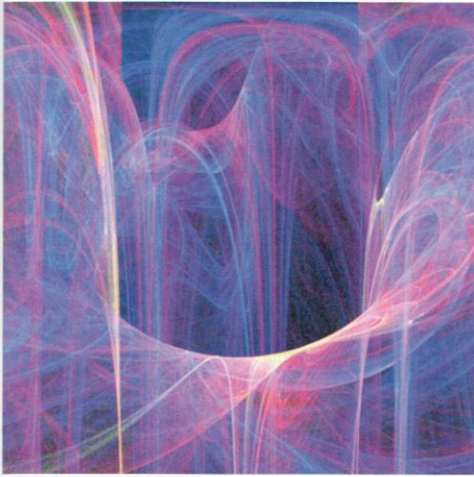


★ Chaos and complexity — a discussion of the impact of nonlinear science on contemporary childbirth

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Introduction

The rigorous, reductionist approach obstetric science has taken for determining the nature of childbirth has dedicated itself to the pursuit of cause and effect, proceeding under the laws of linear evidence. It maintains certainty that there are basic structures, rules, and replicable patterns that govern human reproduction. This article arises out of mounting dissatisfaction with these claustrophobic premises and the near invisibility of the dynamics of natural processes. Far more subtle and sophisticated perspectives on reality are now emerging.

Virtually all of science is devoted to understanding the process of change. A branch of cutting edge science termed *chaos theory*, and even more recently, *complexity theory*, (dynamic systems theories) have taken a potentially revolutionary leap forward in the evolution of scientific thought. These theories encapsulate ideas about change that have shifted scientists' focus from reductionism toward holistic diversity.

This article aims to consider the inherent complexity and richness of the human experience of change through the lens of dynamic systems theories in relation to the highly complex transitional period of childbirth and by outlining how cutting-edge physics provides new insights into the physiological process of birth. It is hoped that the reader will begin to see how these frameworks provide a new way of viewing not only obstetrics, but all of the interconnectedness of human experience. The role of the practitioner in providing flexible and safe care in light of the complexity of birth is explored, and two particular challenges are identified. It is argued that principles of nonlinear science have the potential to raise the status of practitioner experience, impressions, clinical judgement, and individual responsiveness. The final section of the article considers the importance of enhancing positive birth experiences, viewing childbirth as a potential catalyst in the emergence of greater coherence, or well-being, also making links with attachment theory, emphasising how a secure parent/child bond and the fostering of compassion have significant long term implications for the individual and wider community.

Brief overview of chaos/complexity theories

In order to understand childbirth as a physiological process, and one that does not easily conform to the simple linear models that underpin most of the current authoritative knowledge applied to health care, new theories need to be explored. To begin, chaos turns out to be far subtler than the common sense idea that it is the messiness of mere chance. The scientific term 'chaos' refers to an underlying interconnectedness that exists in apparently random events. Chaos science focuses on hidden patterns and nuances to include greater sensitivity, as well as 'rules' for how the unpredictable leads to evolution and development of the new (Smith 2007).

Chaos theory postulates spontaneity in the process of change as opposed to an ordered, step-by-step, gradual process. Rather than a reductionist science that attempts to experimentally repeat results in order to make predictions, chaos focuses on understanding and describing the inherently unpredictable, random, and holistic nature of

systemic functioning. It is a theory that focuses on change, process, and pattern rather than stability, causality, and control (Chamberlain & Bütz 1998). According to chaos theory, even very tiny fluctuations in behaviour by any part of a system can have profound effects on the structure and functioning of the entire system. This phenomenon of connectivity is formally termed 'sensitive dependence on initial conditions'. Metaphorically it has been called the 'butterfly effect': the idea that a butterfly stirring the air today in Peking can transform storm systems next month in New York. Profound shifts in the patterns of interaction in any connected system, like a labouring woman, can be set in motion by slight differences in the behaviour of a single variable. That a tiny difference in input can quickly become an overwhelming difference in output is a cornerstone of complexity theory (Kiel & Elliott 1996).

