# QT Interval Disturbances in Elderly Residents of Long-Term Care Facilities

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**ABSTRACT:** **Background:** The QT interval reflects the total duration of ventricular myocardial repolarization. Disturbed QT – either prolonged or shortened – is associated with arrhythmia and is life-threatening.

**Objectives:** To investigate an elderly population for disturbed QT interval.

**Methods:** We conducted a cross-sectional study on residents of long-term care wards in a geriatric hospital. Excluded were those with pacemaker, atrial fibrillation or bundle branch block. The standard 12 lead and lead 2 electrocardiograms in the patients' files were used for the evaluation of QT interval.

**Results:** We screened the ECGs of 178 residents. QTc prolongation based on the mean 12 ECG leads was detected in 48 (28%), while 45 (25%) had prolonged QTc based on lead L2. Factors associated with QT prolongation were male gender, chronic renal failure and diabetes mellitus. Short QT was found in 7 residents (4%) and was not related to any parameter.

**Conclusions:** About one-third of the elderly long-term care residents in our study had QT disturbances. Such a considerable number warrants close QT interval follow-up in predisposed patients.

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**KEY WORDS:** QT interval disturbances, long-term care elderly residents

The QT interval reflects the total duration of ventricular myocardial repolarization. QT prolongation is associated with polymorphic ventricular tachycardia, such as torsade de pointes, which can be fatal [1]. The QT interval duration exhibits a certain degree of variability between the leads on the electrocardiogram, which may reflect heterogeneity in the recovery of repolarization [2]. Beat-to-beat QT interval variability is also a measure of repolarization liability and a predictor of sudden death [3]. Although torsade de pointes may occur in several settings, it is most often seen in association with drug therapy [4]. In the past decade, the most common reason for the withdrawal or restriction of drugs was the prolongation of the QT interval associated with torsade de pointes [4]. About 1% of patients on anti-arrhythmic drug therapy develop torsade de pointes [5]. Other reported risk factors for prolonged QT are female gender [6], bradycardia [7] hypokalemia [8], diabetes [9], congestive heart failure [10], and hypertension with left ventricular hypertrophy [11]. A positive correlation was detected between QT prolongation and mortality in patients with congestive heart failure and hypertension with left ventricular hypertrophy [10,11].

With aging, there is a progressive prolongation of the QT interval, which is associated with a concomitant increase in mortality [12]. Polypharmacy, including drugs potentially causing torsade de pointes, is common in the elderly [13]. Therefore, detection of QT prolongation is of particular importance in this age group. The short QT syndrome, characterized by a short refractory period, is a risk factor for atrial fibrillation, ventricular arrythmias and sudden death [14].

In a previous study [15] we screened patients of an acute geriatric ward who represented elderly living in the community. Surprisingly, a high incidence (29%) of prolonged QTc was detected in this group. Although the large majority of elderly people live in the community, about 5% reside in long-term care wards. These are patients with a high level of comorbidity, disability and polypharmacy. In the United States over 1.6 million people belong to this category [16] and unlike community-living elderly they are under constant medical surveillance, assuring that all their possible risk factors are detected and addressed. The prevalence of QT disturbance in this population has not yet been evaluated. In this study we assessed the prevalence of QT interval disturbances and the associated conditions in residents of long-term care wards in a geriatric hospital.

## PATIENTS AND METHODS

This was a cross-sectional study of residents institutionalized in five LTC geriatric wards (190 beds) in the Shmuel Harofe Geriatric Medical Center. On admission every LTC resident undergoes an ECG and a complete blood analysis as routine evaluation. The files of all the residents hospitalized were screened and the relevant demographic, clinical and laboratory data were retrieved. Included in this study were patients whose electrolyte levels of calcium, potassium and magnesium were in the normal range. Patients with pacemaker, bundle branch block or atrial fibrillation were excluded.

