DEPARTMENT OF HEALTH (1999) *Modern Standards and Service Models. National Service Framework for Mental Health* (http://www.hcsu.org.uk/index.php?option=com_content&task=view&id=243&Itemid=109).

DEPARTMENT OF HEALTH (2005) *National Service Framework for Long-term Conditions* (http://www.dh.gov.uk/en/publicationsandstatistics/publications/publicationspolicyandguidance/dh_4105361).

FLEMINGER, S., LEIGH, E. & McCARTHY, C. (2006) The size of demand for specialised neuropsychiatry services: rates of referrals to neuropsychiatric services in South Thames region of the United Kingdom. *Journal of Neuropsychiatry and Clinical Neurosciences*, **18**, 121–128.

LEONARD, F., MAJID, S., SIVAKUMAR, K., *et al* (2002) Service innovations: a neuropsychiatry outreach clinic. *Psychiatric Bulletin*, **26**, 99–101.

LIDZ, T. (1966) Adolf Meyer and development of American psychiatry. *American Journal of Psychiatry*, **159**, 695–704.

MITCHELL, A. J. & AGRAWAL, N. (2005) Training in neuropsychiatry: is it time to reintegrate into mainstream

psychiatry? *Psychiatric Bulletin*, **29**, 361–364.

YUDOFSKY, S. C. & HALES, R. E. (2002) Neuropsychiatry and future of psychiatry and Neurology. *American Journal of Psychiatry*, **159**, 1261–1264.

*Niruj Agrawal Consultant in Neuropsychiatry, Department of Neuropsychiatry, Clare House, St George's Hospital, London SW17 0QT, email: Niruj.Agrawal@swlstg-tr.nhs.uk, **Simon Fleminger** Consultant in Neuropsychiatry, **Howard Ring** Consultant in Developmental Neuropsychiatry, **Shoumitro Deb** Clinical Professor of Neuropsychiatry and Intellectual Disability

original papers

LUKE SOLOMONS, ADRIAN TRELOAR AND RYAN NORONHA

Competence of psychiatric clinicians in interpreting electrocardiograms and QT intervals: can they do this? Does it matter?

AIMS AND METHOD
We assessed the abilities of trainee and consultant psychiatrists in reading and interpreting electrocardiograms (ECGs) and QT intervals using a questionnaire and standardised ECG.

RESULTS
Only 5% of our sample of trainee and consultant psychiatrists could correctly indicate a QTc interval. Performances on other measures, such as rate were also poor, with senior house officers performing better than consultants.

CLINICAL IMPLICATIONS
The increased awareness of problems caused by antipsychotics has not been reflected in improved knowledge of ECGs among psychiatrists. Machines do not reliably calculate QT intervals. We therefore urge better training and understanding of ECGs for psychiatrists.

People with mental illnesses, especially schizophrenia, have a higher mortality rate than the general population, the causes of which are yet poorly understood but could be related to side-effects of antipsychotic medication (Waddington *et al*, 1998). Psychotropic medication has been shown to increase the risk of serious ventricular arrhythmias and thus, sudden cardiac death. Ray *et al* (2001) and Liperoti *et al* (2005) showed that moderate doses of antipsychotics were associated with large absolute and relative increases in the risk of sudden cardiac death. Prolonged QT intervals reflect electrical dysfunction of the myocardium and may indicate predisposition to malignant tachycardias and sudden death. The QT interval is prolonged by a slow pulse and being female, and shortened by anxiety. Importantly, drugs and ischaemia can also prolong it. The corrected QT (QTc) gives a better indication of the risks by allowing for the pulse rate. There are various methods of calculating this, but the most commonly used is the Bazett's formula (Box 1) because of its relative simplicity, despite inaccuracies associated with heart rate. Failure to identify a prolonged QT leaves patients at risk of sudden death.

Recent work by Minerotti *et al* (2006) has shown increased QTc intervals in healthy men with neurotic personality traits, in alcohol dependence syndrome (Borini *et al*, 2003), and in incident diabetics (Carnethon

et al, 2006). The new consensus statement on high-dose antipsychotic medication from the Royal College of Psychiatrists (2006) recommends assessing cardiovascular risk with electrocardiogram (ECG) monitoring prior to use of antipsychotic medication to reduce risk of arrhythmias – we presume this has increased awareness and ordering of ECGs. Proper monitoring of QTc interval may detect prolongation and reduce occurrence of potentially lethal cardiac arrhythmias.

