Pioneer Profile – Marshall H. Klaus, MD

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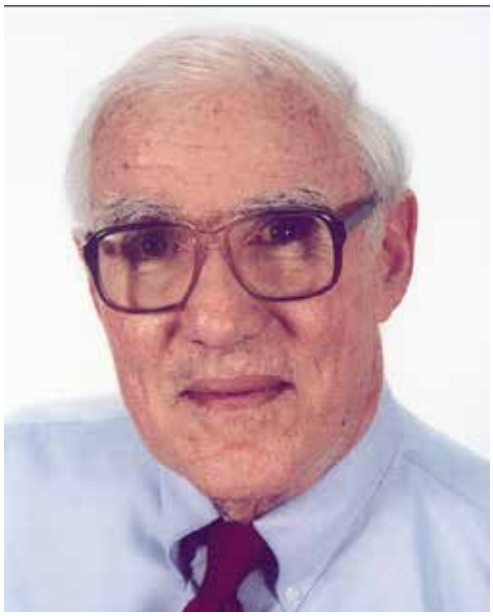

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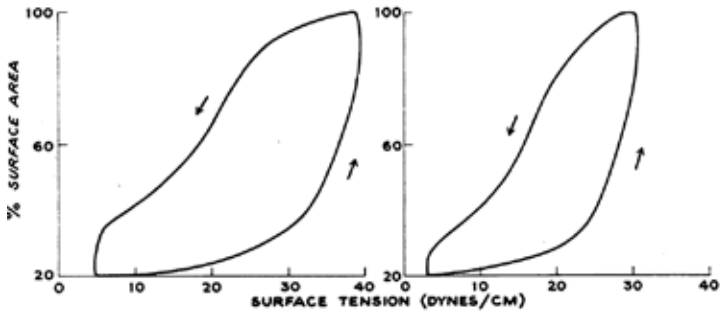
"Dr. Klaus was not content with private practice and took a pulmonary fellowship position with the Cardiovascular Research Institute at the University of California at San Francisco. He was mentored by some greats there, including Julius Comroe, MD, and John Clements, MD. It was there that he commenced his work on neonatal pulmonary physiology."

Marshall Klaus made enormous contributions to both neonatology and obstetrics. He was born and raised in Cleveland, Ohio, and attended Case Western Reserve University for both undergraduate and medical school education (1). He served his residency at what is now Rainbow Babies and Children's Hospital, then served in the Air Force, followed by a brief stint in private practice. Dr. Klaus was not content with private practice and took a pulmonary fellowship position with the Cardiovascular Research Institute at the University of California at San Francisco. He was mentored by some greats there, including Julius Comroe, MD, and John Clements, MD. It was there that he commenced his work on neonatal pulmonary physiology. Dr. Klaus was the lead author of a brief manuscript identifying the composition of pulmonary surfactant and demonstrating its characteristic hysteresis in a modified Wilhelmy balance (Figure 1) (2).

Dr. Klaus returned to Case Western as an Assistant Professor and continued his work on respiratory disorders in the newborn.

Figure 1. Surface tension–area diagrams measured on a modified Wilhelmy balance. The left is dried lung foam, and the right is lung phospholipid extract (2).



He described the morphology of the alveolar lining layer and elaborated on the relationship of alveolar surface tension to the alveolar radius (3). He was a co-author of a report on the first attempt at surfactant replacement therapy using aerosolized dipalmitoyl phosphatidylcholine (DPPC), which failed because DPPC is a waxy solid at body temperature (4).

Stanford University recruited Dr. Klaus back to the West Coast, where he was among the first to use prolonged mechanical ventilation with endotracheal intubation in neonates (5). Among his collaborators was Philip Sunshine, a legend in his own right. While at Stanford, Dr. Klaus observed that mothers whose infants had been ventilated for extended periods had difficult and abnormal bonding with their babies and sometimes demonstrated bizarre behaviors toward their infants, sparking a lifelong interest in maternal-infant bonding.

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In 1967, he was recruited back to Case Western as Neonatal Director, where he remained for the rest of his illustrious career. Again, early work involved the respiratory system. Dr. Klaus contracted polio while a medical student, which left him with a flail arm and weak leg. He was averse to the use of mechanical ventilation unless necessary. This led to a publication showing that intermittent bag and mask ventilation was effective in managing infants with respiratory distress syndrome (RDS) (6). I recall using this technique early in my training and practice years for infants with CO_2 retention. Intermittent bagging was used to bring $PaCO_2$ levels down.

