practitioner contract, the publication of an interesting and readable guide to immunisation by the Department of Health,[1] and the publication of the British Paediatric Association's manual on infection and immunisation.[8] Let us hope that immunisation rates will reach the targets necessary to eliminate the mortality and morbidity from preventable infection.

PETER T RUDD

Consultant Paediatrician,
Bath Unit for Research into Paediatrics,
Royal United Hospital,
Bath BA1 3NG

1 Department of Health, Welsh Office, Scottish Home and Health Department. *Immunisation against infectious disease*. London: HMSO, 1990.
2 Halsey N, Galazka A. The efficacy of DPT and oral poliomyelitis immunisation schedules initiated from birth to 12 weeks of age. *Bull WHO* 1985;**63**:1151-69.
3 Bernbaum JC, Daft A, Anolik R, *et al*. Response of preterm infants to diphtheria/tetanus/pertussis immunisation. *J Pediatr* 1985;**107**:184-8.
4 Gustafson TL, Lievens AW, Brunell PA, *et al*. Measles outbreak in a fully immunized secondary school population. *N Engl J Med* 1987;**316**:771-4.
5 American Academy of Pediatrics Committee on Infectious Diseases. Measles: reassessment of the current immunization policy. *Pediatrics* 1989;**84**:1110-3.
6 Markowitz LE, Sepulveda JA, Diaz-Ortega JL, *et al*. Immunization of six month old infants with different doses of Edmonston Zagreb and Schwarz measles vaccines. *N Engl J Med* 1990;322: 580-7.
7 Tudor-Williams G, Frankland J, Isaacs D, *et al*. Haemophilus influenzae type B conjugate vaccine in Oxford. *Arch Dis Child* 1989;**64**:520-4.
8 Nicoll A, Rudd PT, eds. *British Paediatric Association manual on infections and immunization in children*. London: British Paediatric Association, 1989.

Stick testing

Reliable, safe, and economical—but only if the instructions are followed

Stick technology is to classic laboratory analytical technology what instant (Polaroid) photography is to traditional wet film photography. Under many conditions it provides all that is required of it—quickly, conveniently, and inexpensively.[1] It may not always have the refinements of the classic analytical technology it is designed to replace. These refinements may, however, impose constraints on timeliness—the importance of which is often overlooked by laboratory workers—as well as being unnecessarily elaborate for the purpose.[2 3]

The technological key to stick testing is dry chemistry. This typically comprises thin pads or films containing all the reagents required for performing an assay. The number of substances of clinical importance that can be measured by dry chemistry technology in blood as well as in urine has grown almost exponentially and shows no sign of diminishing.[4] Faeces and saliva may also be used for specific purposes. Tests available in stick format are biochemical, microbiological, and haematological. Even allergy testing is possible[5 6] with a sensitivity and specificity comparable to that of traditional methods.[7]

Many stick tests are still performed on urine, mainly for analytes such as glucose and protein,[8] but now that the technological difficulties of the measurements have been overcome increasing attention is being given to their clinical usefulness and cost effectiveness.[9] Urine stick tests used for detecting systemic or metabolic disease (such as liver disease or diabetes), though still popular are based on much less secure grounds than tests used to detect (or eliminate) urinary tract disease,[10-16] and they have largely been replaced by blood tests.

Stick tests for blood have been available for over 25 years, but until recently their use was largely confined to semiquantitative measurement of glucose for the control of diabetic treatment, for which they have rendered urine analysis virtually obsolete.[17] The greatest fillip to the expansion of stick tests for use with blood outside the laboratory was the introduction of the Reflotron blood analysis system.[18] This enables a variety of the most commonly requested tests, such as urea, creatinine, uric acid, and especially cholesterol concentrations, to be measured on a whole blood sample collected from a simple finger prick. The tests can be performed within three minutes by a person with minimal training yet provide an accuracy and precision comparable with that obtainable in a quality controlled laboratory.[18-20]

More recently multiple analyte test sticks for blood analogous to those already available for urine and capable of giving liver, cardiac, and kidney "profiles," as well as individual test results, have become available.[21] Simple and reliable stick techniques also exist for measuring concentrations of therapeutic drugs in the blood.[22-24] These open the way to an increased use of therapeutic drug monitoring within the community, where most drugs are prescribed.[25 26]

