A Survey of Health Care Practitioners' Knowledge of the QT Interval

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OBJECTIVE: To assess health care practitioners' ability to correctly measure the QT interval, and to identify factors and medications that may increase the risk of QT-interval prolongation and torsades de pointes.

DESIGN: A cross-sectional analysis of a survey administered between April 2002 and March 2003.

PARTICIPANTS AND SETTING: Health care practitioners attending Grand Rounds Conferences at 6 academic institutions in the United States in internal medicine and psychiatry and at 6 community hospitals in the same geographical areas as the academic institutions.

INTERVENTION: Anonymous, self-administered questionnaire that included 20 questions on the QT interval.

MEASUREMENTS AND MAIN RESULTS: Of approximately 826 attendees, 517 (63%) completed the survey. Of about 608 attendees of internal medicine conferences, 371 (61%) responded, and of about 208 attendees of psychiatry conferences, 146 (67%) responded. Of a total number of 20 questions, the median number of correct answers for the whole group was 10 (interquartile range 7–13). The median number of correct answers for internists was 12 (interquartile range 9–13), for psychiatrists 10 (interquartile range 7–13), and for other specialists 10 (interquartile range 5–13). Respondents who graduated between 1990 and 1999 and academicians performed significantly better overall than other respondents. Of the 517 respondents, 224 (43%) measured the QT interval correctly. Physicians in training and academicians were more likely to measure the QT interval correctly.

CONCLUSION: The majority of health care practitioners cannot correctly measure the QT interval and cannot correctly identify factors and medications that can prolong the QT interval. Our findings suggest that greater attention to the QT interval is warranted to ensure safer use of QT prolonging medications.

KEY WORDS: QT interval; survey; health care practitioners.

DOI: 10.1111/j.1525-1497.2005.0101.x

J GEN INTERN MED 2005; 20:392–396.

Accepted for publication January 4, 2005

Sana Al-Khatib, Nancy Allen LaPointe, Judith Kramer, Anita Chen, Bradley Hammill, and Liz Delong have no conflicts of interest in relation to this paper.

Robert Califf is the director of the Duke Clinical Research Institute. The following provide support for clinical research at the Duke Clinical Research Institute: Actelion, Agilent Technologies, Amgen, Astra Zeneca, Aventis, Biotechnology General Corporation, Boehringer Ingelheim, Bristol Myers Squibb, Centocor, Chiron, Dade Behring, Daiichi, Eli Lilly, Genentech, GlaxoSmithKline, Guidant, Hewlett Packard, Hoffman-LaRoche, Integrus Baptist Medical Center, The Medicines Company, Intracel, Johnson and Johnson, Knoll Ag, Lincare, MEDCO Research, Medtronic, Merck, Millenium, Novartis, Ortho Biotech, Otsuka, Parke Davis, Pfizer, Pharmacia/Upjohn, Proctor and Gamble, Rhone Poulenc Rorer, Roche, Sanofi, Schering Plough, Warner-Lambert/Parke-Davis, Wyeth-Ayerst, and Yamanouchi.

These results were presented at the American College of Cardiology's 53rd annual scientific sessions in New Orleans, LA, March 8, 2004.

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See editorial by Williams and Gerrity, p. 450.

Several medications are associated with QT-interval prolongation that can predispose patients to a distinctive type of ventricular tachycardia known as torsades de pointes.^{1–4} To enhance the safety of such medications, health care practitioners must be able to balance the risk and benefit of QT prolonging medications. To that end, they should know how to measure the QT interval, should be familiar with drugs and other factors that could prolong the QT interval, and should be cognizant of how to properly monitor the QT interval. The QT interval is measured from the beginning of the QRS complex to the end of the T wave; however, data on the best way to adjust the measured QT for changes in heart rate are lacking. Despite paucity of information regarding the proper measurement and monitoring of the QT interval for many QT prolonging drugs, health care practitioners should have basic knowledge of what is currently known.⁵

The percentage of physicians who know how to measure the QT interval is not known. One study showed that of 158 physicians of diverse specialty and seniority, only 24% were able to define the QT interval correctly.⁶ A recent pilot survey of health care practitioners who were predominately specialists in cardiology suggested that there is a knowledge deficit in measuring the QT interval and in identifying factors and medications associated with QT-interval prolongation and torsades de pointes.⁷ To more fully evaluate the extent of this knowledge deficit, we surveyed health care practitioners attending 6 Internal Medicine and 6 psychiatry conferences. We specifically sought to determine whether practitioners know how to measure the QT interval, and whether they are familiar with medications and factors that can cause QT-interval prolongation.

