

General practice

What future for continuity of care in general practice?

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Continuity of care has had many definitions,¹ but in the context of general practice it is still virtually synonymous with care from one doctor, usually spanning an extended time and more than one episode of illness.² Although this longitudinal continuity, with its implied personal relationship, is seen by many as a core feature of the discipline, there is little supporting evidence. Seeing the same doctor does not guarantee a good patient-doctor relationship, and in any case such continuity can no longer be taken for granted. In many countries it is being abandoned under pressure from modern developments in medicine, in organisation of practices, and in society generally. A recent report from the British General Medical Services Committee suggested that it is being replaced by continuity within the primary care team.³

The practical question is whether patients should be enabled as far as possible to see the doctor of their choice or whether to go further and state that they should normally see only one general practitioner because this is better for them. We think that current evidence does not support this last view. Instead general practitioners, primary care teams, managers, politicians, and the public need to develop a shared understanding of the strengths and drawbacks of continuity, which when allied with good communication we call personal continuity (box).

Longitudinal versus personal continuity

Longitudinal continuity is a simple concept with strong face validity. It is easy to measure quantitatively,⁴ but it says little about the patient-doctor relationship and quality of care. Its value rests on the assumption that any doctor can relate well to any patient provided that there is sufficient opportunity. Sometimes, though, a

Summary points

Changes in society and professional developments are squeezing out traditional continuity of care

Patients want doctors who listen and solve problems more than longitudinal continuity

Longitudinal continuity should be replaced by personal continuity, where medical decisions are taken by the patient in consultation with the doctor

Seeing the same patients increases job satisfaction and education but requires high personal commitment

A policy of personal continuity requires commitment from all members of the primary care team

Continuity of care with the whole team may be more feasible than continuity with one doctor

patient may find it easier to communicate with, and hence trust, a different doctor. Longitudinal continuity tends to be used as a proxy for the desired quality of personal continuity.

Personal continuity implies both empathy and personal responsibility according to McWhinney and others.^{5,6} It is harder to measure but is clinically more relevant and important. It implies a commitment from patients as well as from doctors, and this may be reflected in the patient's willingness to wait for a particular doctor. It is hard to assess the importance of personal continuity without looking at the content of the consultations as well as counting them. Thus assessment demands qualitative methods, often involving face to face questioning.

Of course, some longitudinal continuity is necessary for personal continuity, but quite low longitudinal continuity may be enough. Interviews in both pilot and published studies have found some patients with a clear identity of their personal doctor even though they had not consulted him or her for a long time.^{7,8} Likewise in Norway some patients reported the feeling of personal doctoring after only a few consultations with a new gen-

Definitions of continuity of care

Longitudinal continuity

- Care given by one practitioner over a defined time
- This has traditionally been a general practitioner practising alone
- Much of the evidence for its benefit is from hospital outpatient settings

Personal continuity

- An ongoing therapeutic relationship between patient and practitioner
- Typically the patient will look to this practitioner as their most valued source of care
- The nature and quality of the contacts are more important than the number

eral practitioner, while others had not attained this after several years of contact with the same doctor.⁹

What sort of continuity of care?

Continuity of care can be understood in various ways. It can mean care in one place or from one person, coordinated care, or a common medical record.^{5 10-13} Literally, the phrase implies that care received by the patient should be continuous and hence presumably consistent. This is particularly relevant now that care is becoming increasingly complex and often shared between teams in primary and secondary care. However, medicine remains highly personal, and continuity of carer is often sought in order to get better continuity of care.^{2 10}

Most research has studied longitudinal continuity. It has been associated with various benefits including compliance with therapeutic regimens,¹⁴ reduced number and duration of hospital admissions,¹⁵ saving time and tests in primary care,¹⁶ patient satisfaction,^{15 17} doctor satisfaction,^{18 19} reporting of emotional problems by patients,²⁰ and reduction of inappropriate attribution of symptoms by outpatients with functional abdominal complaints.²¹ Breslau pointed out that continuity may be much more important for patients with a chronic or serious illness.²² However, other aspects of care have shown no improved outcome. These include care of pregnancy,²³ hypertension,²⁴ gonorrhoea in teenagers,²⁵ and epilepsy.⁷

