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Roberto Caldeyro-Barcia – a pioneer in obstetrics

IN BYGONE DAYS

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Through his interest in physiology and research, Roberto Caldeyro-Barcia helped advance the understanding of perinatal care. He studied foetal monitoring and the impact of labour on neonates, while also emphasising the importance of treating maternity patients and their families with respect and providing support.

It is now widely recognised that effective monitoring of labour progression is crucial for preventing serious complications. However, this has not always been the case, as good obstetric care requires a fundamental understanding of the physiology of the feto-placental unit and knowledge of the importance of social and environmental factors.

In the early 1950s, most births took place in delivery rooms in rural areas or in hospital labour suites. The fetus was monitored during labour using simple instruments. During the pushing stage, the woman had to lie flat on a delivery bed while midwives listened to the baby's heartbeat with a stethoscope and checked uterine contractions by palpating the abdomen. Fathers were rarely present during the birth, and neonates were kept in a separate room and brought to their mothers only for breastfeeding – typically every four hours (1).

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The introduction of biophysical and biochemical techniques for foetal monitoring in the 1950s and 60s led to a significant improvement in the health of neonates. The Uruguayan doctor Roberto Caldeyro-Barcia (1921–96) was a key pioneer in establishing modern electronic labour monitoring, which is still used worldwide. He ensured that basic pregnancy physiology was applied in practice for the monitoring, diagnosis and treatment of maternity patients and neonates (2, 3).

Who was Caldeyro-Barcia?

Roberto Caldeyro-Barcia was born in Montevideo in 1921. He was from an academic family and attended an English school in Montevideo (4). In 1947, he graduated with distinction in medicine from the University of Montevideo. He chose to become a researcher in physiology after being inspired by the discoveries of Louis Pasteur (1822–95) in microbiology and Claude Bernard (1813–78), the founder of experimental medicine (4). After studying physiology both in Uruguay and abroad during the 1940s and 50s, he was appointed professor of physiology at the University of Montevideo in 1961 (3, 4) (Figure 1).

