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编　辑
中华生殖与避孕杂志
编辑委员会
200237,上海市老沪闵路779号
电话:(021)64438169
传真:(021)64438975
Email:randc@sibpt.com
http://zhszybyzz.yiigle.com

总编辑
乔　杰

编辑部主任
王　健

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Editing
Editorial Board of Chinese Journal of Reproduction and Contraception
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Fax: 0086-21-64438975
Email: randc@sibpt.com
http://zhszybyzz.yiigle.com

Editor-in-Chief
Qiao Jie

Managing Director
Wang Jian

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·与生殖相关的监控指标专栏·

辅助生殖质量监控的重要性、面临的问题及挑战

当前全球不孕不育问题日益严重，我国不孕不育发生率已高达18%，影响约5 000万育龄夫妇。不孕不育是导致我国生育力下降及人口负增长的重要健康和社会问题。辅助生殖技术（assisted reproductive technology， ART）是不孕不育的有效治疗手段，我国ART发展迅速，每年实施助孕周期数超100万，占全球总量的33.5%，位居世界首位。每年通过ART诞生的婴儿数超30万，约占总出生人口数的3%。ART治疗是一个涉及多个流程、多个环节且环环相扣的治疗过程，包括复杂的临床处理及精细化的实验室操作等多个步骤。鉴于我国庞大的ART实施规模，以及ART本身的精密性和复杂性，建立严格的ART质量监控体系至关重要，以确保ART的安全、规范和有序开展。

我国ART经历了30余年的发展，取得了长足的进步，其技术水平已与国际接轨，但ART的监管和总体质量控制仍相对滞后。ART助孕多胎率居高不下、助孕人群日趋高龄化、病因多样化及复杂化、胚胎植入前遗传学检测（preimplantation genetic testing，PGT）技术应用规模不断扩大及人工智能的普及等给ART质量监控带来了更多的机遇与挑战。因此，当前我国ART质量监控面临的关键问题包括：①如何优化临床及胚胎实验室核心监控指标，以确保ART成功率的同时降低多胎率？②如何建立规范化的妊娠风险

识别体系，以提高助孕的安全性？③如何规范 PGT 技术应用，以提高遗传检测的精准性及出生子代的安全性？④如何充分利用人工智能技术推动 ART 自动化及智能化发展？

本期与生殖相关的监控指标专栏邀请了生殖医学临床、胚胎实验室、遗传等研究领域专家就辅助生殖助孕患者妊娠风险等级评估标准及使用建议、ART 临床风险核心指标的监测与管理、胚胎实验室全流程管理的核心监控指标、PGT 技术质量控制及临床风险防范指标、人类精子库运维的核心监控指标，及人工智能在生殖临床及质量管理中的应用等方面进行了充分的探讨，以期为 ART 规范化的质量监控提供新思路和借鉴。

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·与生殖相关的监控指标专栏·

辅助生殖助孕患者妊娠风险等级评估标准及使用建议

辅助生殖助孕患者妊娠风险评估标准及使用建议编写组

通信作者：李蓉，北京大学第三医院妇产科生殖医学中心，国家妇产疾病临床研究中心，北京市人类辅助生殖技术质量控制和改进中心，Email：roseli001@sina.com，电话：+86-10-82266849

【摘要】　人类辅助生殖技术（assisted reproductive technology，ART）是运用医学技术和方法对配子、合子、胚胎进行人工操作，以达到受孕目的的技术。为加强医疗质量安全管理，保障接受 ART 治疗患者助孕期间及妊娠期的安全，北京

市人类辅助生殖技术质量控制和改进中心结合国家卫生健康委员会印发的孕产妇妊娠风险评估与管理工作规范（孕产妇妊娠风险评估五色球管理），拟定本标准及其使用建议。本评估方法通过对接受辅助生殖治疗的女性进行妊娠相关风险的筛查、评估和管理，及时发现并干预相关风险因素，防范不良妊娠结局，保障母婴安全。

【关键词】 生殖技术，辅助； 妊娠风险评估； 专家建议

Evaluation criteria and usage recommendations for pregnancy risk levels in assisted reproductive technology

Expert Group for Evaluation Criteria and Usage Recommendations for Pregnancy Risk in Assisted Reproductive Techonology

Corresponding author: Li Rong, Center for Reproductive Medicine, Department of Obstetrics and Gynecology, Peking University Third Hospital, National Clinical Research Center for Obstetrics and Gynecology, Beijing Human Assisted Reproductive Technology Centre for Quality Control and Improvement, Email: roseli001@sina.com, Tel: +86-10-82266849

【Abstract】 Assisted reproductive technology (ART) is a medical procedure that involves manual manipulation of gametes, zygotes, and embryos to achieve successful pregnancy. In order to enhance the management of medical quality and safety during ART treatment as well as patient prognosis, the Expert Group for Beijing Human Assisted Reproductive Technology Center for Quality Control and Improvement collaborated with the National Health Commission of the People's Republic of China to establish standardized guidelines for Maternal Pregnancy Risk Assessment and Management. These guidelines employ a five-color ball system to evaluate maternal pregnancy risk levels among patients undergoing ART therapy, accompanied by recommendations on their implementation. The method aims to screen, evaluate, and manage pregnancy-related risks in women undergoing assisted reproductive treatment, while promptly identify and address risk factors, prevent adverse pregnancy outcomes, and ensure the safety of both mother and infant.

【 Key words 】 Reproductive technology, assisted; Pregnancy risk assessment; Expert recommendations

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·与生殖相关的监控指标专栏·

辅助生殖技术临床风险核心指标的监测与管理

梅洁　孙海翔

南京大学医学院附属鼓楼医院生殖医学和妇产医学中心　南京大学分子生殖医学中心，南京 210008

通信作者：孙海翔，Email：stevensunz@163.com，电话：+86-25-68183322

【摘要】 辅助生殖技术（assisted reproductive technology，ART）是解决不孕不育患者生育问题的重要手段。欧洲人类生殖和胚胎学协会将ART治疗成功的标准定义为无卵巢过度刺激综合征获得单胎妊娠和足月健康婴儿，因此卵巢过度刺激率和多胎妊娠率是ART临床风险核心指标。加强ART临床风险核心指标的监测评估，构建高危人群风险预防与策略优化的闭环体系，可以明显减少不孕症女性ART相关的医源性并发症，促进ART的良性、有序发展，更好地满足群众生殖健康服务需求。

【关键词】 生殖技术，辅助；　卵巢过度刺激综合征；　多胎妊娠

Monitoring and management of core clinical risk indicators for assisted reproductive technology

Mei Jie, Sun Haixiang

Center for Reproductive Medicine and Obstetrics and Gynecology, Nanjing Drum Tower Hospital, Nanjing University Medical School; Center for Molecular Reproductive Medicine, Nanjing University, Nanjing 210008, China

Corresponding author: Sun Haixiang, Email: stevensunz@163.com, Tel: +86-25-68183322

【Abstract】 Assisted reproductive technology (ART) is the means to solve the fertility problem of infertile patients. The European Society of Human Reproduction and Embryology defines the success criteria for ART treatment as "single pregnancy and full-term healthy infants without ovarian hyperstimulation syndrome". Therefore, ovarian hyperstimulation rate and multiple pregnancy rate are core clinical risk indicators for ART. We should strengthen the monitoring of clinical risk indicators for ART, and construct a closed-loop system for risk prevention and strategy optimization for high-risk populations. It will reduce the iatrogenic complications related to ART in infertile women, and promote the orderly development of ART.