In this context, doctors have come to be more dependent upon computer ECG interpretation. The reliability of such programs has not been proven (Willems *et al*, 1991). Standards regarding the accuracy of these readings were developed in the 1980s, but they have been largely ignored. Recent work in this area (Krishnan *et al*, 2006) has highlighted their deficiencies. The British Heart Foundation (2005) advises that computer-assisted ECG interpretation can identify important anomalies, but errors are common and interpretation should not be accepted without visual inspection. Electrocardiogram departments and cardiologists lack the capacity to provide a QTc validation service. We thus feel that psychiatrists should be competent in this skill – the Royal College of Psychiatrists recommended this in a consensus statement on high-dose antipsychotic medication (Royal College of Psychiatrists, 2006).

Box 1.   QTc calculating formula

Bazett's formula:

$$QTc = \frac{QT}{\sqrt{RR}}$$

QTc, QT interval corrected for rate; RR, interval from the onset of one QRS complex to the onset of the next QRS complex, measured in seconds.

Bazett's formula over-corrects at high heart rates and under-corrects at low heart rates, but it is widely used in clinical practise because of its simplicity.

In a small study, Warner *et al* (1996) reported that less than 20% of psychiatric trainees were able to identify a prolonged QT interval on an ECG. Moreover, studies in medical and surgical specialties have shown lack of elementary knowledge of ECGs among non-psychiatric doctors (Montgomery *et al*, 1994). Ten years on from the publication of Warner *et al*'s study we aimed to find out how much psychiatric clinicians knew about interpretation of aspects of an ECG of immediate clinical relevance.

Method

The study was carried out in London (Oxleas National Health Service (NHS) Foundation Trust) and Manchester (Bolton, Salford and Trafford Mental Health NHS Trust) hospitals, over a 6-month period. Both consultants and trainees in psychiatry were approached with a short questionnaire.

A pilot study produced deceptively good results, as participants took the questionnaires away and filled in researched, perfect answers. Therefore, in the proper study, we asked participants to fill out a semi-structured questionnaire (nine questions in total; see online data supplement 1) in approximately 10 minutes, with the researcher present. Each participant was presented with this questionnaire and a copy of an ECG of a healthy person (online data supplement 2) with instructions to calculate the rate, mark out the QT interval and calculate the QTc. The questionnaire (one side of an A4 sheet) comprised basic questions about grade, post-graduate training in other specialties, medication on which they monitored ECGs and calculation of rate, QT and QTc – all questions considered most relevant in the literature and clinical practice. We did not insist on exact calculation of the QTc, which would have required a calculator, but accepted the answer as right if the formula was written down. The normal ECG used showed a heart rate of 66 beats per minute with a QT interval of 0.38 seconds. We used the Bazett's formula to calculate the QTc, which was 0.39 seconds.

We aimed to approach 100 doctors and to get roughly equal numbers of senior house officers *v.* specialty registrars and consultants. As senior house officers congregated at the Member of the Royal College of Psychiatrists (MRCPsych) course teaching it was easy to get them to fill out the forms and return them between

lectures. Things were more difficult with consultants and a number of questionnaires were left uncompleted as we were asked to return later to collect them. Our responses from consultants for non-participation varied: some did not have the time, some felt it was not relevant to them, and some gave no explanation at all. A total of 49 senior house officers in psychiatry, out of 64 approached (77%, pre-membership), 8 out of 10 specialist registrars (80%) and 5 out of 26 general adult, old age, forensic and learning disability consultants (19%) agreed to complete the semi-structured questionnaire (total response rate 62%). As copies of the same ECG of a healthy person verified by a cardiologist was used, there were no uncertainties about the rate, QT interval and QTc.

Results

No statistically significant differences were noted in responses between hospitals in the two cities and the data was pooled.

Using Fisher's exact test, subgroup analysis showed that clinicians with previous experience in other medical specialties were significantly more likely to calculate the heart rate correctly ($P=0.0193$, Fisher's exact test). However, they were no more likely to read ECGs themselves or able to perform QT interval indication/calculation ($P=1$) than those with no medical experience.

Specialty registrars and consultants were significantly less likely to read ECGs and calculate the heart rate correctly themselves ($P=0.0245$, Fisher's exact test) than senior house officers (the small number of participating consultants severely limits the validity of these

Table 1.   Overview of ECG interpretation by psychiatric clinicians

Parameter	Percentage of respondents (*n*=62)
Pre-membership trainees (senior house officers)	79%
Post-membership psychiatrists (specialty registrars & consultants)	21%
Previous experience in medicine/on accident and emergency wards	38%
Regularly monitored ECGs on patients	83%
When monitoring ECGs,	
Read ECGs themselves	69%
Rely exclusively on computerised readings	31%
On what psychotropic classes was ECGs monitored	
Antipsychotics	78%
Antidepressants	70%
Lithium and mood stabilisers	23%
Clozapine therapy	22%
Features checked	
Heart rate and rhythm	56%
Ischaemic changes	61%
QT interval	70%
Not confident about ECG interpretation	72%

ECG, electrocardiogram.