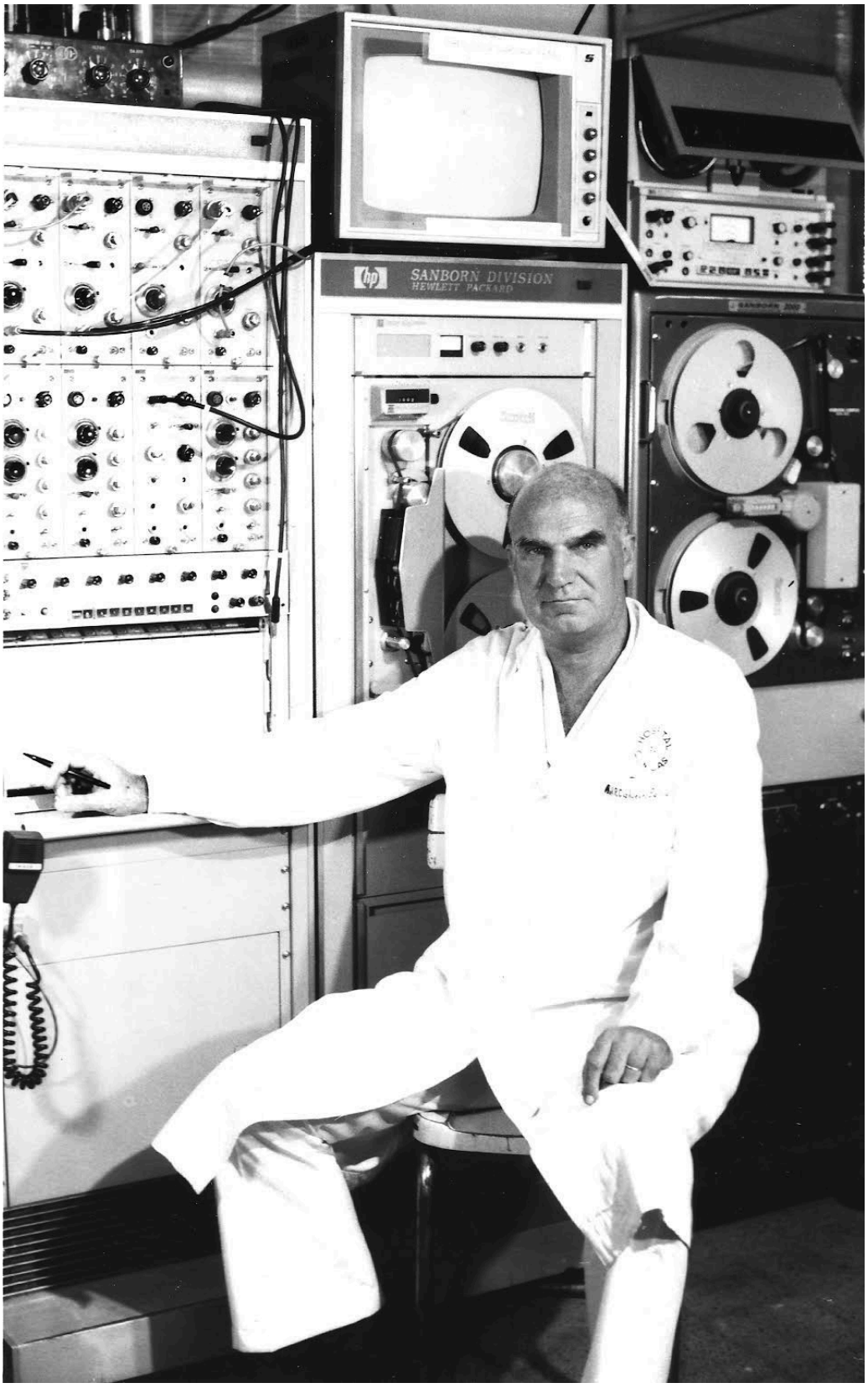

Figure 1 Roberto Caldeyro-Barcia in 1971. Photo: private (reproduced with the family's permission).

Together with Dr Hermógenes Alvarez (1934–95), Caldeyro-Barcia recorded intrauterine pressure by placing balloons inside the uterus. The pressure was measured using what subsequently became known as Montevideo units (MVU) (4) (Figure 2). The purpose was to assess uterine activity, calculate the effectiveness of uterine contractions and identify early signs of intrauterine

foetal hypoxia. This method later provided a better understanding of pregnancy physiology and was described in the Norwegian obstetrics textbook *Propedeutisk Obstetrikk* by Knut Bjøro and Kåre Molne in the 1970s (5).