【Key words】 Reproductive techniques, assisted; Ovarian hyperstimulation syndrome; Multiple pregnancy

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·与生殖相关的监控指标专栏·

人类精子库运维的核心监控指标

陈向锋

上海交通大学医学院附属仁济医院　上海市人类精子库，上海 200135

通信作者:Email：allanbacon@163.com，电话：+86-21-20284581

【摘要】 人类精子库在我国已走过40余年的发展历程，截至目前绝大多数均已进入运维阶段。精子库运维的顺利进行有赖于有效、规范和高水平的质量管理与运行监控。本文通过归纳目前我国人类精子库运维管理的规章性文件内容，回顾既往精子库质量管理和运行监控的相关文献，结合笔者既往的工作经验，从“精子库实验室” “精液外供” “运行安全”及“伦理规范”等角度对人类精子库运维中质量管理与核心监控指标进行汇总，旨在探讨人类精子库运维的核心监控指标如何保障精子库全面高效的质量管理和优化的监控流程，以期为广大从业人员提高精子库服务质量、管理水平及规避安全伦理风险提供理论依据。

【关键词】 人类精子库； 质量管理； 运行监控

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Core barometers of monitoring the operation and maintenance of the human sperm bank

Chen Xiangfeng

Shanghai Human Sperm Bank, Renji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200135, China

Email: allanbacon@163.com, Tel: +86-21-20284581

【Abstract】 The human sperm bank has gone through more than forty years of development in China, and so far, the vast majority have entered the stage of daily operation and maintenance. The key to making the daily operation and maintenance of sperm banks go on wheels depends on whether effective, standardized and high-level quality management and operational monitoring have been carried out. This article summarizes the current regulatory documents related to the operation and management of human sperm banks in China, reviews the relevant literatures on quality management and operation monitoring of sperm banks, and sums up the author's previous work experience, in order to provide a brief summary and commentary on the core barometers of quality management and operation monitoring regarding "sperm bank laboratory" "sperm provision"

"operation safety" and "ethic criterion" in the daily maintenance of human sperm banks. The current article aims to help achieving comprehensive and efficient quality management and optimized monitoring process for the daily maintenance of sperm banks by selecting core monitoring barometers. We hope the study could provide theoretical support for practitioners to improve the service quality, management level of sperm bank, and to avoid security and ethical risks.

【 **Key words** 】 Human sperm bank; Quality management; Operation monitoring

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·与生殖相关的监控指标专栏·

胚胎实验室全流程管理的核心监控指标

黄国宁

重庆市妇幼保健院 重庆医科大学附属妇女儿童医院生殖医学中心，

重庆 400013Email： gnhuang217@sina.com

【摘要】 随着人类辅助生殖技术的不断进步，胚胎实验室作为整个治疗过程中的关键环节，其管理质量直接关系到治疗的成功率和患者的安全。全流程管理的核心在于通过一系列精心设计的监控指标，确保实验室操作的每个环节都能达到最高标准。本文旨在探讨胚胎实验室全流程管理中的关键绩效指标，分析其在当前实践中的应用，并展望未来的发展方向。

【关键词】 胚胎实验室； 管理； 关键绩效指标

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Key performance indicators for comprehensive process management in embryology laboratories

Huang Guoning

Center for Reproductive Medicine, Chongqing Health Center for Women and Children; Women and Children's Hospital of Chongqing Medical University, Chongqing 400013, China

Email: gnhuang217@sina.com

【**Abstract**】 With the continuous advancement of assisted reproductive technology, the embryology laboratory has become a crucial link in the entire treatment process, where the quality of management is directly related to the success rate of the *in vitro* fertilization and the safety of the patients. The essence of comprehensive process management lies in a set of meticulously designed monitoring indicators that ensure every aspect of laboratory operations meets the highest standards. This article aims to explore the key performance indicators within the full process management of embryology laboratories, analyze their application in current practices, and look forward to future development.

【**Key words**】 Embryo laboratory; Management; Key performance indicators

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·与生殖相关的监控指标专栏·

胚胎植入前遗传学检测技术临床风险防范指标

胡晓坤 徐艳文

中山大学附属第一医院生殖医学中心 广东省妇产疾病临床医学研究中心 广东省生殖医学重点实验室，广州 510080

通信作者：徐艳文，Email：xuyanwen@mail.sysu.edu.cn，电话：+86-20-87334762

【摘要】 植入前遗传学检测（preimplantation genetic testing，PGT）技术在近年来迅猛发展，随之而来的是在临床应用时可能存在的问题和风险。我们需要重视PGT的相关临床风险，从PGT适应证的遗传风险评估、疾病本身对于卵巢功能的影响、控制性促排卵强度的控制，以及遗传性肿瘤易感基因携带者的促排卵风险等多个环节进行风险防范，以提高PGT技术的安全性、有效性。

【关键词】 植入前遗传学检测； 风险指标； 防范

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Clinical risk prevention indicators in preimplantation genetic testing

Hu Xiaokun, Xu Yanwen

Reproductive Medicine Center, the First Affiliated Hospital of Sun Yat-sen University; Guangdong Provincial Clinical Research Center for Obstetrical and Gynecological Diseases; the Key Laboratory for Reproductive Medicine of Guangdong Province, Guangzhou 510080, China

Corresponding author: Xu Yanwen, Email: xuyanwen@mail.sysu.edu.cn, Tel: +86-20-87334762

【Abstract】 With the rapid development of preimplantation genetic testing (PGT) technology in recent years, risks in clinical application have arisen at the same time. Related risks include identification of pathogenic variants for PGT, negative impact of disease for PGT on ovarian reservation in female carriers, control of ovarian stimulation, and safety of ovarian simulation in hereditary cancer gene carriers. Risk management should be performed in different steps of the PGT processes.

【Key words】 Preimplantation genetic testing; Risk indicator; Prevention

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·与生殖相关的监控指标专栏·

胚胎植入前遗传学检测技术质量控制

刘心蕊 黄色新 高明 邹洋 高媛

山东大学妇儿与生殖健康研究院 山东大学附属生殖医院分子遗传室 山东大学生殖医学与子代健康全国重点实验室，济南 250012

通信作者：高媛，Email：gaoyuan@sduivf.com，电话：+86-531-86569866

【摘要】 随着胚胎植入前遗传学检测（preimplantation genetic testing，PGT）技术应用规模不断扩大，分子遗传学检测技术在辅助生殖临床诊疗领域也得到了飞速发展和进步。PGT 的稳定性、可靠性和有效性是后续胚胎精准筛选的重要

保障，而实验室质量控制和管理是 PGT 临床应用必不可少的环节。PGT 质量控制的内容可以概括为“人机料法环”和“检测前中后”，这些内容覆盖了 PGT 技术临床应用的各个环节。为使 PGT 技术应用更加标准与规范化，本文就 PGT 的质量控制进行分析和讨论，以期为高质量临床实践提供可靠的实验室诊疗依据。

【关键词】 植入前遗传学检测； 质量控制； 标准操作程序

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Quality control of preimplantation genetic testing

Liu Xinrui, Huang Sexin, Gao Ming, Zou Yang, Gao Yuan

Reproductive Genetics Lab, Institute of Women, Children and Reproductive Health; Center for Reproductive Medicine; State Key Laboratory of Reproductive Medicine and Offspring Health, Shandong University, Jinan 250012, China

Corresponding author: Gao Yuan, Email: gaoyuan@sduivf.com, Tel: +86-531-86569866

【**Abstract**】 With the increasing application scale of preimplantation genetic testing (PGT), the role of molecular genetic testing technology in the clinical diagnosis and treatment of assisted reproductive technology is also rapidly improving. The stability, reliability and validity of PGT results are important guarantees for the subsequent precise embryo screening, and laboratory quality control and management are essential for the clinical application of PGT. The content of PGT quality control can be summarized as personnel, equipment, materials, methods, environment, and pre-test, in-test and post-test, which cover all aspects of whole clinical process of PGT. In order to make clinical PGT practice more standardized, the quality management of each PGT step is analyzed and discussed in this article, so as to provide reliable laboratory diagnosis and treatment basis for high-quality clinical practice.

