ENGLISH VERSION

Research laboratory / team : ICCF- UMR CNRS 6296 – Equipe MPS

Thesis supervisor :

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PhD Thesis Title:

Container–content interactions between medical devices used in assisted reproductive technologies (ART) and contact media: study under simulated use conditions

PhD Thesis Summary:

Medical devices used in assisted reproductive technologies (ART), such as in vitro fertilization (IVF) or intracytoplasmic sperm injection (ICSI), are primarily composed of polymeric materials (polystyrene, polycarbonate, polyethylene, etc.). While these devices comply with European medical device regulations, their detailed chemical characterization remains incomplete, particularly in light of their direct contact with sensitive biological media such as gametes and embryos.

These materials may release a wide range of chemical compounds, including additives (plasticizers, antioxidants…), degradation products, or non-intentionally added substances (NIAS). Identifying these compounds is a prerequisite for any risk assessment.

This PhD project is positioned at the crossroads of materials engineering and analytical chemistry, and aims to:
• Identify critical materials and devices used at key stages of ART procedures,
• Conduct a comprehensive study of extractable substances using standardized extraction methods to map potentially leachable compounds,
• Select, from this pool, substances with known or suspected toxicological profiles (e.g., CMR substances, endocrine disruptors),
• Investigate the migration of these substances under simulated clinical use conditions,
• Build an analytical database useful for device qualification and the optimization of selection practices in sensitive biomedical contexts.

This work lies at the interface between materials science, analytical chemistry, and process engineering applied to health technologies.

Thesis Objectives

1. **Map the main steps of ART procedures (IVF/ICSI)** to identify the medical devices used and the critical parameters (contact time, temperature, media, etc.).
2. **Select a representative panel of devices** based on their clinical use and polymeric composition.
3. **Perform an extractables analysis** using reinforced extraction conditions (pH, solvents, temperature) to obtain a comprehensive profile of potentially leachable substances.
4. **Target priority compounds** based on their known or suspected toxicological risk profile.
5. **Conduct migration studies under simulated use conditions** to assess the amount and nature of substances released into relevant media.
6. **Implement sensitive and specific detection and quantification methods** (LC-MS/MS, GC-MS/MS, UV-fluorescence) adapted to the identified compounds.
7. **Build a structured technical database** to support quality control and qualification of medical devices used in ART.

Expected Outcomes

- Robust methodologies for extractables and leachables analysis in ART-related devices
- Data on the nature, frequency, and quantities of released substances
- A rational selection of priority substances to monitor in sensitive biomedical contexts
- Decision-making tools for manufacturers, IVF laboratories, and regulatory bodies

Techniques Used

- Solid-liquid extraction under reinforced conditions (simulants, solvents, temperature)
- Liquid chromatography with UV and fluorescence detection
- Gas chromatography – tandem mass spectrometry (GC-MS/MS)
- Liquid chromatography – tandem mass spectrometry (LC-MS/MS)
- Sample preparation, conditioning, and analysis of complex materials

Project Location

The project will be conducted within the **UMR CNRS 6296 "MPS" (Materials, Processes, Sciences)** team, based at the Faculty of Medicine and Pharmacy in Clermont-Ferrand, in collaboration with partner analytical platforms and clinical stakeholders involved in ART practices.