Some studies highlight the personal element of continuity. Ettlenger and Freeman studied compliance with short term regimens of antibiotics in two general practices and found a highly significant association between good compliance and patients feeling that they knew the doctor well.²⁶ The association of longitudinal continuity with compliance was less strong, though still significant. This suggests that personal continuity can be achieved with relatively few contacts. Hjortdahl and Laerum studied the relation between the personal (qualitative) and longitudinal aspects of continuity more directly. They found a significant sevenfold rise in patient satisfaction associated with the patient seeing "my personal doctor for all my health problems."⁹ The equivalent odds ratio for how long the patient and doctor had known each other was less strong (1.85 for five years or more (95% confidence interval 1.07 to 3.19)) while increased frequency of contacts in the past 12 months had no significant effect on patient satisfaction. Thus the concept of a personal doctor seems to have added value compared with repeated contact alone.

Costs of continuity

Few studies report increased costs or negative effects of longitudinal continuity, possibly because of publication bias. However, Miller reported late referral²⁷ and two studies found reduced conformity with professional standards.^{28 29} The most comprehensive European study published to date showed savings in time and tests associated with an increased use of wait and see policies but more prescribing, referrals, and sickness certification.¹⁶ This suggests that the influence of personal continuity of care on a doctor's decisions in a consultation is complex and multidimensional. One possibility is that knowing the patient limits diagnostic



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Patients like to have a personal doctor, but it can put extra pressure on general practitioners

costs but encourages spending on managing disease. Another is that patients who know their doctors well persuade them to do more, perhaps by feeling more empowered. Thirdly, doctors who know their patients better may wish to do more. Finally, less familiar general practitioners may defer positive action (except for tests) until patients see their usual doctors.

Costs for patients

Any policy encouraging or imposing longitudinal continuity may reduce choice for patients. It may also increase waiting times by discouraging doctors from sharing the workload.³⁰ However, this may not necessarily dissatisfy patients. Patients in the strict personal list practice in Freeman and Richards' study had little opportunity to see another of the six general practitioners and showed little wish to do so when asked.⁸ Their contentment was strikingly different from that of patients in two shared list practices with much less longitudinal continuity where the patients seemed both better informed and more willing to criticise individual doctors.

Costs for doctors

The main costs of offering high longitudinal continuity through a personal list system are the personal commitment and high personal availability, which result in doctors being more tied to the practice with less scope for outside interests and for personal or professional development.¹⁰ This lack of flexibility may mean more doctors are needed to maintain a given level of service, but there is no firm evidence for this.

What do patients want?

The evidence about patients' views on quality care in general practice has recently been reviewed by Rees Lewis.³¹ He refers to a study which found that longitudinal continuity was patients' third priority after a doctor who listens and a doctor who sorts out problems.³² Patient satisfaction is said to be the only one of four outcomes that can be influenced by quality primary care (the other three are self reported health, disability, and medical costs).³³ The key factors associated with patient satisfaction are providing information, medical skills, and interpersonal skills, none of which is directly linked to longitudinal continuity of care.³⁴

Hjortdahl and Laerum point out that personal continuity and satisfaction are bidirectionally related.⁹ Not only does continuity lead to increased satisfaction but satisfaction ratings predict what patients will do next time they need health services: "Incompatibility problems may cause the patient to use their 'exit' option and change doctors." This conclusion was shared by Freeman and Richards, who found that patients appreciated choice in shared list practices but then felt frustrated if unable to see their chosen doctor when they wished.⁸

In the same study patients in the personal list practice were more satisfied and made fewer suggestions for change than those in the combined list practices. This point was reinforced in a study of 89 practices in southwest England where a full personal list system, rather than a partly personal or a pooled system, was strongly correlated with general satisfaction³⁵ and with satisfaction with consultations.³⁶

What do general practitioners want?

General practitioners in countries with a well developed primary medical care system such as Britain,³⁷ Norway,¹⁰ and Australia³⁸ seem caught between the rhetoric and tradition of longitudinal continuity and the often conflicting pressures of patients' expectations and society's demands. To be in demand is a yardstick of success in any profession.³⁹ To be asked for personally by patients is much more satisfying than seeing a succession of patients who just want any doctor. A personal following, whether formalised by a personal list or as a result of demand from patients on a shared list, is a considerable investment and an assurance for general practitioners. Although general practitioners often feel overworked, it may be worse to feel unwanted.