【**Key words**】 Preimplantation genetic testing; Quality control; Standard operating procedures

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人工智能在生殖临床及质量管理应用的研究进展

于医萍　孙莹璞

郑州大学第一附属医院生殖医学中心，郑州　450052

通信作者：孙莹璞，Email：syp2008@vip.sina.com，电话：+86-371-66279062

【摘要】　人工智能是新一代生产力。目前人工智能在医学领域的应用已取得一定的突破，已有成熟的人工智能模型应用于临床辅助决策，在辅助生殖医学领域，已建立了助孕结局预测、超声自动化监测、辅助促排卵过程的临床决策、精液自动分析和胚胎选择等方面的人工智能模型。本文综述人工智能在生殖临床的研究进展，探讨未来人工智能在生殖临床的质量控制和管理中存在的尚待解决的问题，为人工智能在辅助生殖临床的进一步广泛应用提供建议。

【关键词】　人工智能；　生殖临床；　临床决策支持；　质量控制

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Progress on the application of artificial intelligence in the field of reproductive clinical activities and quality control

Yu Yiping, Sun Yingpu

Reproductive Medicine Center of the First Affiliated Hospital of Zhengzhou University, Zhengzhou 450052, China

Corresponding author: Sun Yingpu, Email: syp2008@vip.sina.com, Tel: +86-371-66279062

【Abstract】　Artificial intelligence is the new generation of productivity. Currently, there have been significant breakthroughs in the application of artificial intelligence in the field of medicine. Artificial intelligence models have been applied to support clinical decision. In the field of assisted reproductive medicine, artificial intelligence models have been established for predicting pregnant outcomes, automating ultrasound monitoring, monitoring ovulation induction processes, and automating semen analysis and embryo selection. This article reviews the research progress of artificial intelligence in reproductive clinicals, discusses future issues related to quality control and management of artificial intelligence in reproductive clinical practice, and provides recommendations for the further widespread application of artificial intelligence in assisted reproductive clinical activities.

【Key words】　Artificial intelligence; Reproductive clinical activities; Clinical decision support; Quality control

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·实验研究·

LncAC079944.2 通过 miR-149-5P/EFNA1 轴调控子宫内膜容受性

商俊宇[1]　陈雨美[2]　朱小兰[1]

[1]江苏大学第四附属医院生殖中心，镇江 212000；[2]江苏大学第四附属医院妇科，镇江 212000

通信作者：朱小兰，Email：zxl2517@163.com，电话：+86-18136816505

【摘要】　目的　筛选并鉴定与子宫内膜容受性（endometrial receptivity，ER）密切相关的 lncRNA：lncAC079944.2，并进一步探究其调节 ER 的作用与机制。方法　根据对 GEO 数据库的两个数据集共 71 个子宫内膜组织样本转录组数据的加权基因共表达网络分析（weighted gene co-expression network analysis，WGCNA），筛选出与 ER 显著相关的 RNAs。对 2021 年 10 月至 2022 年 10 月期间在江苏大学第四附属医院生殖中心就诊患者的子宫内膜样本分析验证生物信息学筛选的 RNAs 与其临床表达的一致性。应用细胞功能学实验分析筛选的 lncAC079944.2 对 Ishikawa 细胞（子宫内膜癌细胞，替代子宫内膜细胞）增殖、迁移和侵袭等功能的影响。通过双荧光素酶报告基因、qRT-PCR、免疫印迹实验等验证 lncAC079944.2、*EFNA1* 的表达模式以及和筛选的 miRNA 之间的相互作用关系，并验证三者在细胞功能上的影响。结果　LncAC079944.2 在分泌中期表达较分泌早期明显上调（$P<0.001$），反复种植失败（recurrent implantation failure，RIF）患者分泌中期表达较正常患者分泌中期明显降低（$P<0.001$）。在干扰 lncAC079944.2 的表达后，Ishikawa 细胞的增殖（$P=0.004$）、迁移（$P=0.001$）与侵袭（$P<0.001$）能力均有不同程度的减弱。qRT-PCR 结果显示 lncAC079944.2 的表达后，*EFNA1* 的表达也呈现下降趋势（$P=0.030$），而加入 miR-149-5p inhibitor 后，*EFNA1* 的表达有所恢复（$P=0.034$）。同样地，在加入 miR-149-5p inhibitor 后，Ishikawa 细胞因 lncAC079944.2 的表

达受到干扰而减弱的增殖（P<0.001）、迁移（P=0.001）与侵袭（P=0.008）能力有所恢复。在胚胎黏附实验中，干扰 lncAC079944.2 的表达会抑制 JAR 细胞球体（模拟胚胎）和 Ishikawa 细胞之间的黏附（P<0.001），而加入 miR-149-5p inhibitor 后，胚胎和 Ishikawa 细胞之间的黏附程度回升（P<0.001）。结论 LncAC079944.2 与 ER 相关，下调 lncAC079944.2 可显著降低 ER。LncAC079944.2 可作为 miR-149-5p 的分子海绵，调节 EFNA1 的表达，影响 Ishikawa 细胞的增殖、迁移与侵袭能力，并影响胚胎与 Ishikawa 细胞的黏附，从而影响 ER。LncAC079944.2 可通过 miR-149-5p/EFNA1 轴调控 ER，有望成为 ER 评估的新指标，为寻找新的改善 ER 的策略提供实验依据。

【关键词】 lncAC079944.2； *EFNA*1； miR-149-5p； 子宫内膜容受性； Ishikawa 细胞

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LncAC079944.2 regulates endometrial receptivity via miR-149-5P/EFNA1 axis

Shang Junyu[1], Chen Yumei[2], Zhu Xiaolan[1]

[1] The Department of Reproductive Medicine, the Fourth Affiliated Hospital of Jiangsu University, Zhenjiang 212000, China; [2] The Department of Gynecology, the Fourth Affiliated Hospital of Jiangsu University, Zhenjiang 212000, China

Corresponding author: Zhu Xiaolan, Email: zxl2517@163.com, Tel: +86-18136816505

【**Abstract**】 **Objective** To screen and identify the lncRNA AC079944.2, which is closely associated with endometrial receptivity (ER), and further delved into its functional role and regulatory mechanism in ER. **Methods** Weighted gene co-expression network analysis (WGCNA) was performed on transcriptome data obtained from 71 endometrial tissue samples sourced from two datasets in the GEO database, leading to the identification of RNAs exhibiting significant correlation with ER. The consistency of bioinformatic-screened RNAs and their clinical expression was verified by analysis of endometrial samples from patients treated in the Department of Reproductive Medicine, the Fourth Affiliated Hospital of Jiangsu University from October 2021 to October 2022. Subsequently, the impact of lncAC079944.2 on Ishikawa cells' proliferation, migration, invasion was evaluated through cytofunctional experiments. The expression patterns of lncAC079944.2 and EFNA1, along with their interactions with screened miRNAs, were validated using dual luciferase reporter gene assays, qRT-PCR, and Western blotting analysis. Furthermore, their effects on cell function were confirmed. **Results** LncAC079944.2 was significantly upregulated in the middle secretory stage compared with the early secretory stage (P<0.001), and its expression in the middle secretory stage of recurrent implantation failure (RIF) patients was significantly lower than that of normal patients (P<0.001). Silencing the expression of lncAC079944.2 resulted in varying degrees of weakened proliferation (P=0.004), migration (P=0.001), and invasion (P<0.001) of Ishikawa cells. qRT-PCR revealed that silence of lncAC079944.2 led to a decrease in the expression of *EFNA*1 (P=0.030), whereas the addition of miR-149-5p inhibitor resulted in the recovery

