

A Review on Effects of Air Borne Particles and Volatile Organic Compounds (VOC's) On Gametes and Embryos

*Ms. Arshdeep kaur, **Mr. Saurabh

(Asst. Embryologist, Arti fertility and gynae center, Jalandhar city),

Chief Embryologist, Navchetan Multicpeciality Hospital, Pathankot, Punjab, Freelance Embryologist)

Date of Submission: 01-08-2021

Date of Acceptance: 14-08-2021

ABSTRACT: Assisted Reproductive Technology laboratory is a sterile area in which positive or filtered air is filled inside the laboratory. Different types of Volatile organic compounds (VOC's) such as Ethyl alcohol, formaldehydes, glutaraldehyde can affect the morphological characteristics of Gametes, fertilization rates, quality of embryo and Implantation rates as well. Higher the presence of Volatile organic compounds (VOC's), air particles lesser will be the success rates. Presence of any type of microorganisms can also disturb the whole ICSI/IVF cycle. So the removal of Volatile organic compounds (VOC's), air particle, Microorganisms and any type of toxic compound is a major step to get the best outcomes.

Objectives: To check the effects of air particles, volatile organic compounds (VOC's) on fertilization and quality of embryo.

Keywords: ART, Volatile organic compounds (VOC's), CODA, HEPA, ICSI, IVF, Blastocyst.

I. INTRODUCTION

Assisted Reproductive Technology (ICSI/IVF) laboratory is the area in which we do all the work in optimum, controlled air borne particles and volatile organic compounds (VOC's) (1). The air surrounding inside the working area of

ICSI/IVF laboratory carries different types of Volatile organic compounds such as Ethyl alcohol, formaldehydes, glutaraldehyde, bacteria, Air borne particles and all are found to be as a highly toxic compounds for gametes and embryos. During the growth and development of the embryos VOC's will directly attach to the DNA and disrupt the growth (2).

It is very important to maintain the filtered environment through different types of filtration units or with the help of Air handling units inbuilt with different types of filters. The presence or absence of the air borne particles and volatile organic compounds (VOC's) depends upon the different factors such as HVAC system, the quality and making of the equipments used in the ICSI/IVF laboratory, materials used to design the laboratory (includes paint, flooring etc), disposables to be used (non toxic or toxic) (3).

All types of volatile organic compounds (VOC's) are not toxic for gametes and embryos such as silicones in some CO2 incubators silicones gaskets, tubing used to maintain the rigidity of the parts. There are many techniques are generally used to check the range of the volatile organic compounds (VOC's) like Gas chromatography or gas chromatography mass spectroscopy.

Volatile organic compounds (VOC's)	Mean AIHA
Ethanol (ethyl alcohol)	18–100 ppm
Isopropyl alcohol (2-propanol)	19–43 ppm
Acetone	62–130 ppm
Formaldehyde	0.03–9970 ppm
Acetaldehyde	0.067 ppm

The main sources of volatile organic compound inside the laboratory working area are laboratory fabric, consumables, gases used in the incubator to maintain osmolarity, contaminants

from the Air conditioners used inside the laboratory, sterility of the disposables to be used. All types of volatile organic compounds dissolve in

the culture medium used for handling the gametes and embryos which can affect the development (4).

II. REVIEW OF LITERATURE

One of the studies shown that human gametes and embryos are highly sensitive to contamination, Laboratory environmental VOCs (Alcohol and acetone), inorganic gases (carbon monoxide), components related to laboratory equipment such as adhesives, perfumes, deodorants, Paint and other cleaning products. Detergents and disinfectants used in labs are responsible for the release of Aldehydes, which can impair embryonic development (5, 6). Several studies have shown that using the CODA air filtration system in human IVF laboratories has improved pregnancies, but the morphological quality of embryos has not improved (7,8).

In 2004, Forman M et al., conducted a study and it was concluded that after using the HEPA system with high activated carbon, potassium permanganate filter and CODA, air quality improved as well as VOCs and aldehydes were reduced (9).

In 2002, Worrilow et al., reported that the Infertility clinic located in one of the state in china using CODA system in their laboratories from many years but they did not find any improvement in fertilization and pregnancy rates. Due to located at the one side of the river Guangzhou city's air quality is high, VOCs are high and the climate was hot and high level of humidity. The filters get saturated in advance and some VOCs cannot be removed. (10).

In year 1997, Cohen et al., studied the effects of chemical contamination on ICSI/IVF outcomes under different conditions. In this study, a new IVF laboratory was built on one of the busiest streets in southern Italy, which is known for its high industrial emissions and stagnant air. At the beginning of the clinical work, they found fall in success rates, but after the installation of push air through a water-filtered gas bottle, the success rates were returned to average. After some time they want to increase the success rates so they installed solid carbon and potassium permanganate filters in the IVF laboratory to remove adhesive and paint smells and other pollutants. One more study conducted on 1400 patients during the period of 16 months (after the installation of solid carbon and potassium permanganate filters) they found increased Implantation and fertilization rates from 22% to 36% (11).