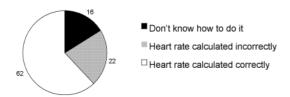| Table 2. Calculation of heart rate and QTc	
Parameter	Percentage of respondents (*n*=62)
Heart rate calculation correct (margin of error − 10%)	62%
Heart rate incorrect	22%
	(16% did not calculate)
QT interval marked on ECG	23%
QT interval marked on ECG correctly	15%
QTc indicated correctly (margin of error − 10%)	5%
ECG, electrocardiogram.	

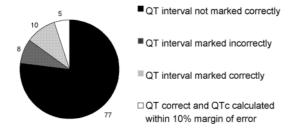*Fig. 1. Heart rate calculation (%).*

Fig. 2. QT interval calculation.

conclusions). QT interval indication/calculation was equally poor for both groups.

General questions

About three-quarters of respondents felt the questionnaire had highlighted deficiencies in their knowledge (Table 1).

Calculations

The respondents' ability to calculate heart rate and QT interval on the ECG is shown in Table 2 and Figs. 1 and 2. Only 62% of respondents calculated the heart rate correctly and 5% correctly indicated/calculated QTc using Bazett's formula.

Presentation of the findings and discussion with colleagues at an Oxleas NHS Trust audit meeting brought forward suggestions that psychiatrists could not be expected to read ECGs and that they should depend on

automated readings and on general practitioners to provide physical healthcare (including interpreting ECGs).

Krishnan *et al* (2006) suggest overreading of 12 lead ECGs is required to circumvent errors of computerised ECG interpretation. In light of this, we undertook a further audit of ECG tracings of machines used by the Oxleas NHS Foundation Trust, looking at the accuracy of the measurement of QT intervals. Fifty-three consecutive ECGs performed on three of the Trust's five Mortara Eli 250 electrograph machines (which use Mortara's Veritas analysis algorithm for interpretation) were reviewed. We found that on a sample of 53 consecutive ECGs, seven QT intervals were incorrectly measured. Thus, 13% of the sample of Trust ECG machine QT reports were inaccurate and 6% had underestimated QT interval.

Discussion

This study suggests that knowledge of role of ECGs and the interpretation of heart rate, QT interval measurement and QTc calculation is unsatisfactory among psychiatrists. The study was carried out across teaching and non-teaching settings in a sample we expect is representative of UK psychiatrists generally, though several consultants did not participate for various reasons, which may limit the generalisation of findings. Our sample size of 64 respondents was more than twice the size of the earlier study of psychiatric trainees by Warner *et al* (1996). Our response rate was 62% compared with 97% in the earlier study. We endeavoured to cover all trainees and consultants in the participating hospitals, but were limited by the nature of our criteria, namely that the specified questionnaires be completed and returned immediately to the researchers. There were statistically significant differences between the trainee and consultant groups, but the small number of consultants could affect validity.

Most respondents were aware of the need to monitor ECGs, but a significant proportion was unable to calculate heart rate and measure QT intervals. These findings replicate those of previous studies (Montgomery *et al*, 1994) of doctors working in acute medicine, in which 24% of doctors correctly identified the QT interval, as well as a study of psychiatrists in training (Warner *et al*, 1996) in which 20% of the sample identified prolonged QT intervals correctly. We expected that the increased awareness of the cardiotoxicity of psychotropics and interaction between medications would have made psychiatrists more adept at QT interval and ECG abnormality interpretation, but this study indicates that the problem remains.

As reviewed in the introduction, evidence suggests that it is important to monitor QT intervals and ECGs in high-risk patient groups. The British Heart Foundation has presented good evidence, in line with the Oxleas Trust audit, that computerised readings of ECGs are not completely reliable. Data suggest that the type of error made by computerised ECG recording includes dangerous underestimation of the QT interval. Requesting other clinicians to check all ECGs will have huge resource and time implications. We therefore think it essential that

293

original
papers

psychiatrists improve their skills in this important area. The view that psychiatrists monitor mental health and do not have time to provide holistic care is potentially dangerous. O'Brien & Oyebode (2003), acknowledging that widespread monitoring of the psychiatric population is difficult, suggested that some interested psychiatrists may do more of this work than others. We argue that ECG interpretation is a basic medical skill and calculation of rate, rhythm and QTc measurement are relatively straightforward and deserve to be carried out within existing services (for a short instruction on how to interpret ECGs see online data supplement 3).