of *EFNA*1 expression (*P*=0.034). Similarly, the addition of miR-149-5p inhibitor restored the weakened proliferation (*P*<0.001), migration (*P*=0.001) and invasion (*P*=0.008) abilities of Ishikawa cells, which had been compromised by silence of lncAC079944.2. In the embryo adhesion experiment, disruption of lncAC079944.2 expression significantly suppressed the adhesion between JAR cell spheres (simulated embryos) and Ishikawa cells (*P*<0.001). However, upon addition of a miR-149-5p inhibitor, there was a notable increase in the degree of adhesion between the embryos and Ishikawa cells (*P*<0.001). **Conclusion** LncAC079944.2 is associated with ER, and downregulating lncAC079944.2 can significantly decrease ER levels. lncAC079944.2 functions as a molecular sponge for miR-149-5p, modulating EFNA1 expression and impacting the proliferation, migration, invasion ability of Ishikawa cells, as well as influencing embryo adhesion to Ishikawa cells, thus affecting ER. LncAC079944.2 can regulate ER via the miR-149-5p/EFNA1 axis, which is expected to become a new indicator for the evaluation of endometrial receptivity, and provide experimental data for finding new strategies to improve ER.

【 **Key words** 】 LncAC079944.2; *EFNA*1; miR-149-5p; Endometrial receptivity; Ishikawa

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·实验研究·

过硫谷胱甘肽可改善高脂食物导致的雄鼠低睾酮水平状态

张美幸[1] 张玲玲[2] 万小凤[1] 郭敏[1] 孙敏[1] 叶淑柯[1] 张方喜[2] 郑华军[1] 李润生[1]

[1]国家卫生健康委员会计划生育药具重点实验室 上海生殖健康药具工程技术研究中心 上海市生物医药技术研究院，上海 200237；

[2]国家卫生健康委员会计划生育药具重点实验室　上海生殖健康药具工程技术研究中心　上海市生物医药技术研究院　复旦大学药学院，上海 200237

通信作者：李润生，Email：runshengli2007@163.com，电话：+86-21-64437446

【摘要】 目的　探究过硫谷胱甘肽（glutathione persulfate，GSSH）是否可以改善雄性肥胖小鼠的低睾酮水平，并探讨其作用机制。方法　将45只小鼠平均分为3组，低脂饮食（low-fat diet，LFD）组：喂LFD 10周，随后45 d继续LFD同时每天腹腔注射生理盐水（normal saline，NS），记为LFD+NS组（n=15）；高脂饮食（high-fat diet，HFD）组：喂HFD 10周，随后45 d继续HFD同时每天腹腔注射NS，记为HFD+NS组（n=15）；HFD+GSSH组（n=15）：HFD 10周，随后45 d HFD同时每天腹腔注射GSSH（200 mg/kg）。处理结束后所有小鼠眼眶取血，断颈处死小鼠并解剖取出睾丸，分别用ELISA、qPCR以及Western blotting的方法检测小鼠血清睾酮和丙二醛（malondialdehyde，MDA）水平、睾酮关键合成酶（StAR、3β-HSD、Cyp11a1、Cyp17a1）以及抗氧化蛋白（StAR、3β-HSD、NR5A1、EHD3）表达水平等。此外，用100 μmol/L的GSSH处理小鼠睾丸碎片后检测睾酮合成酶表达水平。最后用50 μmol/L和100 μmol/L的GSSH分别处理小鼠睾丸间质TM3细胞株24 h后，加入100 μmol/L的H_2O_2，继续培养TM3细胞24 h，然后收集细胞检测NR5A1、SOD与Nrf2蛋白表达水平。结果　①给药结束后，LFD+NS组、HFD+NS组与HFD+GSSH组小鼠的体质量分别是(30.67±1.22) g、(40.43±1.56) g、(33.30±0.95) g；HFD+NS组体质量增加了24.53%，给药前后差异有统计学意义（P=0.002），而LFD+NS组、HFD+GSSH组的体质量在给药前后差异均无统计学意义（均P>0.05）。②HFD+NS组小鼠睾酮浓度为（12.9±1.7） μg/L，显著低于LFD+NS组［(18.3±1.2) μg/L］，差异有统计学意义（P=0.020）；HFD+GSSH组小鼠睾酮浓度为（25.4±2.1） μg/L，显著高于HFD+NS组，差异有统计学意义（P=0.030）。RT-PCR检测结果显示，与LFD+NS组小鼠相比，HFD+NS组小鼠睾丸所有被检测的睾酮合成关键基因（*StAR*、3β-*HSD*、*Cyp*11a1及*Cyp*17a1）表达水平都显著下降（P=0.003、P=0.007、P<0.001、P<0.001）。这些基因的表达水平则在HFD+GSSH组小鼠睾丸中得到了恢复（P=0.002、P<0.001、P<0.001、P=0.006）。③与LFD+NS组小鼠［(9.00±1.59) nmol/mL］相比，HFD+NS组小鼠血清MDA水平［(10.61±1.73) nmol/mL］显著升高（P=0.016）；与HFD+NS组小鼠相比，HFD+GSSH组小鼠血清MDA水平［(9.23±0.94) nmol/mL］下降，且具有统计学意义（P=0.048）。④HFD+NS组的肥胖小鼠睾丸中NR5A1、EHD3、StAR与3β-HSD蛋白水平与LFD+NS组小鼠相比明显下调（P=0.002、P=0.012、P=0.004、P=0.043），HFD+GSSH组小鼠睾丸中NR5A1、EHD3、StAR与3β-HSD蛋白水平与HFD+NS组的肥胖小鼠相比则显著上升（P<0.001、P=0.017、P=0.004、P<0.001）。⑤TM3细胞在H_2O_2的存在下，NR5A1、Nrf2与SOD的表达水平皆发生显著下调（P<0.001、P=0.002、P=0.004）。结论　GSSH通过提高睾酮合成所需关键基因表达而改善HFD喂养的雄鼠睾酮水平。

【关键词】 高脂食物； 睾酮生物合成； 过硫谷胱甘肽； NR5A1
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Glutathione persulfide prevents high-fat diet induced down-regulation of testosterone biosynthesis

Zhang Meixing[1], Zhang Lingling[2], Wan Xiaofeng[1], Guo Min[1], Sun Min[1], Ye Shuke[1], Zhang Fangxi[2], Zheng Huajun[1], Li Runsheng[1]

[1] NHC Key Lab of Reproduction Regulation; Shanghai Engineering Research Center of Reproductive Health Drug and Devices; Shanghai Institute for Biomedical and Pharmaceutical Technologies, Shanghai 200237, China; [2] NHC Key Lab of Reproduction Regulation; Shanghai Engineering Research Center of Reproductive Health Drug and Devices; Shanghai Institute for Biomedical and Pharmaceutical Technologies, School of Pharmacy Fudan University, Shanghai 200237, China

Corresponding author: Li Runsheng, Email: runshengli2007@163.com, Tel: +86-21-64437446