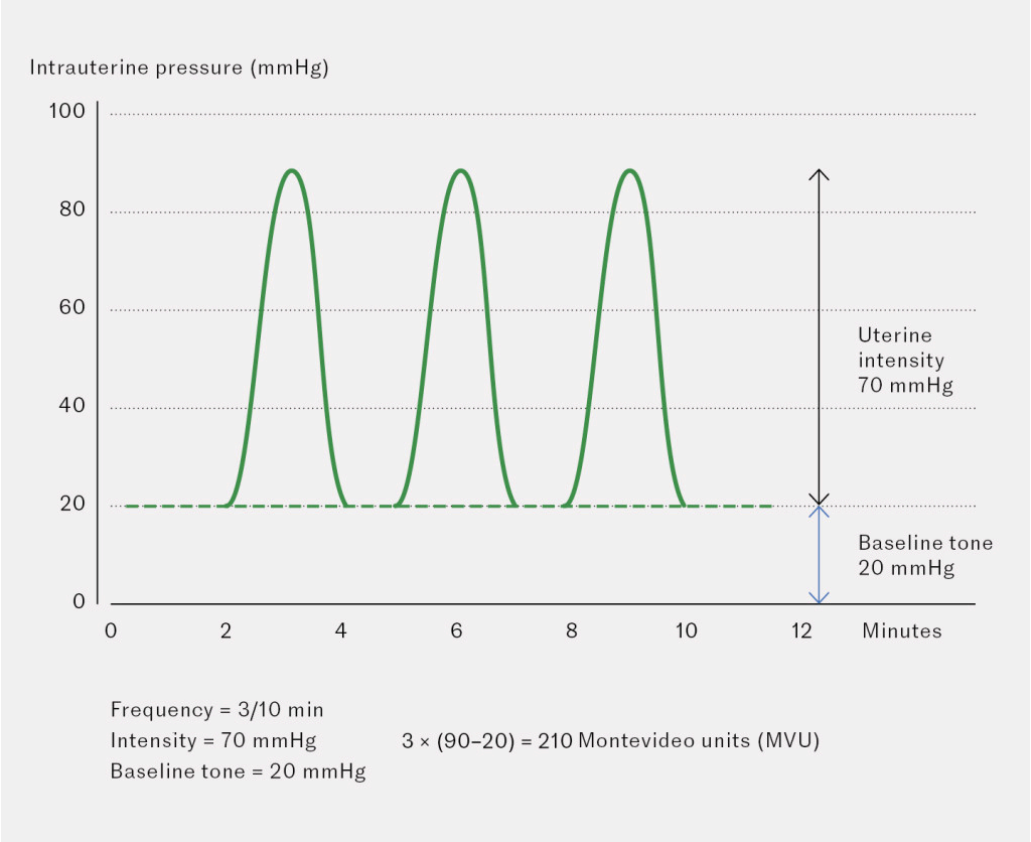

Figure 2 Montevideo units (MVU) are a standard measurement of uterine activity during labour, with a value of 200 MVU considered normal.

Uterine activity was recorded using a small spring-loaded piston, or a sensor, which was attached to the mother's abdomen in the fundal area. Internal monitoring was performed via a catheter inserted into the amniotic cavity after the membranes had been ruptured (5, 6) (Figure 3). The pioneering work of Caldeyro-Barcia led to the development of electronic foetal monitoring during labour, with the aim of tracking foetal heart activity to identify foetal hypoxia. In modern clinical practice, external transducers are the most widely used method for foetal monitoring (7).

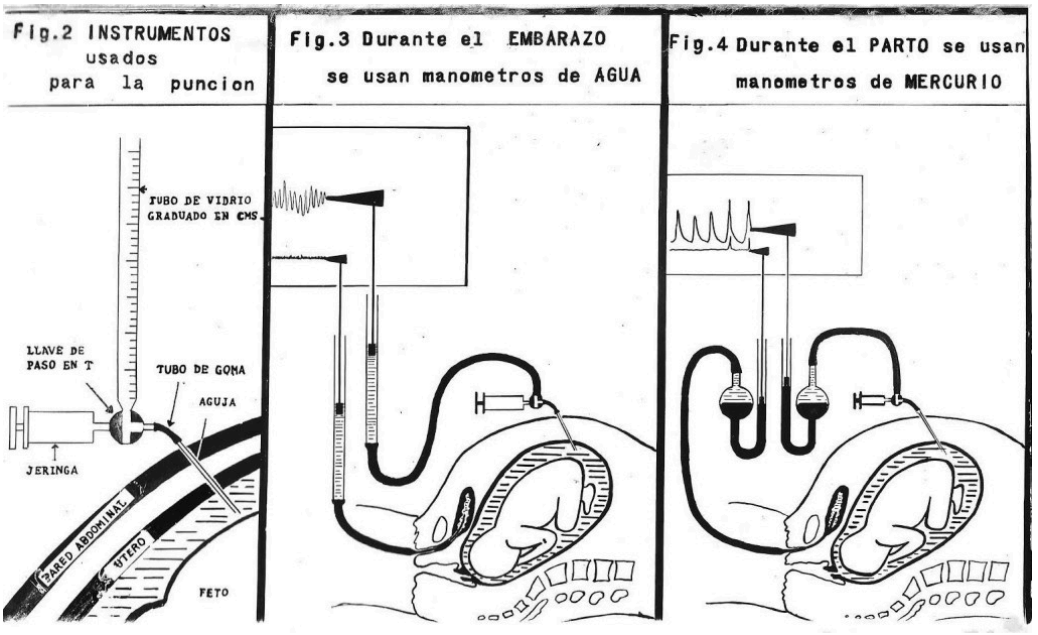

Figure 3 Roberto Caldeyro-Barcias' doctoral work *Contractility of the human uterus during pregnancy and childbirth*. Photo: private (reproduced with the family's permission).