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Another important innovation was developing a practical device for administering continuous positive airway pressure (CPAP) spearheaded by Dr. John Kattwinkel, one of Dr. Klaus' many mentees (7). This device was widely used for decades, and variations of it are still used in NICUs today. Another mentee, Richard Martin, MD, began his research career with Dr. Klaus, studying the effect of CPAP on the Hering-Breuer reflex and expiratory time (8, 9). A third mentee, Dr. Avroy Fanaroff, published seminal observations concerning insensible water loss in low-birth-weight infants and showed that the use of a heat shield placed within the single-walled incubators in use at the time greatly reduced insensible losses and improved the thermal environment (10). Observations such as these led to the double-walled redesign of infant incubators. Thus, Dr. Klaus and his early trainees made major contributions to the medical care of premature infants. As important as these contributions were, however, they pale in comparison to the truly monumental and revolutionary advances he pioneered in mother-infant bonding, which led directly to what we now call family-centered care.

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As far back as his residency days, Dr. Klaus had noted the improved family satisfaction with patient care when unlimited family visitation was allowed (1). In those times, family visitation was typically limited to a half hour per week, usually on Sundays. As mentioned earlier, he had also observed at Stanford the sometimes abnormal behavior of mothers whose infants had received prolonged mechanical ventilation. Once established at Case Western, he paired up with John H Kennell, MD, to study mother-infant bonding, forever changing the course of newborn infant care.

Together with colleagues, they described in detail the initial maternal behavior patterns when mothers were presented with their nude infants just after birth and noted that these patterns were different for term and preterm infants (11). The standard of care at the time was for mothers to have limited contact with their newborns. Klaus and colleagues showed that mothers who had extended contact with their infants spent significantly more time in the "en face" position and fondled their babies more often one month after birth than those who were in a standard-of-care group and that these differences persisted at one year of age (12, 13). It was further shown that speech patterns were different out to two years between the two groups, with the extended contact group having more complex and less commanding speech than the controls (14). The authors postulated that a "special attachment period shortly after birth" was essential for normal maternal-infant bonding. This led to suggestions for change to the standard practice of separating the mother from her baby for extended periods after birth (15, 16).

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Along with Avroy Fanaroff, Klaus and Kennell showed that mothers who visited their premature infants less often were more likely to have disorders of mothering and to abuse or neglect their children more than those who visited more often (17). This observation led to the publication of suggested guidelines for the care of the parents with a normal or high-risk neonate with an emphasis on unrestricted visitation (18, 19). Their recommendation for early mother-baby skin-to-skin contact eventually led to the kangaroo care model and unrestricted nursery visitation, now the standard of care worldwide. Klaus and Kennell also published an important study on the mourning response to the death of their newborn baby (20).

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Dr. Klaus was also an advocate for breastfeeding. He showed that more frequent breastfeeding led to increased milk intake and weight gain in babies in the first weeks after birth and that this

was also associated with lower serum bilirubin levels in the more frequent feeding group (21–23).

Working in Guatemala in collaboration with Dr. Roberto Sosa, Klaus and Kennell showed that the presence of a support person called a doula during labor led to significantly shorter labors, less need for augmentation of labor and cesarean section, and improved neonatal outcomes (24, 25). These observations were confirmed with a large randomized, controlled trial (RCT) in the United States and by a later review of eleven RCTs (26, 27).

Dr. Klaus authored several important books, the most notable of which is *Care of the High-Risk Neonate*, which he co-authored with Dr. Avroy Fanaroff and which most of us older neonatologists cut our teeth on and still recommend to trainees interested in newborn medicine (28). This book is now in its eighth edition. Other important books include *Maternal-Infant Bonding: The Impact of Early Separation or Loss on Family* (29), *The Amazing Newborn: Discovering And Enjoying Your Baby's Natural Abilities* (30), *Bonding: The beginnings of parent-infant attachment* (31), *Bonding: Building The Foundations Of Secure Attachment And Independence* (32), and *The Doula Book: How a Trained Labor Companion Can Help You Have a Shorter, Easier, and Healthier Birth* (33). He also produced a video, Amazing Newborn, showcasing the talents and abilities of newborn infants, proving there is more to the neonate than just brainstem responses (34).

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Dr. Klaus mentored numerous trainees. Four of them were most notably honored with the Apgar Award, the highest award bestowed by the AAP Section on Neonatal Perinatal Medicine (SoNPM): Drs. Avroy Fanaroff, John Kattwinkel, Wally Carlo, and Richard Martin. SoNPM also annually bestows the Marshall Klaus Perinatal Research Awards of $5,000 each plus travel expenses to trainees in four categories: Bench or Clinical Research (up to 12 per year), Health Services Research (up to 2 per year), and one each per year for Education Research and Necrotizing Enterocolitis Research.

Dr. Klaus received numerous obituaries upon his death, including from *Pediatric Research* (1), *Acta Paediatrica* (35), *The New Your Times* (36), Lamaze International (37), and numerous other news and society publications. He contributed as much as anyone ever to the evolution and modernization of newborn care and founded what we now call family-centered care.

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