【**Abstract**】 **Objective** To investigate effects and underlying mechanisms of glutathione persulfate (GSSH) on the level of testosterone in male obese mice. **Methods** Totally 45 mice were divided into 3 groups on average. Low-fat diet (LFD)+normal saline (NS) group: 15 mice were fed with LFD for 10 weeks, followed by LFD together with daily intraperitoneal injection of saline for 45 d; high-fat diet (HFD)+NS group: 15 mice were fed with high-fat diet for 10 weeks, followed by HFD and daily intraperitoneal injection of NS for 45 d; HFD+GSSH group: 15 mice were fed with HFD for 10 weeks, followed by a HFD for 45 d and daily intraperitoneal injection of GSSH (200 mg/kg). After the treatment, all mice were killed with their necks-severed, testis and serum were taken out from the mice. Serum levels of testosterone and malondialdehyde (MDA), the mRNA levels of key enzymes for testosterone synthesis (*StAR*, 3β-*HSD*, *Cyp*11a1 and *Cyp*17a1) were measured by RT-PCR. The testicular protein levels of StAR, 3β-HSD, NR5A1 and EHD3 were measured by Western blotting assay. Protein levels of NR5A1, SOD and Nrf2 were measured in mouse Leydig TM-3 cells that were treated with 50 μmol/L and 100 μmol/L GSSH, respectively, following with treatment with 100 μmol/L H_2O_2. **Results** 1) After treatment, the body weight of mice in HFD+GSSH group did not change significantly, while the body weight of mice in HFD+NS group raised by 24.53% (from 32.46 g to 40.43 g) during the 45-day-intraperitoneal injection (P=0.002). 2) Serum level of testosterone in HFD+NS group [(12.9±1.7) μg/L] was significantly lower than that in LFD+NS group [(18.3±1.2) μg/L, P=0.020]. However, serum level of testosterone in HFD+GSSH group was (25.42±2.1) μg/L, which was significantly higher than that in HFD+NS group (P=0.030). The RT-PCR test results showed that compared with LFD+NS group, the expression levels of all key genes involved in testosterone synthesis (*StAR*, 3β-*HSD*, *Cyp*11a1, *Cyp*17a1) showed a significant decrease in HFD+NS group (P=0.003, P=0.007, P<0.001, P<0.001). The expression levels of these genes were restored in the mouse testes of HFD+GSSH group (P=0.002, P<0.001, P<0.001, P=0.006). 3) Similarly, compared with LFD+NS group [(9.00±1.59) nmol/mL], the serum MDA level of HFD+NS group [(10.61±1.73)

nmol/mL] raised significantly (P=0.016), while GSSH reversed the raised HFD+NS high level of serum MDA in HFD+GSSH group [(9.23±0.94) nmol/mL, P=0.048]. 4) Both levels of NR5A1, EHD3, StAR, and 3β-HSD were reduced in HFD+NS group (P=0.002, P=0.012, P=0.004, P=0.043), but their levels were significantly restored in HFD+GSSH group (P<0.001, P=0.017, P=0.004, P<0.001). 5) The levels of NR5A1, Nrf2 and SOD were obviously down-regulated in TM3 cells treated with H_2O_2 (P<0.001, P=0.002, P=0.004). **Conclusion** GSSH can raise serum level of testosterone in HFD-fed mice by up-regulating expression of genes which are important for testicular testosterone biosynthesis.

【**Key words**】 High-fat diet; Glutathione persulfide; Glutathione persulfate; Nr5A1

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·临床报道·

基于阴囊超声参数及机器学习的中重度生精功能障碍风险评分系统的构建与验证

吴萌[1] 李学峰[2] 李鑫焱[1] 刘菲菲[1] 杨洁[1] 崔广和[1]

[1]滨州医学院附属医院超声医学科，滨州 256603；[2]滨州医学院附属医院生殖医学科，滨州 256603

通信作者：崔广和，Email：cghbyfy@163.com，电话：+86-15054338681

【摘要】 目的 建立基于阴囊超声参数及机器学习的中重度生精功能障碍风险评分系统并探讨其价值。方法 回顾性队列分析2021年6月至2022年12月期间在滨州医学院附属医院生殖医学科确诊无精子症、中重度少、弱精子症患者112例及同期在本院因不孕而就诊的116例生精功能正常男性的阴囊超声参数。分别使用随机森林、支持向量机、逻辑回归、K-最近邻算法、XGBoost构建模型。综合各模型各参数的平均沙普利可加性模型解释方法值构建风险评分系统。通过受试者工

作特征曲线评估模型的预测效能，临床决策曲线评估模型的临床应用价值。结果 评分系统包括双侧睾丸总体积、睾丸回声是否均匀，右侧精索静脉内径及精索静脉曲张血液反流时间。风险评分系统训练集的曲线下面积（area under the curve，AUC）为 0.757，测试集 AUC 为 0.718，决策曲线显示该评分系统具有较高的临床价值。结论　基于阴囊超声参数及机器学习建立风险评分系统可有效预测中重度生精功能障碍，对此类患者的早发现有着积极意义。

【关键词】　生精功能障碍；　机器学习；　SHAP；　阴囊超声

Construction and validation of a risk scoring system for moderate to severe spermatogenic dysfunction based on scrotal ultrasound parameters and machine learning

Wu Meng[1], Li Xuefeng[2], Li Xinyan[1], Liu Feifei[1], Yang Jie[1], Cui Guanghe[1]

[1] Department of Ultrasound Medicine, Affiliated Hospital of Binzhou Medical University, Binzhou 256603, China; [2] Department of Reproductive Medicine, Affiliated Hospital of Binzhou Medical University, Binzhou 256603, China

Corresponding author: Cui Guanghe, Email: cghbyfy@163.com, Tel: +86-15054338681

【Abstract】　Objective　To establish a risk scoring system for moderate to severe spermatogenic dysfunction based on scrotal ultrasound parameters and machine learning, and to explore its value. **Methods**　A retrospective cohort analysis was conducted on 112 patients diagnosed with azoospermia, moderate to severe oligospermia, and asthenospermia in the Department of Reproductive Medicine at Binzhou Medical University Affiliated Hospital from June 2021 to December 2022. Scrotal ultrasound parameters of these patients were compared with those of 116 normal male patients who visited the same hospital during the same period for reproductive assistance. Models were constructed using Random Forest, Support Vector Machine, logistic Regression, K-nearest neighbor algorithm, and XGBoost. A risk scoring system was established based on the average SHapley Additive exPlanation values of each model. The predictive performance of the model was evaluated using the receiver operating characteristic curve, and the clinical application value of the model was evaluated using the decision curve analysis. **Results**　The scoring system included bilateral testicular total volume, whether the testicular echo was uniform, the inner diameter of the right spermatic vein, and the reflux time of varicocele. The area under the curve (AUC) of the risk scoring system for the training set was 0.757, and the AUC for the test set was 0.718. The decision curve showed that this scoring system had a high clinical value. **Conclusion**　A risk scoring system based on scrotal ultrasound parameters and machine learning can effectively predict moderate to severe spermatogenic dysfunction, which is of positive significance for early detection of such patients.

