discussing policy adjustments based on multi-party assessment. On the basis of reaching certain consensus, the "14-day rule" should be extended prudently and appropriately. Martin Pera, a stem cell biologist at The Jackson Laboratory, believes that ethics committees and scientific review institutions should conduct individual assessments based on the merits and ethical risks of research proposals [36]. Additionally, public dialogue involving scientists, regulatory authorities, and the public must be conducted to discuss any potential objections [40], and the views of all stakeholders should be valued [36]. Furthermore, small-scale public opinion polls in the UK and public opinion research in China have shown that most respondents in the samples adopt supportive or neutral attitudes toward extending the "14-day rule" [41,42].

Thus, while the scientific community, ethics community, and the public hold different attitudes toward adjusting the "14-day rule," these differences are not irreconcilable.

4. Policy Recommendations for Extending the "14-day Rule" for In Vitro Human Embryo Research

The "14-day rule" was not an inherent moral principle or final solution but a policy tool for balancing various viewpoints, creating policy space for scientific research exploring human early development. With current embryo culture technology and considering the significant and urgent scientific importance of research in this field, it is necessary to reasonably adjust this rule. In China's 2003 *Ethical Guidelines for Human Embryonic Stem Cell Research*, the 14-day limit for in vitro human embryo research was clearly stipulated as a guideline rule. Currently, China's life science-related laws and policies have not responded to calls for extending the "14-day rule" in light of actual developments. To enable China to better achieve a new balance between rapid scientific development and ethical governance needs, we propose the following seven policy recommendations and specific measures:

(1) **Initiate the policy agenda for extending the "14-day rule" and carefully recalibrate the time limit for in vitro human embryo research.** We recommend that China's life science-related management departments actively discuss rule-making for human embryo research be-

yond 14 days, conduct multi-angle argumentation from scientific, ethical, and legal perspectives, fully assess the scientific research environment and public attitudes, and initiate policy adjustment and formulation work.

(2) **Scientifically set specific plans for extending the "14-day rule" to meet universal moral and ethical standards.** Given the high sensitivity of extending the "14-day rule," we recommend adopting an alternative scheme of "developmental stage + time range + biological feature constraints." (a) Regarding developmental stage, Carnegie stages are internationally recognized divisions of embryonic development. Carnegie stage 11 (days 23–26 post-fertilization) involves early heart formation and completion of cranial neural tube closure, while Carnegie stage 12 (days 26–30) involves completion of three germ layer development and initiation of major tissue and organ formation. (b) Regarding time range, 25–28-day embryos generally reach Carnegie stage 12, satisfying the need to understand gastrulation and early embryonic development, and functional neural connections have not yet formed at this stage, so pain perception does not occur. (c) Regarding biological features, due to individual differences in embryonic development time, we recommend using heartbeat or neural tube development as termination constraints—once an embryo shows heartbeat or neural tube development, research should be terminated immediately even if Carnegie stage 12 is not yet complete. In summary, we recommend selecting Carnegie stage 12, corresponding to a time range of 25–28 days, as the experimental termination node, with heartbeat or neural tube development as termination constraints.

(3) **Conduct pilot programs, selecting qualified laboratories to perform human embryo research beyond 14 days.** We recommend conducting pilots under China' s regulatory system, selecting laboratories with good research conditions, strong reputations, consistent ethical self-discipline, and complete ethics review conditions to conduct human embryo research beyond 14 days in an orderly manner after full review. In actual regulatory processes, relevant regulatory measures should be fully adjusted, regulatory capacity improved, and a "case-by-case" and "project-by-project review" regulatory framework involving the entire process should be constructed.

(4) **Formulate ethical oversight measures for extending the "14-day rule."** Extending the "14-day rule" must be conducted in a cautious, reasonable, and step-by-step manner, with timely amendments to current ethical regulations, clear specific oversight rules, and appropriate ethical supervision. For example, after extending the "14-day rule," detailed rules for application, review, project approval, and ethics review during research for projects on human embryos beyond 14 days need to be formulated.

(5) **Encourage multi-stakeholder participation in discussions on extending the "14-day rule."** The perspectives of scientists, ethicists, policymakers, research funders, and other stakeholders should be broadly

considered, and public attitudes toward human embryo research should be fully surveyed. On the basis of comprehensive consideration of diverse interests and formation of certain consensus, policy adjustment and formulation should be promoted, and a governance model featuring full communication and multi-party co-governance should be explored. Policy consultation or adjustment processes should be as transparent and evidence-oriented as possible [13], achieving balance between promoting research and responding to various ethical concerns.

(6) **Give full play to the positive role of the scientific community and scientists.** The role of domestic life science-related societies, research institutions, and scientific organizations should be leveraged to promote consensus formation and rule compliance within China' s scientific community through the formulation of internal ethical guidelines and timely adjustments and updates. Scientists play a key role in public discussions on extending the "14-day rule" and should maintain communication with the public through various channels, actively conduct science popularization, share cutting-edge scientific research results with the public, timely respond to public ethical concerns, cultivate public rational understanding of human embryo research, and maintain trust between the scientific community and the public.

(7) **Actively seek international consensus on extending the "14-day rule."** Extending the "14-day rule" is a global scientific community initiative involving all countries and requires full consideration of different nations' scientific development stages, cultural traditions, and religious differences. We recommend conducting extensive international scientific community dialogues to seek consensus, strengthening exchanges and cooperation with countries at the forefront of human embryo research, promoting communication and collaboration with the ISSCR, and conveying China' s concept of responsible innovation in human embryo research to the world.

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Footnotes:

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Note: Figure translations are in progress. See original paper for figures.