METHODS

Study Population

Using a ranking published by the *US News and World Report* in 2001, we identified the 3 highest ranked academic institutions in Internal Medicine and the 3 highest ranked academic institutions in psychiatry.⁸ We solicited the participation of these 6 programs in the survey. One of the highest ranked 3 academic institutions in Internal Medicine declined to participate; therefore, we solicited the participation of the fourth-ranked institution. This institution agreed to participate.

None of the 3 highest ranked academic institutions in psychiatry responded to our request to participate in the survey. Thus, we solicited the participation of academic institutions that were ranked in the top 10. Three of these top 10 ranked institutions agreed to participate.

After the academic institutions were selected, suggestions from each academic institution were used to select one community hospital in the same geographical area as the academic institution. For each academic institution in Internal Medicine, one community hospital with a large staff of internists

was selected. For each academic institution in psychiatry, one community hospital with a large staff of psychiatrists was selected.

Survey Design and Administration

Because we wanted to survey practitioners attending a Grand Rounds conference, we contacted coordinators of Grand Rounds conferences at each of these institutions and informed them of the survey. To enhance the uniformity of survey methods at all institutions, 1 or more members of our research team oversaw the distribution and collection of the surveys at 7 of the 12 institutions. At the remaining 5 institutions, administrative personnel were identified within the institution to distribute and collect the surveys. These administrative personnel were given specific instructions on how to distribute and collect the surveys. At all 12 institutions, the surveys were distributed at the beginning of a Grand Rounds conference and participants were allowed approximately 10 minutes to complete the surveys. Of the 12 participating institutions, 4 (2 academic and 2 community institutions) invited us to give a presentation on the QT interval at the same time the survey was conducted. At these sites, all completed surveys were collected before the presentation started; no survey was accepted after the presentation had started. At other sites, some of the surveys were collected at the end of the conference as the topic of the conference was not related to the QT interval.

The survey was conducted using an anonymous, self-administered questionnaire. The questionnaire was modified from a previous questionnaire that had been used in a pilot study assessing knowledge of the QT interval.⁷ That questionnaire was developed using literature reviews, focus groups, and comments from experts in this field. The questionnaire for this survey was pretested by a small number of physicians; it was designed to take no more than 10 minutes to complete.

The questionnaires were administered between April 2002 and March 2003. Response enhancement methods included announcement of the importance of the survey before distributing the questionnaires, participation of at least 1 of the investigators in administration of the questionnaire (at 7 out of 12 institutions), and repeating the administration of the survey once at 2 of the institutions. At institutions where the survey was repeated, screening of the completed questionnaires showed that there were no potential duplicates. The overall survey response rate was 63% (61% at Internal Medicine programs and 67% at psychiatry programs). The response rate was 57% (range 29%–95%) at academic institutions and 75% (range 55%–100%) at community hospitals.

Content of Questionnaire

The questionnaire consisted of 2 sections (see Appendix, available online). The first section contained 4 questions intended to collect information on participants' professional status, area of specialization, gender, and year of graduation from professional school.

The second section included 20 questions on the QT interval. One of these questions was an open-ended question in

which the participant was asked to measure and record the QT interval on an electrocardiogram (ECG) strip displaying 1 sinus beat with distinct onset of the QRS complex and offset of the T wave. Answers to this question were considered correct if they were within a prespecified measurement error of 20 milliseconds from the actual value. Answers recorded in seconds rather than milliseconds were also considered correct if they were within 0.02 second of the actual value in seconds. The other 19 questions were fixed response questions and inquired about factors, drugs, and drug combinations that could prolong the QT interval (see Appendix). These drugs were chosen because they are commonly prescribed by Internists and psychiatrists and most of the drug combinations were selected because their concomitant use is declared as contraindicated in the labeling of these drugs. We finally asked participants when they would check an ECG to assess the QT interval if they start a medication that could prolong the QT interval.

