Chaos theory in obstetrics and gynaecology

Sir,
In an amazing and interesting commentary (Vol 101, November 1994) Professor Brincat gave some examples of how chaos theory can be applied to obstetrics and gynaecology in order to overcome problems where traditional mathematical models seem to be inadequate. However, there are two points of application where we think his interpretation could be misleading.

1. *Oscillatory mechanisms*: According to the author, heart rate exhibits periodic oscillation, but nonperiodic variation with chaotic behaviour may lead to the *steady state equilibrium of death*. However, based on the fractal anatomy of the His-Purkinje system, as the structural substrate, *chaotic* variability is believed to be a physiological feature of fetal and adult heart rates (Goldberger & West 1987). On the other hand, *regular* oscillations and loss of variability represent pathological heart rate features: in adults with increased risk of cardiac failure (Singer *et al.* 1988) and in fetuses with increased risk of perinatal death (Modanlou & Freeman 1982). Obviously a transition from normal to pathological categories occurs when heart rate periodicity changes from chaotic to regular, rather than the other way around. This is more than just an abstract mathematical curiosity.
2. *Feedback systems*: Brincat states that *nonlinearity in feedback processes serves to regulate: a linear process, given a slight nudge, remains slightly off-track; a nonlinear process, given the same nudge, tends to return to its starting point*. The author then considers a possible application to the ovarian cycle. However, whether a dynamic biological system, after a perturbation, will return to its starting point is not a question of linearity but of stability (Finkelstein & Carson 1985). Thus regulation is not necessarily based on nonlinear feedback control. Nevertheless, the ovarian cycle is controlled by negative and, under a specific set of circumstances, also by positive feedback mechanisms, and thus is susceptible to instability.

Whether modern mathematical methods like chaos theory and fractals apply better to oscillatory mechanisms and feedback systems in obstetrics and gynaecology than traditional mathematical methods remains an interesting and difficult question, and the author is to be congratulated for his promising commentary. In an attempt to brainstorm, it may be stimulating

Always think of the Universe as one living organism,
with a single substance, and a single soul;
and observe how all things are submitted to the single
perceptivity of this one whole;
all are moved by its single impulse, and all play their part
in the causation of every event that happens.
Remark the intricacy of the skein, and the complexity of the web.

Chaos theory gives a rationale for day to day variation in symptoms and nonrepeatability of objective tests. In the 1970s, many infant deaths were caused by premature intervention purely on the basis of low oestriol results. This is but one tragic example of how ignorance of the complex nonlinear nature of the body's control mechanisms may lead to wrong management or even disaster.

Urinary controls gives an excellent example of the complexity of a nonlinear system. Pad tests for stress incontinence, urodynamic tests for bladder instability, and micturition pressures are poorly repeatable. Recently it has been demonstrated that bladder instability in women may be a premature activation of the micturition reflex (Petros & Ulsten 1993). Of 115 women with a history of bladder instability (i.e., wetting prior to arrival at the toilet), 108 experienced urge symptoms on a provocative handwashing test. A fall in urethral pressure was experienced by 91 women, 56 experienced a rise in detrusor pressure and 52 actually lost urine: all differing manifestations of the micturition reflex.

In a complex system, especially one where the urethral resistance varies according to the fourth power of the radius, even a tiny change in the urethral diameter can create a vast change in the detrusor pressure recorded, as the latter is entirely dependent on the urethral resistance (Griffiths 1991), a classical example of the butterfly effect. Multiple factors impact on urine expulsion and retention, reflexes, muscles, connective tissue, multiple initiatory and inhibitory centres. According to the chaos theory each factor, no matter how small, may impact on this process, and, depending on the interaction of each and every component factor with another, actually change the end result.

What then is the alternative if we can no longer rely on a particular symptom or test? The answer may lie in creating a hierarchy of manifestations, each assigned a probability factor. This would require a huge database, and computer systems which automatically classify and weight various diagnostic parameters. Such systems are available, but very large numbers would be