The statement on high-dose antipsychotic medication published by the Royal College of Psychiatrists (2006) calls for training in ECG interpretation for clinicians, and also for ready access to a cardiologist for interpretation. This need is being addressed in some ways by the introduction of an ECG interpretation Observed Standardised Clinical Examination (OSCE) station in the MRCPsych exam and could be one reason for improved knowledge of ECGs among senior house officers compared with consultants. Introduction of mandatory ECG teaching for psychiatrists in training and refresher courses for consultants is one way forward and will help improve the care of our patients.

Declaration of interest

None.

References

ABDELMAWLA, N. & MITCHELL, A. J. (2006) Sudden cardiac death and antipsychotics. Part 2: Monitoring and prevention. *Advances in Psychiatric Treatment*, **12**, 100–109.

BORINI, S. B., TERRAZAS, J. H., FERREIRA JÚNIOR, A., *et al* (2003) Female alcoholics: electrocardiographic changes and associated metabolic and electrolytic disorders. *Arquiros Brasileiros de Cardiologia*, **81**, 506–517.

BRITISH HEART FOUNDATION (2005) Factfile 12 Computer-Assisted ECG Interpretation. British Heart Foundation (http://www.bhf.org.uk/research_health_professionals/health_professionals/factfiles.aspx).

CARNETHON, M. R., PRINEAS, R. J., TEMPROSA, M., *et al* (2006) The association among autonomic nervous system function, incident diabetes, and intervention arm in the diabetes prevention program. *Diabetic Care*, **29**, 914–919.

KRISHNAN, S. & BOGUN, F. (2006) Accuracy of electrocardiogram interpretation by cardiologists in the setting of incorrect computer analysis. *Journal of Electrocardiology*, **39**, 343–345.

LIPEROTI, R., GAMBASSI, G., LAPANE, K. L., *et al* (2005) Conventional and atypical antipsychotics and the risk of hospitalization for ventricular arrhythmias or cardiac arrest. *Archives of Internal Medicine*, **165**, 696–701.

MINORETTI, P., POLITI, P., MARTINELL, V., *et al* (2006) QT interval duration in apparently healthy men is associated with depression-related personality trait neuroticism. *Journal of Psychometric Research*, **61**, 19–23.

MONTGOMERY, H., HUNTER, S., MORRIS, S., *et al* (1994) Interpretation of electrocardiograms by doctors. *BMJ*, **309**, 1551–1552.

O'BRIEN, P. & OYEBODE, F. (2003) Psychotropic medication and the heart. *Advances in Psychiatric Treatment*, **9**, 414–423.

RAY, W. A., MEREDITH, S., THAPA, P. B., *et al* (2001) Antipsychotics and the risk of sudden cardiac death. *Archives of General Psychiatry*, **58**, 1161–1167.

ROYAL COLLEGE OF PSYCHIATRISTS (2006) *Consensus Statement on High-Dose Antipsychotic Medication.* Council report [CR138] (http://www.rcpsych.ac.uk/files/pdfversion/CR138.pdf).

TRELOAR, A. & SHARMA, S. (2006) Audit of QT interval automated readings – Oxleas Foundation NHS Trust Audit report (unpublished). Report available from authors.

WADDINGTON, J. L., YOUSSEF, H. A. & KINSELLA, A. (1998) Mortality in schizophrenia. Antipsychotic polypharmacy and absence of adjunctive anticholinergics over the course of a 10-year prospective study. *British Journal of Psychiatry*, **173**, 325–329.

WARNER, J. P., GLEDHILL, J. A., CONNELL, F., *et al* (1996) How well do psychiatric trainees interpret electrocardiograms. A cross-sectional survey. *Psychiatric Bulletin*, **20**, 651–652.

WILLEMS, J. L., ABREU-LIMA, C., ARNAUD, P., *et al* (1991) The diagnostic performance of computer programs for the interpretation of electrocardiograms. *New England Journal of Medicine*, **325**, 1767–1773.

*Luke Solomons Specialist Registrar, Department of Neuropsychiatry, St Thomas Hospital, Westminster Bridge Road, London SE1 7EH, email: luke.solomons@gmail.com, **Adrian Treloar** Consultant and Senior Lecturer in Old Age Psychiatry, Memorial Hospital, London, **Ryan Noronha** Senior House Officer, General Adult Psychiatry, Manchester Royal Infirmary, Manchester