Seeing the same patients is also vital for feedback on the efficacy of diagnosis and treatment. Observation over time makes an important contribution to education of general practitioners, particularly in encouraging a wait and see policy and being aware of the natural course of disease. Reflective practitioners⁴⁰ wish to review the outcomes of their professional work, and seeing the patient in person powerfully enhances this form of continuing medical education.⁴¹

All over the world governments struggle to contain the costs of medical care against technological advances and rising patient expectations. Often they turn to primary care to act as gatekeeper. However, over hasty development of primary care may risk steeply rising costs. Hjortdahl and Borchgrevink's evidence of increased testing and reduced expectant management (wait and see) among less well known patients deserves further study.¹⁶

Traditionally, appointment as a general practitioner was seen as a full time job for life associated with a stable place in the community. Today young graduates hesitate to commit themselves to a professional lifetime in one community; there is more demand for part time work in general practice from men as well as women. This increasingly threatens longitudinal continuity and the personal list. One solution may be more emphasis on continuity with the whole team, as advocated by Pratt.⁴² Another is to be more explicit about shared responsibility between

Elements of a coordinated policy to encourage personal continuity

The consultation

- Make it worthwhile for patients if they have waited to see a particular general practitioner. Patients will be prepared to wait a little longer when the problem is serious enough and the benefit is good enough
- Take notice if a patient seems to be changing frequently. It may be enlightening to discuss what has led to this behaviour
- Referral within the team for special skills is good as long as it is negotiated openly and it is clear who is clinically responsible
- Negotiate rebookings sensitively with the patient's chosen doctor. It is easier to judge how definitely to encourage a patient to rebook if you know which doctor they asked for initially

Access to the primary care team

- Explain the practice policy on continuity in practice leaflets and at introductory consultations. This must be backed up by all team members with both words and deeds. Requirements include adequate consulting time, receptionist training, agreement about coping with fluctuation in demand, and regular feedback and audit of requests and of waiting times for bookings and consultations. If patients have to be very assertive or tolerate long delay to see their usual practitioner the policy may need review
- Display the usual doctor's name prominently on all patients' records and keep it up to date. Routinely record the requested doctor for each appointment
- Advise patients that important decisions need consultation with the agreed usual doctor; receptionists need to know they will be backed up

Health authorities

- Managers need to be aware of the distinctions between longitudinal and personal continuity and between forced and open longitudinal continuity. They need to value staff as well as patient satisfaction and to look for evidence of quality assessment
- Measures of success will include satisfied patients, high staff morale, low waiting times, relatively high longitudinal continuity, and evidence of regular audit and feedback including qualitative surveys

The public

- Patients need to know that it is usually worth waiting for a doctor they like but that there is no firm evidence that it is good for them to see the same doctor each time against their wish
- Though the practice should make every effort for patients to see their chosen practitioner, this also implies some willingness for the patient to wait for this person to be available

individuals as in job sharing or in nomination of a first and alternative choice by patients.

The future: encouraging personal continuity

People seek a general practice consultation to find out what is happening to them, what it means, what might be done, and to what effect.⁴³ Providing a response to these concerns is what most general practitioners feel they are best at and are happiest doing. If we think personal continuity is valuable then our clinical and administrative actions must constantly encourage it; we must be far more positive but stop short of compulsion. Our aim should be to maximise personal continuity while maintaining an element of choice (see box). This will sometimes mean hard decisions,

particularly in balancing short term workload and adequate personal availability. Longitudinal continuity will generally rise but not perhaps to the levels found in practices maintaining a strict personal list for each general practitioner. Personal continuity is an essential attribute of general practice enabling us to deliver care that is both individual and cost effective. Longitudinal continuity provides just one element of the framework supporting this personal continuity, along with excellent communication skills and good teamwork and records. There remains another vital and intuitive element which has been described as mysterious.⁴⁴ We must try to help our students learn this element for the benefit of future patients.