Statistical Analysis. Continuous variables are presented as medians with 25th and 75th percentiles and categorical variables as frequencies. Multivariable linear regression analyses were performed to identify variables that correlate with the total number of correct answers, the number of correct answers to the 8 questions related to factors that can prolong the QT interval, and the number of correct answers to the 10 questions related to medications that can prolong the QT interval. Because physicians within a hospital are more likely to be similar, random effects models were used to adjust for correlations among clustered responses⁹ (e.g., within hospital correlations). Random effects models allow fixed effects and random effects in the linear models where the random effects are the hospitals. A stepwise procedure was used for selecting variables that correlated with correctly measuring the QT interval. Results were declared significant at $P < .05$. All analyses were performed using SAS software (SAS Institute, Cary, NC).

RESULTS

Characteristics of Sample

The overall number of respondents was 517. Of about 608 attendees of Internal Medicine conferences, 371 (61%) responded, and of about 208 attendees of psychiatry conferences, 146 (67%) responded. Characteristics of the survey sample are presented in Table 1. Of the 517 respondents, 192 (37%) were attending physicians, 204 (39%) were physicians in training, 48 (9.3%) were medical students, 13 (2.5%) were nurses, 7 (1.4%) were physician assistants, 7 (1.4%) were pharmacists, and 46 (9%) either had another professional status or did not answer this question.

Attendees of Internal Medicine and psychiatry conferences were similar in gender and distribution of professional status. The specialties of attendees of Internal Medicine and psychiatry conferences were significantly different. The proportion of attendees of Internal Medicine conferences who graduated after 1999 was appreciably higher than that of attendees of psychiatry conferences (39% vs 20%).

Table 1. Characteristics of the Survey Sample

	All Respondents (N=517)	Attendees of Internal Medicine Grand Rounds (n=371)	Attendees of Psychiatry Grand Rounds (n=146)	P Value
Gender (%)				
Male	312 (60)	229 (62)	83 (57)	.276
Female	203 (39)	140 (38)	63 (43)	
Missing	2 (0.4)	2 (0.5)	0	
Professional status (%)				
Attending physician	192 (37)	131 (35)	61 (42)	.272
Physician in training	204 (39)	154 (42)	50 (34)	
Other status	111 (22)	79 (21)	32 (22)	
Missing	10 (2)	7 (2)	3 (2)	
Specialty (%)				
Internal medicine	204 (39)	201 (54)	3 (2)	<.001
Psychiatry	120 (23)	1 (0.3)	119 (82)	
Cardiology	50 (10)	50 (14)	0	
Family practice	14 (3)	11 (3)	3 (2)	
Other specialty*	106 (21)	90 (24)	16 (11)	
Missing	23 (4)	18 (5)	5 (3)	
Year of graduation (%)				
Graduation before 1990	171 (33)	111 (30)	60 (41)	<.001
Graduation between 1990 and 1999	156 (30)	107 (29)	49 (34)	
Graduation after 1999	174 (34)	144 (39)	30 (20)	
Missing	16 (3)	9 (2)	7 (5)	

*Of the 106 respondents who listed a specialty other than cardiology, family practice, Internal Medicine, or psychiatry, only 11 appeared to be non-clinicians.

Overall Performance

The median number of correct answers for the whole group was 10 (interquartile range 7–13). The median number of correct answers for internists was 12 (interquartile range 9–13), for psychiatrists 10 (interquartile range 7–13), and for other specialists 10 (interquartile range 5–13). Figure 1 illustrates the distribution of scores.

Variables that correlated with the overall number of correct answers are presented in Table 2. As compared with respondents who graduated before 1990, those who graduated between 1990 and 1999 had 1.13 more correct answers. As compared with physicians in training, respondents with professional status other than attending physician had 2.52 fewer correct answers. Academicians had 2.36 more correct answers than nonacademicians. These comparisons were statistically significant.