LTC = long-term care

The standard 12 lead ECG in the patient's file was used for the QT interval evaluation. All measurements were done by the same physician. The RR and QT intervals were measured in 12 leads using a graduated lens. The QT interval was measured from the beginning of the QRS complex to the end of the down slope of the T wave [17]. The QT interval corrected for the previous cardiac cycle length (QTc) was calculated according to Bazzet's formula: QTc = QT/RR1/2 [18]. Prolonged QTc was considered as QTc ≥ 0.47 seconds for women and QTc ≥ 0.45 for men [19,20]. For statistical evaluations, borderline QTc values of 0.45–0.46 in women and 0.43–0.44 in men were considered normal. Patients with short QT intervals (QT or QTc ≤ 0.3 seconds) were evaluated as a separate group. A calculation of the mean QT was done in each lead, using the mean of two consecutive complexes. Two methods of measurement were performed for the evaluation of QTc prolongation: the mean of 12 leads and the QTc of lead L2 [19]. The study/data analysis protocol was approved by the hospital's ethics committee. SPSS software was used for statistical processing. Descriptive analysis included frequencies and distributions of all study variables. Student's t-test, chi-square or Fisher's exact test was used for comparing those with QTc prolongation to those with normal or borderline QTc; Pearson correlation test and multivariate analysis by logistic regression were performed to test the association of age, gender, comorbidiy, drugs and laboratory data with the mean QTc intervals.

## RESULTS

The study group comprised 178 residents. Their relevant clinical and laboratory data are presented in Tables 1 and 2.

**Table 1.** Clinical data of 178 LTC geriatric residents with prolonged vs. normal/borderline QT

| | Normal/ Borderline (N=130) | Prolonged (N=48) | |
|---|---|---|---|
| | No. (%) | No. (%) | *P* |
| **Relevant diseases** | | | |
| Dementia | 79 (60.8) | 27 (56.3) | 0.59 |
| Hypertension | 61 (46.9) | 23 (47.9) | 0.96 |
| Feeding tube | 64 (49.2) | 17 (35.4) | 0.10 |
| S/P stroke | 57 (43.8) | 19 (39.6) | 0.61 |
| Decubitus ulcer | 49 (37.7) | 17 (35.4) | 0.78 |
| Anemia | 42 (32.3) | 21 (43.8) | 0.16 |
| Diabetes mellitus | 40 (30.8) | 21 (43.8) | 0.11 |
| Recurrent urinary tract infection | 44 (33.8) | 14 (29.2) | 0.55 |
| Ischemic heart disease | 34 (26.2) | 19 (39.6) | 0.08 |
| Congestive heart failure | 17 (13.1) | 5 (10.4) | 0.63 |
| **Relevant drugs** | | | |
| Laxatives | 99 (76.2) | 36 (75.0) | 0.87 |
| H2 blockers | 49 (37.7) | 14 (29.2) | 0.290 |
| Aspirin | 45 (34.6) | 14 (29.2) | 0.27 |
| ACE inhibitors | 33 (25.4) | 13 (27.1) | 0.82 |
| Benzodiazepines | 32 (24.6) | 12 (25.0) | 0.96 |
| Neuroleptics | 25 (19.2) | 10 (20.8) | 0.81 |
| Diuretics | 22 (16.9) | 12 (25.0) | 0.22 |
| Antihistamines | 25 (19.2) | 8 (16.7) | 0.70 |
| Anticonvulsants | 26 (20.0) | 6 (12.5) | 0.25 |

ACE = angiotensin-converting enzyme

Prolongation of QTc was detected in 48 patients (28%) based on the mean of 12 ECG leads, and in 45 patients (25%) based on lead L2 [Table 3]. Only a small proportion of these patients (n=7, 15%) had QTc above 500 msec. The prevalence of QTc prolongation was higher in men [Table 3]. Age was not related to QTc prolongation. Higher heart rate was positively related to the prolongation of QTc interval.

The clinical parameters related to QTc prolongation were diabetes (non-insulin dependent) in lead L2 and chronic renal failure in all 12 leads. We found that no drugs correlated with prolonged QTc. Short QT was found in 7 patients (4%), as calculated by the mean 12 leads as well as in lead 2. Univariate and multivariate analyses on all relevant parameters did not demonstrate any specific factor correlating with short QT interval.