Chaos is described as a 'far-from-equilibrium' state as the theory emphasises that for a reorganisation to occur, there must first be an increase in chaos or disorder. Some degree of randomness, confusion, and unpredictability precedes and precipitates change and it is argued that periodic instability is the foundation of adaptation and transition (Smith 2007). Natural progression of change, as stated previously, does not manifest in gradual increments, but often in discontinuous leaps. These leaps occur following a gradual accumulation of stresses that a system resists until it reaches a breaking point, known as the 'edge of chaos'. Exactly when the leap will occur and how the system will reorganise is unpredictable. These patterns can be strikingly observed when witnessing the progress of an undisturbed labour. The term bifurcation, or crisis moment, is a tipping point, and is often referred to in chaos theory to describe the dynamic that initiates a transformation. Many birth attendants would understand and welcome the points in labour where the woman feels utterly overwhelmed and out of control, knowing these are the critical points of change. What is apparent is that, although the way an individual event may progress seems random and chaotic, the overall pattern is regular, in this case where the labour results in the baby being born (Chamberlain & Bütz 1998, Down 2004).

Chaos researchers are attempting, in a nonlinear world, to understand dynamic, apparently unordered systems. The view is that nonlinear situations, unlike linear deterministic ones, give individual solutions that are not predictable since they reveal the importance of small changes in variables (Brincat 1994). The chaos theory term 'fuzzy logic' comes closer to reality by replacing the inflexible yes or no with a more-or-less best option, identifying that there is no such thing as certainty of action (Demling 1992).

Chaos theory provides realistic endpoints for individuals as well as for larger populations. Such a viewpoint could shift the pendulum of importance back from large multicentral studies to small observational ones. It presents a much more realistic way of looking at natural phenomena, based on experience and observation, which is something practitioners can immediately relate to (Brincat 1994, Chamberlain & Bütz 1998).

Brincat (1994), commenting on the relevance of chaos theory to obstetrics, emphasises the value of human

sensitivity in working with highly complex clinical situations. He explores how the physics and mathematical tenets of chaos theory provide rationale for day to day variation in symptoms and non-repeatability of objective tests. Ignorance of the complex nonlinear nature of the body's control mechanisms may lead to wrong management or even disaster, as evidenced by the many infant deaths caused purely on the basis of low oestrial results in the 1970s. The question is raised: what then is the alternative if we can not fully rely on a particular symptom or test? The answer lies with the practitioner where their clinical experience provides the means for such a filter (Brincat 1994).

Though medicine is perhaps moving towards acceptance of theories around nonlinearity, the explosion in medico-legal matters is a sad example of how society is moving away from it in seeking perfection where a 'perfect' result is not possible in a nonlinear system (Dixon 2010). Brincat (1994) comments that the consequence of not recognising this will be to bog down obstetric care in a morass of tests, paperwork, and pseudo-legal documents, something many practitioners already experience on a daily basis.

It is interesting that there is increasing appreciation that chaotic patterns, as opposed to ordered regularity, can be a critical definition of health in physiology (Brincat 1994). One pertinent and obvious example is fetal heart rate variability. *Chaotic* variability is believed to be a physiological feature of fetal and adult heart rates (Stables 1999). On the other hand, *regular* oscillations and loss of variability represent pathological heart rate features signalling fetuses at risk of poor perinatal outcome. So it is that the transition from normal to pathological categories occurs when heart rate periodicity changes from chaotic to regular, not the other way around (Brincat 1994).

For childbirth to progress optimally, many practitioners will understand the value of the space, trust, and recognition of individual variability most often identified outside of hospital institutionalised regimes and conformity. The home birth approach to maternity care has much to teach the rest of the world in regards to only 'treating' childbirth if it becomes pathological (Banks 2000).

Chaos theory is designed to investigate complex behaviour and look for underlying patterns in what appears random. Certainly, this has implications for practitioners working with human systems. Understanding the underlying structures and patterns in human interactions will help carers to be more precise and will be beneficial in their interventions and treatment of truly dysfunctional situations. Although chaos theory eliminates the idea of predictability and control in human systems, it enhances the concepts of description, understanding, and influence (Brincat 1994, Chamberlain & Bütz 1998).

Sensitivity, responsiveness, flexibility – the role of the practitioner

Having offered the glimpse of a new perspective on the nature of change that applies strongly to physiological

birth dynamics, this has set the foundation for the benefits of care based on physiology.