Correct Measurement of the QT Interval

Of the 517 respondents, 224 (43%) measured the QT interval correctly (i.e., gave an answer between 400 and 440 millisec-

onds or between 0.40 and 0.44 second). Figure 2 shows distribution of QT measurements. In an adjusted analysis, 2 factors were determined to increase the odds of measuring the QT interval correctly. These factors were physicians in training (OR, 1.74; 95% CI, 1.04 to 2.91) and academicians (OR, 2.25; 95% CI, 1.67 to 3.05).

Correct Identification of Factors and Medications Associated with QT Prolongation

For the 8 questions on factors that can prolong the QT interval, the median number of correct answers for internists was 5 (interquartile range 4–6), for psychiatrists 4 (interquartile range 2–5), and for other specialists 4 (interquartile range 2–6). For the 10 questions on medications that can prolong the QT interval, the median number of correct answers for internists was 5 (interquartile range 3–7), for psychiatrists 5 (interquartile range 3–7), and for other specialists 5 (interquartile range 2–6).

Academicians answered correctly 1.05 more questions related to factors that can prolong the QT interval than non-academicians. As compared with physicians in training, respondents with professional status other than attending physician had 0.71 fewer correct answers to questions on factors that could prolong the QT interval. These comparisons were statistically significant.

Respondents who graduated between 1990 and 1999 were more likely to correctly answer questions on medications that can prolong the QT interval than respondents who graduated before 1990. Compared with physicians in training, respondents with professional status other than attending physician correctly answered 1.61 fewer questions on medications that can prolong the QT interval. Academicians gave 1.09 more correct answers to questions on medications that can prolong the QT interval than nonacademicians. These comparisons were statistically significant.

FIGURE 1. Distribution of scores of participants in the survey.

Table 2. Estimates for Variables that Correlate with Answering Questions Correctly

Variable	All Questions		Questions on Factors that Can Prolong the QT Interval		Questions on Medications that Can Prolong the QT Interval	
	Adjusted Estimates [‡] (95% CI)	P Value	Adjusted Estimates [‡] (95% CI)	P Value	Adjusted Estimates [‡] (95% CI)	P Value
Graduation after 1999*	−0.27 (−1.28 to 0.74)	.002	−0.10 (−0.63 to 0.42)	.558	−0.31 (−0.94 to 0.32)	<.001 [§]
Graduation between 1990 and 1999*	1.13 (0.27 to 1.99)		0.14 (−0.31 to 0.58)		0.90 (0.37 to 1.44)	
Attending physician [†]	−0.32 (1.27 to 0.62)	<.001	0.16 (−0.32 to 0.65)	.002	−0.34 (−0.93 to 0.24)	<.001
Professional status other than attending physician [†]	−2.52 (−3.43 to −1.60)		−0.71 (−1.18 to −0.24)		−1.61 (−2.17 to −1.04)	
Practicing at an academic institution	2.36 (1.03 to 3.69)	<.001	1.05 (0.40 to 1.71)	.002	1.09 (0.34 to 1.84)	.005

*Reference variable is graduation before 1990.

[†]Reference variable is physicians in training.

[‡]Estimates should be interpreted as follows: negative estimates indicate a fewer number of correct answers, positive estimates indicate a higher number of correct answers.

[§]P values are for any difference among the 3 comparison groups (graduation before 1990, graduation between 1990 and 1999, and graduation after 1999).

^{||}P values are for any difference among the 3 comparison groups (attending physician, professional status other than attending physician, and physicians in training).

Monitoring of the QT Interval

Four hundred nineteen respondents (81%) stated that they would check an ECG before and after starting a QT prolonging medication.

DISCUSSION

In this survey of health care practitioners' knowledge of the QT interval, we found that an appreciable number of health care practitioners cannot correctly measure the QT interval and cannot identify factors and medications that cause QT-interval prolongation. Although the median number of correct answers for internists was higher than that for psychiatrists and other specialists, all groups lacked substantial knowledge of the QT interval. Because internists and psychiatrists very frequently prescribe QT prolonging medications, their substantial lack of knowledge of the QT interval poses a significant problem.