【Key words】　Spermatogenic dysfunction; Machine learning; SHAP; Scrotal ultrasound

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·现场调查·

中文版哥本哈根多中心不孕症—生育问题心理压力简式量表（COMPI-FPSS）在不孕人群中的信效度研究

李婧　徐诗榕　王媛媛　王颖

北京大学第三医院生殖医学中心，北京 100191

通信作者：王颖，Email：Wangying02114@bjmu.edu.cn，电话：+86-10-82266843

【摘要】 目的　探究中文版哥本哈根多中心不孕症－生育问题心理压力简式量表（Copenhagen Multi－Centre Psychosocial Infertility research program Fertility Problem Stress Scales，COMPI-FPSS）在不孕人群中的信度和效度。方法　遵循 Brislin 翻译原则对 COMPI-FPSS 原量表进行汉化，采用便利抽样法抽取 2023 年 3 月至 2023 年 9 月期间于北京大学第三医院生殖医学中心初次就诊的不孕症女性进行调查，应用 SPSS26.0、AMOS26.0 软件对中文版 COMPI-FPSS 进行探索性因子分析及结构模型构建行验证性因子分析，研究该量表的信效度。结果　本研究共回收有效问卷 967 份，COMPI-FPSS 总体 Cronbach’s α 系数为 0.896，各维度组合信度均>0.7，量表信度好。探索性因子分析中，共提取 3 个公因子，累积贡献率为 74.05%(KMO=0.855)；验证性因子分析中，通过结构方程模型构建：χ^2=104.54，χ^2/df=4.36，近似误差均方根=0.06，比较拟合指数=0.99，拟合优度指数=0.98，规范拟合指数=0.98，增值拟合指数=0.99，模型拟合良好；各条目在相应维度上的因子负荷值为 0.631~0.914 ，量表结构效度好。结论　中文版 COMPI-FPSS 在不孕人群中有良好的信度和效度，可作为可靠测量工具评估不孕症女性社会心理健康及生育压力水平。

【关键词】 不孕症；　生育压力；　哥本哈根多中心不孕症－生育问题心理压力简式量表；　信度；　效度

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Reliability and validity of the Chinese Version of the Copenhagen Multi-Centre Psychosocial Infertility research program Fertility Problem Stress Scalesamong infertile population

Li Jing, Xu Shirong, Wang Yuanyuan, Wang Ying
Reproductive Medical Center, Peking University Third Hospital, Beijing 100191, China
Corresponding author: Wang Ying, Email: Wangying02114@bjmu.edu.cn, Tel: +86-10-82266843

【**Abstract**】 **Objective** To investigate the reliability and validity of the Chinese Copenhagen Multi-Centre Psychosocial Infertility research program Fertility Problem Stress Scales (COMPI-FPPS) among infertile population. **Methods** The COMPI-FPSS was translated into Chinese followed the principles outlined by Brislin, and later the reliability and validity of the scale were tested for use in a Chinese-speaking context. Infertile female patients seeking fertility treatment in the Reproductive Medical Center of Peking University Third Hospital for the first time form March 2023 to September 2023 were surveyed. The reliability and validity of the Chinese COMPI-FPSS were analyzed by internal consistency testing, exploratory factor analysis and structural equation modeling confirmatory factor analysis using SPSS26.0 and AMOS26.0 software. **Results** A total of 967 questionnaires form eligible participants were concluded in the final study. The overall Cronbach's α of the Chinese COMPI-FPSS was 0.896, and the composite reliability of each domain was >0.7, suggesting a good scale reliability. In factor analysis, three main factors were extracted with a cumulative variance rate of 74.05% (KMO=0.855). In confirmatory factor analysis, the results showed that χ^2=104.54, χ^2/df=4.36, root mean-square error of approximation=0.06, comparative fit index=0.99, goodness fit index=0.98, normed fit index=0.98, incremental fit index=0.99, suggesting a good fit of the model; the factor loading on the corresponding dimension was 0.631–0.914, the structural validity was good. **Conclusion** The Chinese version of the COMPI-FPSS is a validated and reliable instrument which can be used to assess the psychosocial health and fertility stress level among infertile women.

【**Key words**】 Infertility; Fertility stress; COMPI-FPSS; Reliability; Validity
Fund program: National Key Research and Development Program of China (2022YFC2702905)

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·个案报道·

NLRP7 基因变异致复发性葡萄胎一个家系的遗传学分析

陈海霞 张静 李芳 田烨 张妍 宋学茹 田文艳 白晓红

天津医科大学总医院妇产科生殖医学中心　天津市女性生殖健康与优生重点实验室，天津 300052

通信作者：白晓红，Email：bxhjj@163.com，电话：+86-13821343592

【摘要】 复发性葡萄胎指同一患者发生 2 次或以上的葡萄胎，常与家族性或散发性双亲来源完全性葡萄胎有关，已有研究表明该疾病与 *NLRP7* 和 *KHDC*3L 基因突变有关。本院生殖医学中心接收 1 例因 2 次葡萄胎史要求助孕患者，收集该家系临床资料，抽取患者及其家属成员的外周血样进行全外显子测序和 Sanger 验证。全外显子组测序结果显示先证者 *NLRP7* 基因存在 c.2282G>A（p.Cys761Tyr）纯合突变，Sanger 测序结果与其一致； Sanger 验证其父母和姐姐是该变异的杂合携带者。先证者通过卵子捐赠和卵胞质内单精子注射技术最终获得临床妊娠。因此，*NLRP7* 基因 c.2282G>A（p.Cys761Tyr）纯合突变是导致该患者复发性葡萄胎的遗传学病因，该变异的发现拓宽了 *NLRP7* 基因致病变异谱，可进一步为该类患者提供生育指导。

【关键词】 复发性葡萄胎； *NLRP7* 基因； 全外显子测序； 基因突变

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Genetic analysis of a family with recurrent hydatidiform mole caused by *NLRP*7 gene mutation

Chen Haixia, Zhang Jing, Li Fang, Tian Ye, Zhang Yan, Song Xueru, Tian Wenyan, Bai Xiaohong

Tianjin Key Laboratory of Female Reproductive Health and Eugenics; Reproductive Medicine Center, Department of Gynecology and Obstetrics, Tianjin Medical University General Hospital, Tianjin 300052, China

Corresponding author: Bai Xiaohong, Email: bxhjj@163.com, Tel: +86-13821343592

【Abstract】 Recurrent hydatidiform moles refer to patients with at least two molar pregnancies. Mutations in *NLRP*7 and *KHDC*3L genes have been implicated in this disease. A pedigree with a history of recurrent hydatidiform mole who visited Tianjin Medical University General Hospital Reproductive Medicine Center, was selected as the study subject. Clinical data of the family member were collected, peripheral blood samples were taken from each member. Whole exon sequencing was carried out for the proband. Candidate genes were validated by Sanger sequencing of her family members. The whole exome sequencing showed that the proband had a homozygous mutation of c.2282G>A (p.Cys761Tyr) in the *NLRP*7 gene, the Sanger sequencing results were consistent with the results. Sanger sequencing results verified that the parents and her sisters carried heterozygous mutations. The proband obtained a clinical pregnancy through egg donation and intracytoplasmic sperm injection. Therefore, homozygous mutation of *NLRP*7 gene c.2282G>A (p.Cys761Tyr) is the genetic cause of recurrent hydatidiform mole. The

discovery of this mutation broadens the spectrum of *NLRP*7 gene pathogenic variants and provide fertility guidance for such patients.

【**Key words**】 Recurrent hydatidiform moles; *NLRP*7 gene; Whole exome sequencing; Gene mutation

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·个案报道·

颅内生殖细胞肿瘤致青春期延迟2例并文献复习

许灵波[1] 孙晓彤[1] 何西彦[1] 蒲瑞阳[1] 甄璟然[2]

[1]甘肃省人民医院产科，兰州 730000；[2]中国医学科学院北京协和医院妇科内分泌与生殖中心，北京 100032

通信作者：甄璟然，Email：zhen_amy@126.com

【摘要】 颅内生殖细胞肿瘤（intracranial germ cell tumors，iGCT）是导致青春期延迟（delayed puberty，DP）的常见原因。本文回顾性分析2例iGCT致DP患者的临床病例资料。2例患者疾病特点包括DP、原发性闭经、生长发育迟缓、身材矮小、亚临床甲状腺功能减退等，经影像学和相关检验明确诊断为DP。在积极治疗原发病的基础上给予相应的性激素药物诱导青春期进展后，2例患者身高、体质量及第二性征有不同程度发育，目前在随诊中。尽早识别并给予适当的临床干预对于DP患者的生殖内分泌功能、骨骼健康和终身高等远期健康具有重要意义。