The physiology and significance of uterine contractions

Roberto Caldeyro-Barcia worked with a dedicated team to deepen the understanding of the fundamental nature of uterine contractions. They demonstrated that rhythmic, strong contractions of the uterus help to open the cervix and push the fetus through the birth canal. In 1949, Alvarez and Caldeyro-Barcia were the first to measure the increase in intrauterine pressure caused by such contractions (4, 8).

To quantify progress during labour, Caldeyro-Barcia developed MVU (3, 4), which are a standard measure of uterine activity during labour, with a value of 200 MVU considered normal. This corresponds to a total pressure change of approximately 27 kPa over a ten-minute period. The measurement is calculated by taking the peak pressure during each contraction (in mmHg), subtracting the uterus's resting pressure and tallying the results for all contractions within ten minutes (4). In a normal labour, intrauterine pressure ranges from 95 to 395 MVU.

Roberto Caldeyro-Barcia's research on pressure changes during labour and how uterine contractions affect the fetus led to the development of new techniques for foetal monitoring (9). In the 1960s, Edward Hon (1917–2006) from California contributed to the early development of continuous intrapartum cardiotocography (CTG) based on Caldeyro-Barcia's concept, and Konrad Hammacher (1928–2001) from Düsseldorf developed the first CTG prototype (10). This technology was further developed into electronic foetal monitoring and the widespread use of Doppler ultrasound during labour. Internal monitoring using a scalp electrode reduces the risk of mixing up the mother's and fetus's heart rates. It also allows for higher-quality recordings and is

therefore preferred following membrane rupture or amniotomy. In healthy women with uncomplicated pregnancies, intermittent auscultation is used during contractions and for at least 60 seconds after, using a midwife's stethoscope or Doppler device. The Pinard horn has largely been replaced by the handheld Doppler foetal heart monitor.

Alvarez and Caldeyro-Barcia demonstrated a linear correlation between oxytocin dosage and effective contractions (11). This confirmed Norman Jeffcoate's (1907–92) theory that ineffective labour was due to uncoordinated uterine contractions. Jeffcoate's description of early, isolated and unsynchronised regional contractions is still relevant when assessing the effectiveness of labour contractions (12).

Safe use of oxytocin

In the early 1950s, Caldeyro-Barcia classified foetal heart rate decelerations during uterine contractions. Based on a study of 1345 maternity patients, he classified foetal bradycardias as type 1 or type 2 dips, with type 2 posing a risk to foetal health and indicating the need for intervention (11). His work led to new techniques for intrapartum foetal monitoring and quantitative measurements of the strength of uterine contractions during labour, as well as shedding light on the effect on uteroplacental perfusion (blood flow to the placenta) and the foetal heart response. Today, it is routine to assess type 1 dips (typically caused by head compression) and type 2 dips (related to hypoxia and reduced uteroplacental perfusion).

> ***«His work led to new techniques for intrapartum foetal monitoring and quantitative measurements of the strength of uterine contractions during labour»***

Caldeyro-Barcia evaluated foetal heart rate in utero as a parameter for foetal health during medically induced labour. He warned against uncritical use of oxytocin, as uterine hyperstimulation could lead to reduced placental perfusion. Using cardiotocography, he showed that 38 % of oxytocin-induced contractions resulted in type 2 dips, which indicated foetal acidaemia (8). Later studies have demonstrated that synthetic oxytocin causes stronger and more frequent uterine contractions, which may negatively affect the fetus due to maternal metabolic and autonomic responses (13).