Because QT-interval prolongation may predispose to torsades de pointes, health care practitioners must be able to assess and balance the risk and benefit of QT prolonging medications. Although the paucity of data on how to best assess these potential risks precludes determination of absolute risk for individual patients, it is possible to identify high-risk situ-

ations. This requires knowledge of proper measurement and monitoring of the QT interval and familiarity with factors, drugs, and drug interactions that could produce QT-interval prolongation and torsades de pointes.^{1,5,10–18} Our findings suggest that educational programs on the QT interval and QT prolonging drugs are needed. These programs should provide health care practitioners with practical guidance on how to assess and balance the risk and benefit of QT prolonging medications. One such program is an internet-based module on the QT interval developed by our group for health care practitioners.¹⁹ Although educating health care providers about the QT interval is an essential first step, it is unlikely to be enough. Incorporating hazard alerts into computer systems used by physicians may lead to safer use of QT prolonging medications; however, the content and threshold for these systems need to be carefully studied.

Respondents who graduated between 1990 and 1999, physicians in training, and academicians were likely to answer more questions correctly. It is not surprising that physicians in training and academicians were more likely to answer questions correctly. Physicians in training have more recently been exposed to a variety of drugs and are making the effort to learn about these drugs. Academicians may have greater access to educational opportunities and may feel obligated to keep their knowledge current because of their teaching role. The finding that those who graduated from medical school between 1990 and 1999 were more likely to answer the questions correctly than those who graduated before 1990 likely resulted from having more physicians in training and academicians in the former group than the latter one. However, it is also possible that teaching in professional schools was better between 1990 and 1999 than before 1990 or that knowledge of the QT interval is not gained in professional schools but rather learned after several years of experience.

The majority of respondents stated they would check an ECG before and after starting a QT prolonging medication. Although we considered this a correct response, there is not a consensus that this practice is indicated for all QT prolonging drugs. For some of these drugs, such as QT prolonging antiarrhythmic medications, measuring a QT interval is indicated because the risk of torsades de pointes is not trivial. However,

FIGURE 2. Distribution of QT measurements. Solid bars correspond to incorrect responses and hatched bars correspond to correct responses.

for many other QT prolonging drugs, the QT interval has to be measured in a huge number of patients to identify 1 person at risk for significant QT prolongation. Counting this as a correct response, however, did not affect the overall conclusions of this study because the majority of the respondents answered this question correctly.

Finally, it is important to note that much remains to be learned about the QT interval. The best method to adjust the measurement of the QT interval for changes in heart rate has not been identified. Epidemiologic studies correlating different methods of adjustment of the QT interval with patients' outcomes have not been done. The proper frequency of monitoring the QT interval for various drugs has not been identified. As knowledge about these important issues is gained, it is imperative to disseminate this knowledge to health care practitioners.

Four limitations should be considered in interpreting the results of our survey. First, our results may not be representative of all health care practitioners. Because the survey was conducted at some of the highest ranked academic institutions, one would assume that findings at these academic institutions represent a best case scenario. The survey was also conducted at 6 community hospitals to widen representation of different practice settings. Second, 37% of the surveyed health care practitioners did not respond. While the nonrespondents may have performed differently, it is conceivable that nonrespondents did not respond due to lack of confidence in their knowledge of the topic. Had these individuals participated, the overall performance might have been even worse. Third, while many of the multivariable comparisons on the correlation between participants' characteristics and number of correct answers were statistically significant, discovered differences may not be clinically meaningful. Fourth, we likely overestimated the real percentage of physicians capable of measuring a QT interval. Because we did not ask participants for the corrected QT interval, which is probably a more clinically relevant measurement, we could not determine the percentage of physicians who could calculate a corrected QT interval. However, one could certainly assume that the percentage of physicians capable of calculating a corrected QT interval is less than 43%.

In conclusion, an appreciable number of health care practitioners cannot correctly measure the QT interval, and cannot correctly identify factors and medications that can prolong the QT interval. Our findings suggest that greater attention to the QT interval is warranted to ensure safer use of QT prolonging medications.

This study was supported by grant U18HS10548 from the Agency for Healthcare Research and Quality, Rockville, MD.

We thank Richeille Ricketts, MPH, for coordinating visits to survey sites and for her help in distributing and collecting the surveys at many participating institutions.

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Supplementary Material

The following supplementary material is available for this article online:

Appendix. Duke Center for Education and Research on Therapeutics: QT Interval Survey.