Air Quality in IVF Clinics

and the trend towards Continuous Monitoring

Dr Ruairi Monaghan

Intro

IVF clinics, especially the laboratories wherein embryo processing occurs, have become highly controlled environments in recent decades. This is a direct output in relation to scientific research based around confounding factors that have been shown to negatively affect embryonic development.

As a background, gametes and embryos are especially sensitive to environmental influence. The reason for this is that they are largely unprotected, lacking in epithelial surfaces, immunological defences, and detoxifying mechanisms. Although typically housed in a controlled incubation environment system throughout their development, they must periodically be interacted with. During these interventions, the gametes/embryos may be exposed to harmful products present in the laboratory environment. As an example, perfumes and cosmetics are discouraged for personnel working with the gametes/embryos, and disinfectants used on the systems or areas near the incubators need to be compatible with IVF labs, highlighting how delicate the immediate environment around these incubators can be [1].

Herein we put forth the importance of continuous real-time air monitoring of these IVF environments, focussing specifically on VOCs, particulates and viable microorganisms [2-6].

Background Research

Improved air quality in IVF laboratories has shown to increase embryo yields and positively affect a variety of aspects of the IVF process [2-6]. However, a governing set of standards isn't mandated globally, at least not currently. When referring to air quality in IVF laboratories, Sciorio et al [2] mentions, '*specific regulatory frameworks mandating air quality control are limited, as are evidence-based guidelines*.' In Europe, the European Society of Human Reproduction and Embryology (**ESHRE**) has a set of guidelines [1] (**Air Quality referenced in section 3.2**) that layout the ideal environment of an IVF laboratory. ESHRE quote IVF clinics should maintain GMP grade A, or at the least GMP grade D (**international standard ISO 14644-1 classes 5 and 8, respectively**) for laboratories where embryo work is ongoing.

A paper by Esteves SC and Bento FC [3] details why this level of laboratory control can be very important. The implementation of cleanroom level control (**specifically the Brazilian Cells and Germinative Tissue Directive, ISO class 5 equivalent**) in an IVF clinic led to an increase of roughly 38% in live birth rates, and a 30% reduction in miscarriage rates also. The reasons behind losses are complex in nature, from exposure of the mother to certain pathogens/particulates/chemicals after insemination as well as exposure of the gametes/embryos during growth in the clinic before insemination, but it was put forth that the generation of healthier embryos was the most likely causality of the improvement in this study. It should be noted that the Brazilian standard in this case, while similar to European standards (**GMP grade A or ISO 14644-1 class 5**), also included VOC filtering using an activated carbon filtration system. So, it is not purely particulate and microbe based, but inclusive of the total air quality.

In another study, Dr Palter et al [4] describes how the introduction of air purification technology into several IVF clinics created a strong positive outcome. The literature describes an increase in Blastocyst conversion rate (BCR), fetal cardiac activity (FCA), and ongoing pregnancy (OP) rates overall, as well as an overall decrease of ~27% in loss rate (LOR).

Air quality in an IVF laboratory can be affected by a range of sources, some of which may be external to the laboratory itself. VOCs (as well as particulates and microbes) for instance can ingress into adjacent rooms/buildings. As an example, a paper by Hall et al [5] detailed how adjacent resurfacing of a parking area led to a large spike in Aldehydes in an IVF laboratory. Upon further investigation into how exposure of these aldehydes could affect the embryos, it was shown that an elevated presence in the culture environment had a large detrimental effect on the cell's development.

VOCs, particulates, and microbial pathogens are all highly detrimental to the embryo development. Borges et al [6] details the reasons why microbial monitoring should be adopted (even though not always mentioned in lab control standards) as the potential outcomes of a microbial infection can be catastrophic for the developing embryo.

Traditionally, much of the air monitoring in laboratories was performed as spot checks, as opposed to continuous monitoring. But with this, there were instances where outbreak events, or failings/breakdown in the environmental control systems, would be missed. And it is during these events that it would be most detrimental to proceed with embryonic interactions. With ongoing monitoring and alerting, staff are made aware of when not to interact with the embryos, allowing instead for preventative action to be undertaken to ensure the environment is appropriate.

Application of Technology

Real-time continuous monitoring of particulates, viable microbes and VOCs can therefore help to assist in the overall process of improving IVF outcomes. By understanding the laboratory environment, and being immediately alerted to issues arising as they happen, it can ensure added stability to the overall process. Air handling issues, particulate and VOC ingress, and temporary microbe outbreaks, can all be reported in real time to operational management, and displayed in a way that can help adapt the laboratory practices for the better.

For more information, visit glan-air.com

References

[1] '*The Revised guidelines for good practice in IVF laboratories (2015)',* ESHRE Guideline Group on good practice in IVF labs

[2] Sciorio R, Rapalini E, Esteves SC. *Air quality in the clinical embryology laboratory: a mini-review*. Therapeutic Advances in Reproductive Health. 2021; 15.

[3] Esteves SC and Bento FC. *Implementation of air quality control in reproductive laboratories in full compliance with the Brazilian cells and germinative tissue directive*. Reprod Biomed Online 2013; 26: 9–21.

[4] Palter S, et al. *multi-center study: innovative control of ambient air quality in multiple IVF laboratories is associated with statistically significant improvements in clinical outcomes - analysis of 5319 cycles*. Fertility and Sterility, Vol 106, Issue 3 Supplement, pp e27-28

[5] Hall J, Gilligan A, Schimmel T, et al. *The origin, effects and control of air pollution in laboratories used for human embryo culture*. Hum Reprod 1998; 13(Suppl. 4): 146–155.

[6] Borges ED, et al. *Microbial contamination in assisted reproductive technology: source, prevalence, and cost.* J Assist Reprod Genet. 2020; 37(1): 53-61.