Obstetric protocols, guidelines, and time frames fit well within a narrow margin of 'normality', but unique individual parameters can make such 'black and white' definitions more problematic than helpful. Being able to inhabit the groundless space of uncertainty with holistic insight into each individual reality requires ultimate skill from the practitioner. It requires an intimate understanding of physiology and an appreciation of the complexity of impact from interacting variables on this. Observation, responsiveness, sensitivity, and flexibility are shown time and again to be the critical factors influencing not only safe, but fulfilling birth experiences (Pelvin 1996, Down 2004, Howarth *et al* 2010). My work to date leads me to support the position that there are two main challenges facing the integrity of safe and beneficial care during childbirth: there must be an increase in the understanding of physiological birth; and there must be a decrease in the overuse of unnecessary medical interventions.

The wisdom of supporting a naturally labouring woman was made clear when the need for effective care was first formally recognised:

'The safest way to help labouring women is to respect nature and not interfere with spontaneous events unless there is clear evidence that to do so would be beneficial. It is a dangerous practice to overestimate the ability of obstetric technology and to underestimate the spontaneous reactions and the innate biological behaviour of the parturient woman.' (Naaktgeboren 1989:803)

Since then, there has been a wealth of international evidence indicating that overuse of medical interventions in childbirth results in both short and long term increased health care costs and strains health resources without improving outcomes (Hynd 2010). The World Health Organization has remained consistent in its estimation that the vast majority of women will not need intervention. It states bluntly that birth is not an illness. Birth needs support rather than medical procedures to ensure safe outcomes (WHO 1985, Banks 2010).

However, unnecessary intervention has become routine. The philosophy and practices of manipulating and controlling labour are so firmly entrenched that they have changed societal views of birth (Mander *et al* 2010). It is no longer commonly accepted that giving birth for healthy women is a normal physical process. Sophisticated technologies are seen to be required to endorse the health of the unborn baby and ensure safe passage for the mother. Yet routinely applied, these technologies are of questionable benefit, and pose real dangers for women and their babies (Goer 1995, Brisson-Carroll *et al* 1996, Khan 1996, Tracy *et al* 2008, Banks 2009). An additionally worrying aspect of this is where the practices to which health professionals subject women and babies are increasingly performed for the protection of the practitioner. Doing 'something', irrespective of whether it is effective or of benefit, still appears to afford

the practitioner protection in the dominant medical culture of birthing (Down 2004).

Chaos theory raises the status of practitioner experience, overview, and judgement. One of the important aspects of the idea of self-organisation, as is the case with physiological labour, is that it emerges when systems are in chaos. The process of change is inextricably linked to disruption, disorder, confusion, and irregularity: chaos. Only when there is sufficient unrest in a system is it likely to be amenable to transformation. Childbirth is such a time. For those caring for the woman experiencing birth, this requires immense tolerance of being with suffering, and working with uncertainty. Birth carers must be committed to nurturing optimal wellness in the mother and baby, and this includes upholding the mother's courage when she loses all grounding. It is in the expressing of the enormity of pain that she is at her most vulnerable. It is a journey into the heart of chaos, and pain and tiredness that is the mechanism for letting go and the bifurcation point of new direction. It is the rawness and inevitability of this process that ensures she does not have any ability or control to withstand the change. The relief and triumph that wash over her once her baby is born will be unrivalled in her life.

Pregnant women, by the very nature of their current experience, are often interconnected with their babies. This places women in the best position to take up the challenges of mothering, but it is also this interconnectedness which is so often destroyed by the technologies of pregnancy and childbirth (Banks 2000).

If the expression of pain is greeted by an attendant who then offers or recommends sedation, the labouring woman's ability to deal with the healthy pain of normal labour is totally undermined. It is a reflection of her carer's inability to provide comfort for her over the peaks of fear surrounding birth, and such attendants may wish to sedate the woman so it is they, not the woman who are more able to deal with the labour. It commences the rapid cascade of intervention that so often leads to birth injury (Banks 2000, Tracy *et al* 2008).