【关键词】 生殖细胞肿瘤； 青春期延迟； 性激素

Two cases of delayed puberty caused by intracranial germ cell tumors and literature review

Xu Lingbo[1], Sun Xiaotong[1], He Xiyan[1], Pu Ruiyang[1], Zhen Jingran[2]

[1] Department of Obstetrics, Gansu Provincial People's Hospital, Lanzhou 730000, China; [2] Center for Gynecological Endocrinology & Reproductive Medicine, Chinese

Academy of Medical Science, Peking Union Medical College Hospital, Beijing 100032, China
Corresponding author: Zhen Jingran, Email: zhen_amy@126.com

【Abstract】 Intracranial germ cell tumors (iGCT) is a common cause of delayed puberty (DP). A retrospective analysis was conducted on the clinical data of two patients with DP caused by iGCT. The disease characteristics of the two patients included DP, primary amenorrhea, growth retardation, short stature, subclinical hypothyroidism, etc. They were diagnosed as DP through imaging and related biochemical tests, and some sex hormone drugs were given on the basis of active treatment of the primary disease. Two patients had varying degrees of development in height, weight and secondary sexual characteristics, and further treatment condition is being tracking by us. Early identification and appropriate clinical intervention are of great significance to the reproductive endocrine function, bone health and long-term health such as terminal height of DP patients.

【Key words】 Germ cell tumors; Delayed puberty; Sex hormones

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·综述·

辅助生殖技术子代出生体质量的影响因素及相关机制研究进展

焦洁静 耿晨 张轶媛 崔琳琳

山东大学生殖医学研究中心（山东大学第二医院） 中国医学科学院配子发生与辅助生殖子代健康研究创新单元（2021RU001） 生殖内分泌教育部重点实验室（山东大学） 山东省生殖医学重点实验室 山东省生殖健康临床医学研究中心 山东省生殖健康技术创新中心 国家辅助生殖与优生工程技术研究中心，济南 250012

通信作者：崔琳琳，Email：fdclear3@126.com，电话：+86-531-85181598

【摘要】 随着不孕症发病率的升高，辅助生殖技术（assisted reproductive technology， ART）逐渐成为不孕人群的主要甚至唯一治疗方法。大量证据表明，ART 子代围产期结局与自然受孕子代间存在差异，如 ART 子代低出生体质量风险增加、远期代谢异常风险增加等。然而，这种差异往往不是 ART 单一作用的结局，不孕症以及胎儿自身因素也发挥了一定的作用。由于出生体质量对新生儿远期健康具有重要作用，现就 ART 中可能影响子代出生体质量的因素及相关机制进行综述，从而为改善 ART 子代健康结局提供一定的参考价值。

【关键词】 生殖技术，辅助； 出生体质量； 妊娠结局； 多囊卵巢综合征； 不孕症

Research progress on influencing factors and related mechanisms of birth weight in offspring of assisted reproductive technology

Jiao Jiejing, Geng Chen, Zhang Yiyuan, Cui Linlin

Center for Reproductive Medicine, the Second Hospital, Cheeloo College of Medicine, Shandong University; Research Unit of Gametogenesis and Health of ART-Offspring, Chinese Academy of Medical Science (2021RU001); Key Laboratory of Reproductive Endocrinology of Ministry of Education, Shandong University; Shandong Key Laboratory of Reproductive; Shandong Provincial Clinical Research Center for Reproductive Health; Shandong Technology Innovation Center for Reproductive Health; National Research Center for Assisted Reproductive Technology and Reproductive Genetics, Shandong University, Jinan 250012, China

Corresponding author: Cui Linlin, Email: fdclear3@126.com, Tel: +86-531-85181598

【Abstract】 With the increase of the incidence rate of infertility, assisted reproductive technology (ART) has gradually become the main or even the only treatment for infertile people. A large amount of evidence showed that perinatal outcomes of ART offspring are different from those of naturally conceived offspring, such as the increased risk of low birth weight and long-term metabolic abnormalities. However, beside of ART, infertility and the fetus factor also play a role in the poor pregnancy outcome. Since birth weight plays an important role in the long-term health of newborns, this article reviewed the factors and related mechanisms that may affect the birth weight of offspring conceived by ART, so as to contribute improving the pregnancy outcome.

【Key words】 Reproductive technology, assisted; Birth weight; Pregnancy outcome; Polycystic ovary syndrome; Infertility

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·综述·

饮食模式改善多囊卵巢综合征患者生殖内分泌紊乱的研究进展

张允芝　窦真　王宝娟　夏天

天津中医药大学第一附属医院生殖医学科　国家中医针灸临床医学研究中心，天津 300193

通信作者：夏天，Email：xiatian76@163.com

【摘要】 饮食干预作为一种简便、易于实施的非药物治疗方法被国际指南推荐为多囊卵巢综合征（polycystic ovary syndrome，PCOS）患者的一线治疗方案。科学合理的饮食干预已经越来越受到人们的重视，一系列饮食模式，包括低升糖指数饮食、地中海饮食、生酮饮食、停止高血压饮食、限时饮食等已被证明可以降低PCOS女性体质量，改善生殖内分泌紊乱。本文从临床和基础实验研究等方面阐述了现有饮食模式改善PCOS女性生殖内分泌紊乱的临床症状及其作用机制，以完善饮食模式在PCOS治疗中的应用证据，为临床管理中提供最佳饮食建议。

【关键词】 多囊卵巢综合征；　生殖内分泌；　饮食模式；　饮食干预

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Research progress on improving reproductive endocrine disorders in polycystic ovary syndrome patients through dietary pattern

Zhang Yunzhi, Dou Zhen, Wang Baojuan, Xia Tian

Department of Reproductive Medicine, First Teaching Hospital of Tianjin University of Traditional Chinese Medicine; National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, Tianjin 300193, China

Corresponding author: Xia Tian, Email: xiatian76@163.com

【 Abstract 】 Dietary interventions are recommended by international guidelines as a simple, easy-to-implement non-pharmacological treatment option for polycystic ovary syndrome (PCOS) patients. Scientific and reasonable dietary intervention has attracted more and more attention, and a series of dietary patterns, including low-glycemic index diet, mediterranean diet, ketogenic diet, dietary approaches to stop hypertension, and time-limited diet, have been proved to reduce the weight of PCOS patients and improve reproductive endocrine disorders. This article described the existing dietary patterns to improve the clinical symptoms of reproductive endocrine disorders in women with PCOS and their mechanisms of action from both clinical and basic experimental studies, in order to improve the evidence for the application of dietary patterns in the treatment of PCOS and to provide optimal dietary recommendations for clinical management.

【Key words】 Polycystic ovary syndrome; Reproductive endocrinology; Dietary pattern; Dietary intervention

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·综述·

卵巢衰老的机制与治疗策略

何甜甜 许博 杜星 付旭锋

宁夏医科大学生育力保持教育部重点实验室，银川 750000

通信作者：付旭锋，Email： fuxufeng100@163.com，电话：+86-951-6980178

【摘要】 卵巢作为女性的重要生殖器官在维持生殖健康和生活质量中具有重要作用。卵巢衰老是指卵巢功能下降直至最终衰竭的过程，不仅会导致女性生育能力的下降，而且还会加速女性衰老并引起一系列相关疾病，严重威胁女性生殖健康和生活质量。因此，阐明卵巢衰老的机制并进一步探究卵巢的抗衰老策略，对减缓卵巢衰老和保持女性生育力具有重要意义。本综述回顾分析了国内外卵巢衰老相关研究，总结了当前卵巢衰老的相关机制并提出了相应的预防和治疗策略。

【关键词】 卵巢颗粒细胞； 卵巢衰老； 抗衰老

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Mechanisms and treatment strategies of ovarian aging

He Tiantian, Xu Bo, Du Xing, Fu Xufeng

Key Laboratory of Fertility Maintenance, Ministry of Education, Ningxia Medical University, Yinchuan 750000, China

Corresponding author: Fu Xufeng, Email: fuxufeng100@163.com, Tel: +86-951-6980178

【**Abstract**】 As an important reproductive organ in women, ovary plays a vital role in maintaining reproductive health and quality of life. Ovarian aging refers to the decline of ovarian function and eventually failure, which not only leads to the decline of female fertility, but also accelerates female aging and causes a series of related diseases, which seriously threatens female reproductive health

and quality of life. Therefore, elucidating the mechanism of ovarian aging and further exploring the anti-aging strategies of the ovary are of great significance for slowing down ovarian aging and maintaining female fertility. This article reviews and analyzes the relevant studies of ovarian aging at home and abroad, summarizes the relevant mechanisms of ovarian aging and puts forward the corresponding prevention and treatment strategies.