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- 1 Starfield B. Continuous confusion? *Am J Public Health* 1980;70:117-9.
- 2 Freeman G. Priority given by doctors to continuity of care. *J R Coll Gen Pract* 1985;5:423-6.
- 3 Wilson M, Ball JG, Banks IG, Barnett RN, Bogle IG, Fradd SO, et al. *Medical workforce*. London: BMA, 1996. (Task group of General Medical Services Committee.)
- 4 Freeman GK. Measuring continuity of care. *Fam Pract* 1987;4:249-50.
- 5 McWhinney IR. *A textbook of family medicine*. New York: Oxford University Press, 1989:12-26.
- 6 Banahan BF Jr, Banahan BF III. Continuity as an attitudinal contract. *J Fam Pract* 1981;12:767-8.
- 7 Freeman GK, Richards SC. Personal continuity and the care of patients with epilepsy in general practice. *Br J Gen Pract* 1994;44:395-9.
- 8 Freeman GK, Richards SC. Is personal continuity of care compatible with free choice of doctor? Patients' views on seeing the same doctor. *Br J Gen Pract* 1993;43:493-7.
- 9 Hjørtdahl P, Laerum E. Continuity of care in general practice: effect on patient satisfaction. *BMJ* 1992;304:1287-90.
- 10 Hjørtdahl P. Ideology and reality of continuity of care. *Fam Med* 1990;22:361-4.
- 11 Hennen BK. Continuity of care in family practice. 1. Dimensions of continuity. *J Fam Pract* 1975;2:371-2.
- 12 Freeman G. Continuity of care in general practice: a review and critique. *Fam Pract* 1984;1:245-52.
- 13 Starfield B. Is primary care essential? *Lancet* 1994;344:1129-33.
- 14 Dietrich AJ, Marton KI. Does continuous care from a physician make a difference? *J Fam Pract* 1982;15:929-37.
- 15 Wasson JH, Sauvigne AE, Mogielnicki RP, Frey WG, Sox CH, Gaudette C, et al. Continuity of outpatient medical care in elderly men: a randomized trial. *JAMA* 1984;252:2413-7.
- 16 Hjørtdahl P, Borchgrevink CF. Continuity of care: influence of general practitioners' knowledge about their patients on use of resources in consultations. *BMJ* 1991;303:1181-4.
- 17 Hjørtdahl P. Continuity of care: general practitioners' knowledge about and sense of responsibility towards their patients. *Fam Pract* 1992;9:3-8.
- 18 Gorlin R, Zucker HD. Physicians' reactions to patients. *N Engl J Med* 1983;308:1059-63.
- 19 Grol R, Mokkink H, Smiths A, Eyck JV, Beek M, Mesker P, et al. Work satisfaction of general practitioners and the quality of patient care. *Fam Pract* 1985;2:128-35.
- 20 Becker MH, Drachman RH, Kirscht JP. A field experiment to evaluate various outcomes of continuity of physician care. *Am J Public Health* 1974;64:1062-70.
- 21 van Dulmen AM, Fennis JFM, Mokkink HGA, van der Velden HGM, Bleijenberg G. Doctor-dependent changes in complaint-related cognitions and anxiety during medical consultations in functional abdominal complaints. *Psychological Med* 1995;25:1011-8.
- 22 Breslau N. Continuity re-examined: differential impact on satisfaction with medical care for disabled and normal children. *Med Care* 1982;20:347-60.
- 23 Flynn SP. Continuity of care during pregnancy: the effect of provider continuity on outcome. *J Fam Pract* 1985;21:375-80.
- 24 Phillips DM, Shear CL. Provider continuity and control of hypertension. *J Fam Pract* 1984;19:793-7.
- 25 Chacko MR, Wells RD, Phillips SA. Test of cure for gonorrhoea in teenagers. Who complies and does continuity help? *J Adolesc Health Care* 1987;8:261-5.
- 26 Ettliger PRA, Freeman GK. General practice compliance study: is it worth being a personal doctor? *BMJ* 1981;282:1192-4.
- 27 Miller MH. Who receives optimal medical care? *J Health Soc Behav* 1973;14:176-8.
- 28 Roos LL, Roos NP, Gillot P, Nicol JP. Continuity of care: does it contribute to quality of care? *Med Care* 1980;18:174-84.
- 29 Morehead MA, Donaldson R. Quality of clinical management of disease in comprehensive neighbourhood health centres. *Med Care* 1974;12:301-15.
- 30 Freeman GK. Receptionists' appointment systems and continuity of care. *J R Coll Gen Pract* 1989;39:145-7.
- 31 Rees Lewis J. Patient views on quality care in general practice: literature review. *Soc Sci Med* 1994;39:655-70.
- 32 Haigh-Smith C, Armstrong D. Comparison of criteria derived by governments and patients for evaluating general practitioner services. *BMJ* 1989;299:494-6.
- 33 Smith WG, Buesching D. Primary medical care and health outcome. *Evaluation and Health Professions* 1985;8:339-48.
- 34 Williams SJ, Calnan M. Key determinants of consumer satisfaction with general practice. *Fam Pract* 1991;8:237-42.
- 35 Baker R, Streatfield J. What type of general practice do patients prefer? Exploration of practice characteristics influencing patient satisfaction. *Br J Gen Pract* 1995;45:654-9.
- 36 Baker R. Characteristics of practices, general practitioners and patients related to levels of patients' satisfaction with consultations. *Br J Gen Pract* 1996;46:601-5.
- 37 Royal College of General Practitioners. *Policy statement 1. Evidence to the Royal Commission on the National Health Service*. London: RCGP, 1985:1-2.
- 38 Harris MF, Frith JE. Continuity of care: in search of the holy grail of general practice. *Med J Aust* 1996;164:456-7.
- 39 Friedson E. *The profession of medicine: a study of the sociology of applied knowledge*. New York: Dodd, Mead, and Co, 1970.
- 40 Schön DA. *Educating the reflective practitioner*. San Francisco: Jossey-Bass, 1988.
- 41 Pendleton DA, Hasler J. *Professional development in general practice*. Oxford: Oxford University Press, 1996. (Oxford General Practice Series 37.)
- 42 Pratt J. *Practitioners and practices: a conflict of values?* Oxford: Radcliffe Medical Press, 1995:60.
- 43 General Medical Services Committee. *Core general medical services and the classification of general practitioner activity*. London: GMS, 1995.
- 44 Heath I. *The mystery of general practice*. London: Nuffield Provincial Hospital Trust, 1995.