Continuity of care, with one known and trusted practitioner, is key to facilitating the attentive and safe care that is required when working with the complexity of birth, at a time of momentous importance for the prospective parents. In a relationship that spans pregnancy and beyond, there is time to work with the individual, becoming aware of her needs, developing an alertness for anything non-reassuring and potentially difficult. It is a partnership of shared information and preparation, where the carer can possess the skills to enhance and optimise the healthy physiology of birth, with the most appropriate and conservative use of resources and technology (Guilliland & Paiman 1994, Hynd 2010). The evidence of the importance of continuity of care is clear (MIDIRS 1996, Hodnett *et al* 2007). It is the responsibility of the practitioner to implement measures that enhance wellness and prevent emergencies, and to provide access to evidence-based skilled emergency treatment for serious complications (Hynd 2010).

There is a high impact in obstetrics of 'sensitive dependence on initial conditions'. In a brave counterpoint to narrow obstetric protocols and definitive guidelines, there is a call for practitioners to examine the beauty of the case study, the elegance of learning from watching and being watched, of seeing what older and wiser carers can accomplish in wielding the skill and art of the practitioner.

Transformation and the emergence of greater coherence

Our relationship to childbearing remains narrowly limited where there is a lack of understanding about the complexity of birth and the potential dynamics of transformation that surround birth. Kauffman (1995), suggests preoccupation with prediction and control is to blame for the 'secular loss of awe and respect'. This concern, this loss of the sacred, is truly a point worthy of consideration. Crime, drugs, isolation and the frenetic pace at which society moves in this modern world are the reasons communities are in strife. This leads to questions about concern over individuals *per se* as well as the role of each person as part of a larger community, a larger humanity. In losing sight of these connections, the future of the whole world is at risk, in terms of health environmental issues. In constructing a picture that illustrates human emotional wellness, coherence, identity, attachment, meaning, altruism, courage and compassion, might all be included, leading to experiences of self-actualisation. Maslow (1968), cited in Chamberlain & Bütz (1998) describes progression towards self-actualisation as following an experience described as an 'edge of chaos' state in which there is the potential to undergo dynamic transformation. Emerging out of this, the person is likely to feel a greater sense of self, a clearer purpose in life, a dedication to some pursuit, an enhanced sense of joy or fulfilment. This seems an excellent description in relation to giving birth and embarking on parenthood.

Studies have shown that infants who develop a secure attachment with their mothers during the first year of life are better able to tolerate stress, which continues throughout life (Ahnert *et al* 2004). Secure attachment predicts a better social-emotional adjustment in later childhood, adolescence, and adulthood (Egeland *et al* 2000). There is evidence confirming that the secure bond between child and parent allows the child considerable benefits: greater confidence; healthy independence; feeling more trusting and competent; developing intimacy through learning to give and receive love; and ultimately expanding their understanding and experience of compassion (Sears 2003). There are also important direct effects of maternal sensitivity and warmth where maternal warmth has been shown to moderate attention problems in five-year olds and conversely, more maternal negativity and less warmth are correlated with antisocial behaviour and are predictive of increases in antisocial behaviour from ages five to seven and onwards (Carlson *et al* 2003, Caspi *et al* 2004, Tully *et al* 2004).

In order for communities to be adaptive and responsive, socially and ecologically oriented, it appears that

individuals must be able to accommodate feelings of tension and of working with difficulties. Being comfortable with uncertainty and working with tension form the means of cultivating courage and compassion. The key point is that through fostering a relationship with such uncertainties within ourselves, we remain open to chaos and vulnerability and can gradually learn to expand compassion to others (Chödrön 2002). It appears that through a sense of connectivity and seeing situations as workable, the essence of well-being can surface even after extreme experiences of suffering (Antonovsky 1979, cited in Bütz 1997). However, the value of such coherence, and the accommodation of tension are simply out of reach if communities continue to allow development of individuals with little sense of integrity or value and no personal responsibility. To achieve strong vital communities there must be development of strong vital individuals that compose the 'whole' of these communities. This sort of development begins in the home and is fostered through: social groups; organisations; policies; and the wider community (Tronick 2010).

It is important to consider the position of childbirth in this context, where a post-modern approach to obstetrics would encompass respect and an encouragement of tenderness and empathy, so that couples emerge in their new identity as parents through an experience of compassion and responsiveness. Giving birth is a landmark experience in any woman's life. One of the factors that either inhibit or facilitate a woman's efforts to develop a sense of herself as a capable mother is her satisfaction with the experience of giving birth to her child (Howarth *et al* 2010). Research has shown that if a woman's birthing experience is positive, she is more likely to develop a positive, interactive, and reciprocal relationship with her child. On the other hand, research has established that a negative birthing experience can affect a mother's early interaction with her child, and hence the development of her maternal identity (Rubin 1984, Nelson 2004, Waldenstrom *et al* 2004, cited in Howarth *et al* 2010).