There is no limit to the number of analytes for which stick tests can be developed nor is the format restricted only to analytes of clinical interest. Solid phase tests have already been used for detecting real or purported toxins in foods and water, and they have obvious applications in veterinary medicine. Tests for pregnancy and predicting ovulation are examples of over the counter tests currently available.[27]

When all cost elements are taken into account many of the single analyte stick tests are competitive with similar tests performed in a central laboratory[28] and have the added advantage of timeliness.[29] The only real obstacle to their more widespread use is the difficulty of maintaining the analytical standards when tests are performed outside the laboratory.[30-33] Strict adherence to protocol is essential if results are to be reliable and clinically useful. Despite their apparent simplicity most stick tests are sophisticated analytical systems, and like all such systems demand efficient quality control—a concept still unknown to many health care providers.

Articles have recently appeared in at least two controlled circulation journals advocating the splitting of blood glucose testing sticks in two with a special device, supposedly to reduce costs.[34 35] This not only renders protection under the Consumer Protection Act 1987 invalid; it also indicates a lack of understanding of the need for meticulous adherence to the manufacturer's protocol if reliable results are to be obtained. Failure to replace the cap of the bottle containing the test strips, for example, may lead to their rapid deterioration with potentially disastrous results.[36]

Guidelines to the proper and safe use of stick and other near patient testing devices have been issued by several professional organisations.[37-39] These need to be followed faithfully if the full advantages of stick technology are not to be squandered by such mishaps as the one that led to the issue of a hazard warning by the Department of Health and Social Security in 1987.[40] In that case a patient died in diabetic coma because a stick designed for use with one instrument was used in another made by a different manufacturer and with which it was incompatible.

Stick technology has come a long way in the past 30 years and is still improving. In the film mode it already provides a challenge to traditional wet chemistry analysis, even in large

central laboratories, because of its reliability, safety, and economy.[41] Although it is only one factor in the trend towards more testing nearer the patient and population screening, dry chemistry is undoubtedly the leader and the one with the greatest potential.