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A memorable patient A shocking recollection

Some 25 years ago, in general practice, I was visiting an elderly woman who was suffering from a chest infection, but who fortunately was not very ill. I was examining the back of her chest when I felt a tingling in my left hand which was in contact with her skin. I had already observed that the patient had an electric blanket in her bed. The patient said, "It's all right Doctor, it's switched off." I saw that the wire from the electric blanket was still connected to the switch, so I turned it off. When I placed my hand again on the back of the patient's chest I still experienced the same tingling sensation. I then pulled the plug out of the socket and replaced my hand on the back of her chest. This time the tingling had disappeared. By now the patient was becoming quite puzzled as to what I was doing, but my interest had now concentrated on the socket on the skirting. I finished examining the patient, gave her a prescription, and told her that I would be returning the next day to see her and to examine the switch. On my visit the next day the patient was much better, and with her

permission I proceeded to investigate the suspect switch. I had brought a mains voltage tester and, with the switch turned off and the plug from the electric blanket removed, I put the tester on to the live side of the switch. This produced no response. I switched on and again there was a negative result. I now repeated the procedure on the neutral side of the switch and the neon glowed. I diagnosed this as reversed polarity due to faulty wiring. I told the patient that she must have this fault checked as soon as possible and on no account was she to use her electric blanket until the fault was remedied. She looked a little puzzled but said that she would do as I advised. I am uncertain whether the patient was impressed with my non-medical skills. In retrospect I think it was hubris on my part to have undertaken this investigation, but I subsequently found out that this potentially dangerous fault had been corrected.

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*Statistics Notes***Units of analysis**

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In clinical studies the focus of interest is almost always the patient. If we carry out a randomised trial to compare two treatments we are interested in comparing the outcomes of patients who received each of the treatments. In some conditions several measurements will be taken on the same patient, but the focus of interest remains the patient. Failure to recognise this fact results in multiple counting of individual patients and can seriously distort the results. We explain this error below. Its frequency in medical research is indicated by the whole chapter devoted to it in Andersen's classic compilation.¹

The simplest case is when researchers study a part of the human anatomy which is, so to speak, in duplicate: eyes, ears, arms, etc. At the other extreme very many measurements can be taken on a single patient. Such data arise frequently in dentistry, with measurements made on each tooth, or even each face of each tooth, and in rheumatology, in which pain or mobility may be assessed for each joint of each finger. In statistical terminology the patient is the sampling unit (or unit of investigation) and thus should be the unit of analysis.