Reaching out beyond individual experiences of childbirth, the foundation of such compassion and a sense of connection offers the potential for a ripple effect that will reach the community and touch the environment. The birth of a first child is particularly a time of momentous change. It can be the beginning of claiming new purpose, new hope and responsibility, and an ultimate investment in our own and our children's humanity. However through an injurious birthing process, unfortunately not uncommon, this development of coherence and construction of positive confidence can be hugely undermined or even sabotaged.

The practitioner engaging with couples during the transformative journey of having a child has an enormously influential role. To support the couple in emerging as fully connected, strong and passionate parents, the practitioner must have skills in working with the complexity of highly unpredictable physiology, as well as the sensitivity to allow the couple to claim and

develop a new identity. Skill to avoid both physical and psychological injury allows parents their optimal potential at this threshold time.

Conclusion

Childbirth is a point of momentous change in a couple's lives. This article has offered a variety of notions stemming from nonlinear dynamics, encouraging an openness to scientific exploration of the manifestation of change. Beginning with a general description of certain touchstones in chaos and complexity theories, some initial thoughts were offered about their application to understanding the physiological processes that result in birth. It is clear that in order to limit the harm that results from birth trauma there must be an increase in the understanding of physiological birth. Only through a decrease in the overuse of unnecessary medical interventions will there be allowed the potential for a profound transition through childbirth.

The shift away from simplistic management toward practitioner oversight is validated not only by complexity theory, but also in the international literature that identifies the benefits of undisturbed normal birth and continuity of caregiver (Guilliland 1998, Hodnett *et al* 2007, Tracy *et al* 2008, Howarth *et al* 2010). Models that emphasise management and control and a linear world's view centre on rejecting that which they cannot explain. However, working with uncertainty leads to tolerance of the difficult process that life is. It seems important to emphasise compassion rather than control, which in the long run enhances tolerance.

This is important, where separateness rather than connectedness, is becoming more the norm. As caregivers around the pivotal point of childbirth, especially with the often challenging first birth when new identities and courage and attachment are formed, the impact of our actions on enhancing or miserably failing this threshold potential is marked. It is hoped that this article has encouraged further exploration of how birth unfolds. The significance of avoiding traumatic birth is evidenced by the lifelong memories that remain with couples who have navigated this journey.

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References

Ahnert L, Gunnar M, Lamb M *et al* (2004). Transition to child care: associations with infant-mother attachment, infant negative emotion, and cortisol elevations. *Child Development* 75(3):639-50.

Banks M (2000). *Home birth bound: mending the broken weave*. Hamilton, New Zealand: Birth Spirit Books Ltd.

Banks M (2009). The obstetric bed: resistance in action. *Birthspirit Midwifery Journal* 4:43-6.

Banks M (2010). Midwifery choices. *Birthspirit Midwifery Journal* 5:37-9.

Brincat MP (1994). Chaos theory in obstetrics and gynaecology. *British Journal of Obstetrics and Gynaecology* 101(11):931-4.

Brisson-Carroll G, Fraser W, Breart G *et al* (1996). The effect of routine early amniotomy on spontaneous labor: a meta-analysis. *Obstetrics and Gynecology* 87(5):891-6.

Bütz M (1997). *Chaos and complexity: implications for psychological theory and practice*. Washington, USA: Taylor and Francis.

Carlson E, Sampson M, Sroufe L (2003). Implications of attachment theory and research for developmental-behavioral pediatrics. *Journal of Developmental and Behavioural Pediatrics* 24(5):364-79.

Caspi A, Moffitt T, Morgan J *et al* (2004). Maternal expressed emotion predicts children's antisocial behaviour problems: using monozygotic-twin differences to identify environmental effects on behavioral development. *Developmental Psychology* 40(2):149-61.

Chamberlain L, Bütz M *eds* (1998). *Clinical chaos: a therapist's guide to nonlinear dynamics and therapeutic change*. Philadelphia, USA: Brunner-Mazel:82.

Chödron P (2002). *Comfortable with uncertainty*. Boston, USA: Shambhala.