VINCENT MARKS

Professor of Clinical Biochemistry,
University of Surrey,
Guildford GU2 5XH

1 Marks V. The clinical laboratory: nearer the patient. *Advances in Pathology* 1988;**1**:1-30.
2 Sandler V. Immediacy: speed of response from the point of view of the physician. In: Marks V, Alberti KGMM, eds. *Clinical biochemistry nearer the patient*. Edinburgh: Churchill Livingstone, 1985:38-51.
3 Hilton S. Near patient testing in general practice, a review. *British Journal of General Practice* 1990;**40**:31-6.
4 Belsey R, Baer D, Sewell D. Laboratory test analysis near the patient. *JAMA* 1986;**255**:775-86.
5 Iwamoto I, Yamazaki H, Kimura A, Ochiai K, Tomioka H, Yoshida S. Comparison of a multi-allergen dipstick IgE assay to skin-prick test and RAST. *Clin Exp Allergy* 1990;**20**:175-9.
6 Imam AA, Novey HS, Orgel HA, Klein GL, Meltzer EO, Ziering RW. A simplified screening test for the diagnosis of allergy. *West J Med* 1990;**162**:313-6.
7 Twiggs JT, Gray RL, Pichler K, Weiner R. Evaluation of multi-allergen dipstick screening test. *Ann Allergy* 1989;**63**:225-8.
8 Newall RG, Howell R, eds. *Clinical urinalysis: the principles and practice of urine testing in the hospital and community*. Stoke Poges: Ames Division, Miles Limited, 1990.
9 Anonymous. Is routine urinalysis worthwhile? [Editorial]. *Lancet* 1988;i:747.
10 Tuel SM, Meythaler JM, Cross LL, McLaughlin S. Cost effective screening by nursing staff for urinary tract infection in the spinal cord injured patient. *Am J Phys Med Rehabil* 1990;**69**:128-31.
11 Flanagan PG, Rooney PG, Davies EA, Stout RW. Evaluation of four screening tests for bacteriuria in elderly people. *Lancet* 1989;i:117-9.
12 Pels RJ, Bor DH, Woolhandler S, Himmelstein DU, Lawrence RS. Dipstick urinalysis screening of asymptomatic adults for urinary tract disorders. 2. Bacteriuria. *JAMA* 1989;**262**:1221-4.
13 Doran HM, Kensit JG. Screening for bacteriuria with Clinitec-200. *J Clin Pathol* 1988;**41**:1127-9.
14 Richardson H. Urine testing in schools: clinical considerations. In: Newall RG, Howell R, eds. *Clinical urinalysis: the principles and practice of urine testing in the hospital and community*. Stoke Poges: Ames Division, Miles Limited, 1990:86-92.
15 Propp DA, Weber D, Ciesla ML. Reliability of a urine dipstick in emergency department patients. *Ann Emerg Med* 1989;**18**:560-3.
16 Britton JP, Dowell AC, Whelan P. Dipstick haematuria and bladder cancer in men over 60: results of a community study. *BMJ* 1989;**299**:1010-2.
17 Marks V, Dawson A. Rapid stick method for determining blood glucose concentration. *BMJ* 1985;**290**:293-4.
18 Stahler F. The technology of dry versus wet chemistry. In: Marks V, Alberti KGMM, eds. *Clinical biochemistry nearer the patient* II. Eastbourne: Baillière Tindall, 1986:10-20.
19 Price CP, Koller PU. A multicentre study of the new Reflotron system for the measurement of urea, glucose, triacylglycerols, cholesterol, γ-glutamyltransferase and haemoglobin. *J Clin Chem Clin Biochem* 1988;**26**:233-50.
20 Maguire TA, McElnay JC. Performance of "bench top" cholesterol analysers. *Pharmaceutical Journal* 1990 May 12:566-8.
21 Okuda K. A compact, automated, dry-reagent chemistry analyzer. *Journal of the International Federation of Clinical Chemistry* 1990;**2**:39-44.
22 Zuk RF, Ginsberg VK, Houts T, *et al*. Enzyme immunochromatography—a quantitative immunoassay requiring no instrumentation. *Clin Chem* 1985;**31**:1144-50.
23 Cuss FM, Palmer JB, Barnes PJ. Rapid estimation of plasma theophylline concentrations. *BMJ* 1985;**291**:384.
24 Mould G, Marks V. The use of solid-phase chemistry in therapeutic drug monitoring. *Clin Pharmacokinet* 1988;**14**:65-70.
25 Chandler MHH, Clifton GD, Louis BA, *et al*. Home monitoring of theophylline levels: a novel therapeutic approach. *Pharmacotherapy* 1990;**10**:294-300.
26 Anonymous. TDM for community pharmacists? [Editorial]. *Pharmaceutical Journal* 1990 Sept 15:357.
27 Paz G, Yogev L, Gottreich A, *et al*. Determination of urinary luteinizing hormone for prediction of ovulation. *Gynecol Obstet Invest* 1990;**29**:207-10.
28 Marks V. The economics of near-patient testing. In: Kerkhof PLM, van Dieijen-Visser MP, eds. *Laboratory data and patient care*. New York: Plenum, 1988:17-23.
29 Harter G, Klimm HD, Konig B, Koberstein R. Evaluation of dry chemistry laboratory methods for step diagnosis in general medicine. *Fortschr Med* 1990;**108**:61-6.
30 Shephard MDS, Penberthy OA, Fraser CG. Urinalysis in an Australian teaching hospital. *Med J Aust* 1982;i:300-1.
31 Drucker RF, Williams DRR, Price CP. Quality assessment of blood glucose monitors in use outside the hospital laboratory. *J Clin Pathol* 1983;**36**:948-53.
32 Rady AA, Jones KW, Halloran SP, Marks V. Bedside blood glucose measurement: quality control and assessment. *Ann Clin Biochem* 1987;**24**(suppl 2):170-1.
33 Smith LA, McNaught J, Hutchinson AS. How well do nurses perform blood glucose analyses at the diabetic clinic? An assessment using the Reflotron analyser. *Ann Clin Biochem* 1990;**27**:156-7.
34 Blackburn J. Curbing the cost of consumables. *Doctor* 1990 April:72.
35 Venables MGM. Cutting the cost of urine tests. *Practice Update* 1990 June:1206.
36 Gallagher EJ, Schwartz E, Weinstein RS. Performance characteristics of urine dipsticks stored in open containers. *Am J Emerg Med* 1990;**8**:121-3.
37 Fraser CG, Geary TD, McLellan GH. Guidelines for the performance of clinical biochemistry tests outside laboratories. *Clinical Biochemistry Reviews* 1981;**2**:24-5.
38 Anonymous. Cholesterol testing: council guidelines [Editorial]. *Pharmaceutical Journal* 1988 Dec 17:786.
39 Marks V. Essential considerations in the provision of near-patient testing facilities. *Ann Clin Biochem* 1988;**25**:220-5.
40 Department of Health and Social Security. *Blood glucose meters*. London: DHSS, 1987. (Hazard notice HN (87)13.)
41 Ashby JP, Blundell G. Dry slide clinical chemistry. *Lancet* 1990;**336**:886.