There are two related consequences of ignoring the fact that the data include multiple observations on the same individuals. Firstly, this procedure violates the widespread assumption of statistical analyses that the separate data values should be independent. Secondly, the sample size is inflated, sometimes dramatically so, which may lead to spurious statistical significance.

Inflated samples

To take a simple case, we may wish to compare the blood pressures of two groups of 30 patients. If we measured blood pressure on each arm of each patient we could double the number of observations but not the amount of information, as the two pressures from each patient will be very similar. The use of the *t* test to compare the two sets of 60 observations is invalid. Andersen¹ presented data from a randomised double blind crossover trial of ketoprofen and aspirin in the treatment of rheumatoid arthritis. An impressive *P* value of 0.00000001 was obtained from an analysis of 3944 observations, but these were obtained from only 58 patients. Such errors are not rare. In a review of 196 randomised trials of non-steroidal anti-inflammatory agents Gøtzsche found that 63% of reports used the wrong units of analysis.²

We previously discussed a similar fallacy arising in the use of correlation coefficients, when multiple observations from each individual produced a spurious increase in the sample size and a corresponding spurious "significant" relationship.³ We suggested techniques to analyse such data when the focus was either the variation within subjects⁴ or between subjects.⁵

There is nothing wrong in collecting such data; indeed the use of multiple observations can often

improve the statistical power of a study. But such studies need to be analysed correctly. The simplest approach is to collapse all the data for an individual into a summary measure.⁶ For example, we could validly analyse the mean of the two blood pressure values for each patient. Alternatively, we can use a statistical method which explicitly takes account of the multiplicity. With well designed studies we may be able to use analysis of variance. A more complex general approach is multilevel modelling,⁷ which is not available in standard statistical software and may be difficult to apply and interpret.

Take account of multiplicity

The same objection applies to the use of multiple measurements made on different occasions. Here too the sampling unit is the patient, and thus the unit of analysis should also be the patient.² A further feature of this type of study is that in some situations the number of measurements made on a patient may itself carry prognostic information. For example, repeat measurements may be made only if there is some clinical concern—for example, fetal ultrasound measurements in pregnancy. To treat all these measurements as independent is clearly wrong, but bias is introduced too when those with more data are systematically different from those with single observations. An extreme example of this phenomenon occurs when analysing multiple hospital admissions for a potentially fatal condition.¹ Those with more than one admission must have survived the first admission.

Failure to carry out the correct analysis can lead to problems of interpretation too. Commenting on one trial, Andersen observed, "This trial resulted in the apparent conclusion that after 1 year 22% of the patients, but only 16% of the legs, have expired."¹

Similar problems arise when we cannot sample individual patients directly but choose a sample of hospitals, wards, or general practices and then obtain data for all or a subsample of the patients within these groups. Here analysis of data for individual patients leads to the errors described above. We consider this type of study in forthcoming *Statistics Notes*.

- 1 Andersen B. *Methodological errors in medical research*. Oxford: Blackwell, 1990.
- 2 Gøtzsche PC. Methodology and overt and hidden bias in reports of 196 double-blind trials of nonsteroidal antiinflammatory drugs in rheumatoid arthritis. *Controlled Clin Trials* 1989;10:31-56.
- 3 Bland JM, Altman DG. Correlation, regression, and repeated data. *BMJ* 1994;308:896.
- 4 Bland JM, Altman DG. Calculating correlation coefficients with repeated observations. Part 1: correlation within subjects. *BMJ* 1995;310:446.
- 5 Bland JM, Altman DG. Calculating correlation coefficients with repeated observations. Part 2: correlation between subjects. *BMJ* 1995;310:633. [Correction *BMJ* 1996;312:572]
- 6 Matthews JNS, Altman DG, Campbell MJ, Royston JP. Analysis of serial measurements in medical research. *BMJ* 1990;300:230-235.
- 7 Goldstein H. *Multi-level statistical models*. 2nd ed. London: Edward Arnold, 1995.