Demling L (1992). Chaos research, fractals, fuzzy logic: from stereotypes to reality - consequences for medicine. *Fortschritte der Medizin* 110(6):77-9.

Dixon L (2010). The perinatal and maternal morbidity report for 2007. *Midwifery News* (New Zealand College of Midwives) 57:35-36.

Down S (2004). *Normal childbirth, evidence and debate*. London: Churchill Livingstone.

Egeland B, Weinfield N, Bosquet M *et al* (2000). Remembering, repeating, and working through: lessons from attachment-based interventions. In: Fitzgerald HE, Osofsky JD *eds*. *WAIMH: handbook of infant mental health: infant mental health in groups at high risk*. New York: Wiley:35-85.

Goer H (1995). *Obstetric myths versus research realities: a guide to the medical literature*. London: Bergin & Garvey.

Guilliland K (1998). Midwives and midwifery - leaders in safe maternity care. *New Zealand College of Midwives National Newsletter* 9:1-3.

Guilliland K, Pairman S (1994). The midwifery partnership: a model for practice. *New Zealand: College of Midwives Journal*. 11:5-9.

Hodnett E, Gates S, Hofmeyer G *et al* (2007). Continuous support for women during childbirth. *Cochrane Database of Systematic Reviews*, Issue 3.

Howarth A, Swain N, Trehan G (2010). A review of psychosocial predictors of outcome in labour and childbirth. *New Zealand College of Midwives Journal* 42:17-20.

Hynd D (2010). The international motherbaby childbirth initiative. *Midwifery News* (New Zealand College of Midwives) 57:32.

Kauffman S (1995). *At home in the universe*. London: Oxford University Press: 302.

Khan K (1996). Meta-Analysis: amniotomy does not reduce the rate of caesarean section. *Evidence-Based Medicine* 1(6):174.

Kiel D, Elliott E *eds* (1996). *Chaos theory in the social sciences: foundations and applications*. Michigan, USA: The University of Michigan Press.

Mander R, Murphy-Lawless J, Edwards N (2010). Reflecting on good birthing: an innovative approach to culture change. Part 2. *MIDIRS Midwifery Digest* 20(1):25-9.

MIDIRS (1996). *Support in labour*. Informed Choice leaflet (1). Bristol: MIDIRS.

Naakteboren C (1989). The biology of childbirth. In: Chalmers I, Enkin M, Keirse MJNC *eds*. *Effective care in pregnancy and childbirth. Vol 2* (Childbirth, Parts VI-X, Index). New York: Oxford University Press: 803.

Nelson AM (2004). Transition to motherhood. *Journal of Obstetric, Gynecologic and Neonatal Nursing* 32(4):465-77.

Pairman S, Pincombe J, Thorogood C *et al* (2006). *Midwifery: preparation for practice*. Sydney: Churchill Livingstone Elsevier.

Pelvin B (1996). On the edge: midwifery and the art of knowing. *New Zealand College of Midwives Journal* 15:14-15.

Rubin R (1984). *Maternal identity and the maternal experience*. New York: Springer.

Sears WM (2003). *Attachment parenting*. London: Thorsons.

Smith L (2007). *Chaos: a very short introduction*. Oxford: Oxford University Press.

Stables D (1999). *Physiology in childbearing: with anatomy and related biosciences*. Edinburgh: Bailliere Tindall.

Tracy SK, Sullivan E, Wang YA *et al* (2008). Birth outcomes associated with interventions in labour amongst low risk women: a population-based study. *MIDIRS Midwifery Digest* 18(1):79-85.

Tronick E (2010). Keynote address. In: *International Conference on Infant, Toddler & Preschool Mental Health. 18th-20th February 2010, Auckland*. Auckland: University of Auckland.

Tully L, Arseneault L, Caspi A *et al* (2004). Does maternal warmth moderate the effects of birth weight on twins' attention-deficit/hyperactivity disorder (ADHD) symptoms and low IQ? *Journal of Consulting and Clinical Psychology* 72(2):218-26.

World Health Organization (1985). *Birth is not an illness: 15 recommendations of the World Health Organization*. Geneva: WHO. <http://www.who.int/reproductivehealth/en/> [5 July 2010].

Kress S. MIDIRS Midwifery Digest, vol 20, no 4, December 2010, pp431-435.