Bovine somatotrophin and public health

Need for further independent and more extensive investigation

Last December the European Council of Agriculture Ministers agreed to extend for a year the ban on the commercial use of recombinant bovine somatotrophin to boost the milk yield of dairy cows, "pending the results of relevant scientific experiments."[1] For the past four years it has been used only on a few commercial farms (of undisclosed identity) for purposes of evaluation, although milk from treated cows has been mixed with the normal supply to consumers. Concerns have been expressed that treatment may jeopardise animal health, but official pronouncements have so far denied that milk from treated animals poses any threat to human health.[2] Yet preserving consumer confidence, strained by recent food scares, may demand more than ex cathedra statements.

Potential risks to human health of bovine somatotrophin excreted in milk have been much debated. Several reasons have been advanced for discounting them. Only a very small amount of bovine somatotrophin finds its way into milk and what does is biologically inactive in humans, is destroyed by pasteurisation, and is likely to suffer extensive proteolysis on ingestion.[2] Critics claim that as most recombinant somatotrophins are xenobiotics (differing from pituitary somatotrophin by from one to nine amino acid residues) they might induce immunogenic or allergenic responses at the gut wall if not systemically.[3] Insulin-like growth factor 1 is potentially a more serious risk as its concentration in milk increases in parallel with bovine somatotrophin's galactopoietic effect. Bovine insulin-like growth factor 1 is identical to human insulin-like growth factor 1: it is a potent mitogen and is not destroyed by pasteurisation.[2] Moreover, in colostrum insulin-like growth factor 1 exists in a truncated form, up to 10 times more potent than insulin-like growth factor 1 itself.[4]

Assurances of the safety of milk from cows treated with bovine somatotrophin are therefore based on the presumption that increased concentrations of insulin-like growth factor 1 in milk, even if statistically significant, are not biologically important. Evidence used to support this view includes the observations that concentrations of insulin-like growth factor 1 remain in the "physiological range" and that when given orally to rats no systemic effects occurred.[2] Such assertions, however, need qualifying. Firstly, including the concentration of insulin-like growth factor 1 in colostrum in the "physiological range," though scientifically valid, is misleading. Colostrum, whose concentration of insulin-like growth factor 1 falls from greater than 150 μg/l at calving to about 25 μg/l within four days,[5] is not marketed.

Moreover, reports of the increase in insulin-like growth factor 1 concentration vary greatly[2]: one described a 360% increase after just seven daily injections,[6] whereas it is proposed that in commercial practice "14 days' worth" would be injected once every fortnight. Even if all concentrations remained in the physiological range the mean values would increase. Secondly, some significant responses to oral insulin-like growth factor 1 in rats were reported (for example, increased tibia length) but, questionably, were discounted as unrelated to treatment.[2] Perhaps, more importantly, there are virtually no published reports of the presence or potency of truncated insulin-like growth factor 1 in milk of cows treated with bovine somatotrophin or of the effects