

## Editorial

# The Expanding Horizon of Maternal-Fetal Medicine: From Preconception to Intrapartum Care, Integrating Risk Assessment, Prenatal Diagnosis, and In-Utero Therapy

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The field of maternal-fetal medicine (MFM) has undergone a remarkable transformation in recent years, progressing from primarily diagnostic services to increasingly sophisticated therapeutic interventions. Today's MFM experts are integral members of multidisciplinary teams, capable of identifying and addressing complications before conception, throughout pregnancy, and even through direct fetal interventions. Recent developments in genomics, advanced imaging, and minimally invasive surgical fetal techniques have indeed represented a paradigm shift in MFM by fundamentally improving outcomes for those families facing high-risk pregnancies and fetal abnormalities.

Contemporary MFM's primary aim is to support human reproduction by both decreasing maternal, fetal and infant mortality while addressing preventable morbidity. Improving outcomes in this setting often requires a multidisciplinary approach, supporting efforts across multiple strategic avenues. First, a preventive preconception counselling should be mentioned. Thus, the journey of contemporary MFM needs to begin before pregnancy itself, through evidence-based proactive interventions that allow to understand, plan and mitigate risks before conception occurs. The shift toward pre-gestational interventions represents more than technical progress; it reflects a fundamental reimagining of reproductive healthcare. Rather than simply responding to complications as they arise, a multidisciplinary team involving reproductive medicine experts and maternal-fetal medicine specialists now work collaboratively with patients to identify risks and develop comprehensive management strategies before conception. This approach has profound implications for patient autonomy and informed decision-making, allowing families to enter pregnancy with greater knowledge and preparation. Effective implementation requires the involvement of general practitioners and physicians caring for individuals of reproductive age, to ensure timely preconception referrals and access to specialized care when needed. Early education on fertility, starting in adolescence, will be critically important to promote timely pregnancies and reduce risks linked to advanced maternal age. At this stage, oocyte freezing for

social reasons should be offered to the growing number of women who wish to preserve their fertility while postponing conception due to health concerns, educational commitments, or work-related obstacles. This approach may result in improved oocyte quality at the time of pregnancy and enhanced placentation, potentially decreasing the risk of placental dysfunction and chromosomal abnormalities due to advanced maternal age, reducing the need for oocyte donation. Other preventive strategies during the pregestational phase may be implemented such as promotion of adequate nutritional counselling and vitamin supplementation (e.g., folic acid and vitamin D), as well as, appropriate vaccination assessment. Prenatal genetic investigations should be offered when there is a relevant familiar history or even in those couples interested in carrier screening [1]. This step will broaden the application of pre-implantation genetic diagnosis, extending it beyond a tool to improve *in vitro* fertilization (IVF) pregnancy rates to a cutting-edge option in pre-gestational maternal-fetal medicine. Finally, pregestational identification and optimization of chronic conditions such as obesity, diabetes mellitus and chronic hypertension would be a further step brought forward. This work will broaden the understanding of complications associated with pregnancies in women of advanced maternal age, with chronic morbidities, or conceived through medically assisted reproduction, and will also highlight the role of reproductive surgery in correcting genital abnormalities prior to conception.

Second, once pregnancy is established, contemporary MFM offers an increasingly sophisticated array of diagnostic tools that have dramatically improved our ability to detect and characterize maternal and fetal conditions. Perhaps one of the most significant recent advancement in prenatal diagnosis has been the development of non-invasive prenatal testing based on cell free fetal DNA which is consistently expanding its field of action to include detection of copy number variations and rare genetic diseases, to the extent of investigating zygosity in twins. This technology has revolutionized prenatal screening by providing highly accurate results without the risks associated with more in-



vasive procedures. The genomic medicine revolution has enhanced our ability to detect chromosomal abnormalities and genetic disorders early in pregnancy. At this stage, ultrasound-based diagnostics in pregnancy should be implemented early to timely detect fetal abnormalities, in order to identify conditions that may benefit from intervention, either before birth or immediately after delivery and by further expanding indications for in-utero interventions.

In fact, perhaps the most dramatic evolution in MFM has been the development of fetal therapeutic interventions, both surgical and/or medical. Fetal therapy is now offering a wide range of innovative procedures from treating fetal arrhythmias to performing in-utero surgical repairs for conditions such as open spina bifida [2,3]. These interventions can significantly reduce the risk of short-term complications while improving long-term outcomes, changing the prognosis for conditions that were previously untreatable until after birth. However, this approach occurs within a careful multidisciplinary framework that balances the potential benefits of intervention against the risks to both mother and fetus.

Furthermore, prediction and prevention of preterm birth (PTB) is a changing paradigm with a shift from a gestational age-based definition to a novel taxonomy capable of defining this complex syndrome based upon different phenotypes and etiologies [4]. More so, prediction is now relying on novel risk factors among which placental dysfunction and abnormalities appear critical [5,6].

Finally, there will be the need to transfer concepts of MFM into the final stages of obstetric practice including intrapartum care: producing reliable quantitative risk assessment for both mother and fetus, reducing emergent accesses and increasing planned deliveries with a tailored and safe approach aimed at minimizing obstetric complications.

Today, in the absence of contraindications, induction of labor is a safe procedure that can improve both intrapartum and postpartum outcomes [7]. On this end, research will need to work on individualization of labor timing and management to improve maternal outcomes while minimizing risks of fetal distress and neonatal acidemia, and this was recently performed assessing placental function by angiogenic factors or by the FMF method for preeclampsia (PE) screening [8–10]. Galileo wrote that math is the language of Nature, and this is currently as true as ever as we keep developing models providing mathematical translations of complex biological mechanisms in order to predict risks in pregnancy and labor while adopting timely preventive measures.

Emphasizing training and education is essential for preparing future experts in MFM. Fellowship programs should prioritize developing a strong foundation in ultrasound skills.

In the meantime, research should concentrate on prediction of maternal and fetal adverse outcomes of which many are still not sufficiently investigated and predicted,

such as preterm birth and dysfunctional placentation leading to an array of adverse maternal and neonatal outcomes including preeclampsia, premature birth (both spontaneous or medically indicated), fetal growth restriction, and still-birth.

We look forward to a time in which we can accurately predict, diagnose, manage and prevent obstetrics complications through personalized, tailored procedures and interventions.

## Author Contributions

PIC designed the editorial topic and idea and revised the manuscript, corrected the proofs. SG and GB drafted the manuscript and contributed to the intellectual content. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

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