In the 1960s, Caldeyro-Barcia and Erich Saling (1925–2021), a professor of obstetrics in Berlin, independently researched methods to delay premature labour using contraction-inhibiting medications known as tocolytics (10, 14). A 2022 Cochrane review found that the effects of tocolytics on perinatal mortality and neonatal infections are uncertain (15). Today, tocolytics are primarily used to delay labour long enough to allow the full effect of prenatal steroids in fetuses under 34 weeks' gestation. Delaying labour by 24–48 hours allows more time to plan and transfer the mother to a specialised neonatal intensive care unit (16).

In 1969, Caldeyro-Barcia held the Perinatal Factors Affecting Human Development Conference, where he presented his research findings (16). He had observed that the supine position led to more frequent but weaker uterine contractions, resulting in slower cervical dilation and an increased risk of foetal hypoxemia. He demonstrated that a more upright birthing position, where gravity increases pressure on the cervix and helps open the pelvis, leads to a more efficient labour. Among the aids described was the birthing chair (17). These findings remain relevant today. Upright positions (standing, kneeling or squatting) also ease breathing (18). During a normal vaginal delivery, women may assume various positions throughout labour. Today, most women choose their own position, but lying flat on their back is discouraged. Left lateral and supported positions are recommended, and most women give birth sitting upright in a delivery bed with their knees pulled up.

Humanisation of childbirth

Caldeyro-Barcia emphasised the support role of healthcare personnel during the natural childbirth process and warned against unnecessary interventions. Modern hospitals, such as University College Hospital in London, encouraged fathers to be present at the birth as early as 1951, but it was not until the late 1960s to the late 1970s that the number of men attending births gradually increased. Caldeyro-Barcia was among the first to involve fathers, helping to create a positive birth experience for expectant parents.

> *«Caldeyro-Barcia was among the first to involve fathers, helping to create a positive birth experience for expectant parents»*

Sociocultural attitudes and values have always had a strong influence on childbirth practices. Today, childbirth is understood not only as a medical event but also as a psychological, social and existential experience. Caldeyro-Barcia aimed to humanise childbirth and recognised the importance of the expectant mother's physical, mental and emotional well-being. Humanisation means respecting women's values, beliefs, feelings, dignity and autonomy during childbirth. Avoiding unnecessary interventions and applying evidence-based knowledge promotes a safe and humanised birth experience. In this regard, Caldeyro-Barcia was ahead of his time – a time that was still marked by rigid clinical practices and authoritarian, patriarchal attitudes both in the private and public health sector. His progressive views on women's rights to self-determination during childbirth sometimes met with resistance.

However, his work led to changes such as rooming-in, where mother and baby stay together in the same room around the clock. This allows the new mother and baby time to get accustomed to each other and bond. The mother also learns how to care for and feed her infant quicker, based on the baby's needs.

Caldeyro-Barcia also pioneered the establishment of perinatal observation units and dedicated maternity wards for low-risk births (4), which aligns with the approach many favour today in maternity care (19).

Knowledge dissemination

Caldeyro-Barcia ensured broad dissemination of his research findings and recommendations, ensuring they reached an international audience. He frequently warned against complications from the unnecessary use of technology (3, 4). From 1969, he was head of the Latin American Center for Perinatology. In collaboration with the World Health Organization, he helped create a supportive environment for new and expectant mothers worldwide (20). He also held numerous national and international positions. In 1987, he was involved in setting up the Basic Sciences Development Programme in Uruguay. This programme was created to help doctors who wished to return to Uruguay after leaving due to the military dictatorship that ruled the country from 1973 to 1985 (21).

> ***«In collaboration with the World Health Organization, he helped create a supportive environment for new and expectant mothers worldwide»***

Caldeyro-Barcia has been described as friendly, demanding, considerate and innovative. He was respected as an excellent teacher and team player (2, 3). He received numerous awards and honours, including a nomination for the Nobel Prize on three occasions (2). His methods for monitoring intrauterine pressure and the development of MVU advanced research on maternal and foetal health and improved the use of medical interventions during childbirth. He was a strong advocate for humanising the support and care for women during childbirth – a topic that will always be relevant.

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