In 2015, Munch et al., conducted a deep study to evaluate the fertilization, cleavage, blastocyst and clinical pregnancy and live birth rates with and without carbon filtration units. It was found that if the activated carbon filter was not replaced by mistake, the fertilization rate, cleavage and blastocyst formation of the fresh IVF were significantly reduced. They also found that after installing a new activated carbon filter, success rates can be increased. The lack of activated carbon air filtration can affected the development of embryos, especially, during the fertilization period because Oocytes are quite sensitive they can't tolerate air quality changes (12).

In 2011, a study conducted by EPA united states environmental protection agency, in which a new type of air filtration system consisting of specially treated honeycomb matrix media installed in the laboratory. This newly developed technology significantly improved the air quality of the ICSI/IVF laboratory by reducing VOC levels and air particle inside the working area in addition to improving IVF results which determined by embryo quality, fertilization, pregnancy and implementation rates (13).

III. CONCLUSION

Improving the environmental conditions and air quality of the IVF laboratory has a great positive impact on laboratory parameters such as decreased contamination rates, higher Fertilization rates, higher numbers of good quality embryos, lesser fragmented embryos, and higher clinical results. Time to time Replacement of the air filtration system to improve air quality by reducing the number of environmental particles (Volatile Organic Compounds, Air particles, microorganisms) is the most important part of the ICSI/IVF Laboratory.

Total VOCs in IVF labs should be less than 500 $\mu\text{g}/\text{m}^3$ and aldehydes should be less than 5 $\mu\text{g}/\text{m}^3$. For the removal of VOCs, an activated carbon or potassium permanganate filters must be installed in the ICSI/IVF laboratory for air treatment. HVAC system should be repaired annually or more frequently (depends upon the load). Exposed packaging, toxic materials should not be included in the assisted reproductive technology. For example, cardboard packaging is a source of fibers, particles, dirt, and fungal spores. Avoid personal care products that release VOCs and air particle such as cleaning products, air fresheners, cosmetics, perfumes, desserts, nail

polish and concentrated or pure ethyl alcohol based hand sanitizers.

REFERENCES:

- [1]. Esteves SC, 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.
- [2]. Heitmann RJ, Hill MJ, James AN, Schimmel T, Segars JH, et al. Live births achieved via IVF are increased by improvements in air quality and laboratory environment. *Reprod Biomed Online* 2015; 31: 364–71.
- [3]. Wale, P.L., Gardner, D.K., 2016. The effects of chemical and physical factors on mammalian embryo culture and their importance for the practice of assisted human reproduction. *Hum. Reprod. Update* 22, 2–22)
- [4]. Environmental Protection Agency, 1999. Air Method, Toxic Organics-15 (TO-15): Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. In: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS), Second ed. Washington, DC. www.epa.gov/homeland-security-research/epa-air-method-toxic-organics-15-15-determination-volatile-organic. EPA 625/R-96/010b.
- [5]. Brown SK. Chamber assessment of formaldehyde and VOC emissions from wood-based panels. *Indoor Air*. 1999;9:209–15.
- [6]. Hall J, Gilligan A, Schimmel T, Cecchi M, Cohen J. The origin, effects and control of air pollution in laboratories used for human embryo culture. *Hum Reprod*. 1998;13(Suppl4):146–55.
- [7]. Mayer JF, Nehchiri F, Weedon VM, Jones EL, Kalin HL, Oehninger SC, et al. Prospective randomized crossover analysis of the impact of an IVF incubator air filtration system (coda, GenX) on clinical pregnancy rates. *Fertility and Sterility Suppl*. 1999;1:S42–3.
- [8]. Racowsky C, Jackson KV, Nurredin A, Balint C, Shen S, de los Santos MJ. Carbon-activated air filtration results in reduced spontaneous abortion rates following IVF. *Proceeding of the Eleventh world congress on in vitro fertilization and human reproductive genetics*; Sydney Australia 1999.
- [9]. Forman M, Polanski V, Horvath P, Gilligan A, Rieger D. Reductions in volatile organic compounds, aldehydes, and particulate air contaminants in an IVF laboratory by centralized and stand-alone air filtration systems. *Fertil Steril*. 2004;82(2):S324.
- [10]. Worrilow KC, Huynh TH, et al. A retrospective analysis: seasonal decline in implantation rates and its correlation with increased levels of volatile organic compounds. *Fertil Steril*. 2002;78(1):S-39
- [11]. Cohen J, Gilligan A, Esposito W, et al. Ambient air and its potential effects on conception in vitro. *Hum Reprod* 1997; 12: 1742–1749.
- [12]. Munch EM, Sparks AE, Duran EH, et al. Lack of carbon filtration impacts early embryo development. *J Assist Reprod Genet* 2015; 32: 1009–1017.
- [13]. EPA: united states environmental protection agency: An introduction to indoor air quality (IAQ), Volatiles organic compounds (VOCs), <http://www.epa.gov/iaq/voc.html>.