【Key words】 Ovarian granulosa cells; Ovarian aging; Anti-aging

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·综述·

Sirtuins家族蛋白在卵巢衰老过程中的作用

王静 程慧茹 章志国 曹云霞

安徽医科大学第一附属医院妇产科 国家卫生健康委配子及生殖道异常研究重点实验室 生殖健康与遗传安徽省重点实验室，合肥 230032

通信作者：章志国，Email：zzg_100@163.com，电话：+86-18155106683

【摘要】 衰老导致的卵巢功能衰退是不可逆的自然生理过程，表现为卵泡的逐渐耗竭和卵巢的卵母细胞质量下降。现有研究表明，Sirtuins家族通过多种途径参与卵巢衰老的发生发展，如调控烟酰胺腺嘌呤二核苷酸水平、氧化应激、染色体分离和基因组稳定性等。本文就目前Sirtuins家族蛋白在卵巢衰老中扮演的角色及其分子机制进行综述。

【关键词】 Sirtuins； 烟酰胺腺嘌呤二核苷酸； 氧化应激； 染色体分离； 基因组稳定性； 卵巢衰老

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Role of Sirtuins family proteins in ovarian aging

Wang Jing, Cheng Huiru, Zhang Zhiguo, Cao Yunxia

Department of Obstetrics and Gynecology, the First Affiliated Hospital of Anhui Medical University; NHC Key Laboratory of Study on Abnormal Gametes and

Reproductive Tract (Anhui Medical University); Anhui Province Key Laboratory of Reproductive Health and Genetics, Hefei 230032, China
Corresponding author: Zhang Zhiguo, Email: zzg_100@163.com, Tel: +86-18155106683

【Abstract】 The decline of ovarian function due to aging is an irreversible natural physiological process, manifested by the progressive depletion of follicles and the decrease of oocyte quality in the ovary. Existing studies have shown that the Sirtuins family is involved in the development of ovarian aging through various pathways, such as regulation of nicotinamide adenine dinucleotide levels, oxidative stress, chromosome segregation and genomic stability. In this paper, we review the current roles of Sirtuins family proteins in ovarian aging and their molecular mechanisms.

【Key words】 Sirtuins; Nicotinamide adenine dinucleotide; Oxidative stress; Chromosome segregation; Genomic stability; Ovarian aging

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·综述·

巨噬细胞异常与复发性流产发病机制的研究进展

杨贾 李莉 王海燕

北京大学第三医院妇产科生殖医学中心，北京 100191

通信作者：李莉，Email：lilis2014@163.com，电话：+86-10-82266164

【摘要】 复发性流产作为临床上难治的妊娠并发症，发病原因复杂。其中免疫因素的影响一直受到人们的关注。巨噬细胞，作为母-胎界面的第二大免疫细胞群，参与女性各种生殖事件，越来越多的研究提示巨噬细胞异常与复发性流产的发生密切相关。本文概括了子宫巨噬细胞的来源及分类，分别从微观层面巨噬细胞的极化异常、宏观层面巨噬细胞的功能异常系统地梳理其与复发性流产的关系，并尝试寻找该领域新的探索方向。

【关键词】 巨噬细胞； 免疫； 复发性流产； 发病机制
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Research progress on macrophage abnormalities and the pathogenesis of recurrent spontaneous abortion

Yang Jia, Li Li, Wang Haiyan

Reproductive Medical Center, Department of Obstetrics and Gynecology, Peking University Third Hospital, Beijing 100191, China

Corresponding author: Li Li, Email: lilis2014@163.com, Tel: +86-10-82266164

【**Abstract**】 Recurrent spontaneous abortion is a clinical complication of refractory pregnancy and has complex causes. Among them, the effect of immunological factors has been received much attention. Macrophages, as the second largest group of immune cells at the maternal-fetal interface, are involved in various reproductive events in women, and a growing number of studies have suggested that their abnormalities are closely related to the pathogenesis of recurrent spontaneous abortion. In this paper, we summarized the sources and classifications of uterine macrophages, systematically reviewed the relationship between the abnormal polarization of macrophages at the microscopic level, the abnormal function of macrophages at the macroscopic level and recurrent spontaneous abortion, thus attempted to find new directions of exploration in this field.

【**Key words**】 Macrophages; Immunity; Recurrent spontaneous abortion; Pathogenesis

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·综述·

子宫内膜容受性分子检测方法研究进展

彭可欣 赵子菡 张慧 刘江

昆明医科大学第一附属医院生殖遗传科，昆明 650032

通信作者：刘江，Email：liujiang6787@163.com，电话：+86-871-65324888

【摘要】 人类的生殖过程包含配子的生成与输送，受精卵的产生与种植，以及胚胎的发育与胎儿分娩等，任何环节的异常都有可能阻碍新生命的诞生。子宫内

膜是女性生殖系统中重要的组成部分，它对于受精卵着床和胚胎发育都起着至关重要的作用。然而，传统形态学观测方法难以准确确定子宫内膜的容受状态，随着分子诊断的发展以及“组学”概念的兴起，出现了一系列新型检测技术。本文主要阐述子宫内膜容受性分子检测方法的研究进展，这些方法利用分子生物学技术对子宫内膜细胞、基因、代谢产物和微生物等方面的特征进行检测，从而更加准确地评估子宫内膜的容受状态。

【关键词】 不孕症； 胚胎植入； 分子诊断技术； 生殖技术，辅助； 子宫内膜容受性； 种植窗

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Research progress on molecular detection methods of endometrial receptivity

Peng Kexin, Zhao Zihan, Zhang Hui, Liu Jiang

Department of Reproduction and Genetics, the First Affiliated Hospital of Kunming Medical University, Kunming 650032, China

Corresponding author: Liu Jiang, Email: liujiang6787@163.com, Tel: +86-871-65324888

【Abstract】 The human reproductive process includes the generation and transport of gametes, the production and implantation of fertilized eggs, as well as the development of embryos and the birth of fetuses. Any abnormality in any of these steps may hinder the birth of new life. The endometrium is an important component of the female reproductive system, playing a crucial role in the implantation of fertilized eggs and embryo development. However, traditional morphological observation methods are difficult to accurately determine the receptive state of the endometrium. With the development of molecular diagnostics and the emergence of the concept of "omics", a series of novel detection techniques have been introduced. This article mainly elaborates on the research progress of molecular detection methods for endometrial receptivity, which use molecular biology techniques to detect characteristics of endometrial cells, genes, metabolic products, and microorganisms, aiming to more accurately evaluate the receptive state of the endometrium.

【 Key words 】 Infertility; Embryo implantation; Molecular diagnostic techniques; Reproductive techniques, assisted; Endometrial receptivity; Window of implantation

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