## DISCUSSION

QT interval disturbances were detected in more than 30% of the elderly residents in the LTC wards. More than 25% of

**Table 2.** Electrolyte's levels of the patients with prolonged vs. normal/borderline QTc

| | QT interval: 12 leads | | | QT interval: lead L2 | | |
|---|---|---|---|---|---|---|
| **Electrolyte levels (mean ± SD)** | **Normal/ Borderline (N=130)** | **Prolonged (N=48)** | ***P*** | **Normal/ Borderline (N=133)** | **Prolonged (N=45)** | ***P*** |
| Calcium (normal range 8.6–10.2 mg/dl) | 8.83 ± 0.63 | 8.68 ± 0.54 | 0.160 | 8.83 ± 0.61 | 8.70 ± 0.62 | 0.230 |
| Potassium (normal range 3.5–5.3 mEq/L) | 4.23 ± 0.47 | 4.23 ± 0.50 | 0.470 | 4.28 ± 0.44 | 4.26 ± 0.56 | 0 .86 |
| Magnesium (normal range 1.8–3.5 mg/dl) | 2.14 ± 0.28 | 2.08 ± 0.25 | 0.220 | 2.14 ± 0.27 | 2.07 ± 0.28 | 0.160 |

**Table 3.** Factors related to prolonged QTc in LTC geriatric residents (n=178)

| | Mean 12 leads | | Lead L2 | |
|---|---|---|---|---|
| | **Normal/ Borderline** | **Prolonged** | **Normal/ Borderline** | **Prolonged** |
| N (%) | 130 (72) | 48 (28) | 133 (75) | 45 (25) |
| QTc (mean ± SD) | 0.422 ± 0.026 | 0.492 ± 0.032 | 0.424 ± 0.028 | 0.494 ± 0.035 |
| QTc (range) | 0.271–0.469 | 0.450–0.649 | 0.270–0.47 | 0.450–0.650 |
| Female (n=112) | 93 (83) | 19 (17) | 95 (83) | 19 (16.7) |
| Male (n=64) | 34 (53) | 30 (47) ** | 38(59) | 26 (40.6)** |
| Age (yrs, ± SD) | 80 ± 11 | 78 ± 10 | 80 ± 11 | 80 ± 11 |
| Heart rate | 82.3 ± 16 | 88.3 ± 19* | 82.6 ± 15 | 88.7 ± 20* |
| **Relevant diseases** | | | | |
| Diabetes mellitus (N=61)<br>Non-diabetic patients (N=117) | 40 (66)<br>90 (77) | 21 (34)<br>27 (23) | 39 (64)<br>91 (78) | 22 (36)*<br>26 (22) |
| Chronic renal failure† (N=21)<br>Non-renal failure (N=157) | 11 (53)<br>119 (76) | 10 (47)*<br>38 (24) | 13 (62)<br>117 (74) | 8 (38)<br>40 (26) |

Only factors that were found statistically relevant to QT prolongation are presented in the table.

*$P < 0.05$.

**$P < 0.05$, comparing the incidence of prolonged QTc in males vs. females

†Creatinine › 1.5

them had prolonged QTc in the mean 12 leads as well as in lead L2. A short QT interval was relatively rare but still found in 4% of the residents. QTc prolongation was correlated with male gender, diabetes mellitus and renal failure.

The association of prolonged QT interval with male gender in this population of elderly LTC patients was a new finding and should be explored. A search of the most recent publications yielded reports on the relation between testosterone and cardiac repolarization, suggesting an inverse association between testosterone levels and the QT interval [21,22]. Pecory Giraldi et al. [23] observed that the prevalence of prolonged QTc in their study was considerably higher in hypogonadal patients than in control men. Further research is needed, particularly among the elderly with prostatic carcinoma receiving anti-testosterone drugs.

Our study, a first of its kind, indicates that QT interval disturbances, mainly prolongation, are a common finding in the LTC geriatric ward residents, similar to what we found in our previous study on acute geriatric wards [15].

With aging, there is a progressive prolongation of the QT interval, which is associated with a concomitant increase in mortality. This is related to electric instability and the risk of ventricular arrhythmogenesis. Arrhythmias increase in frequency with aging, probably due to age-associated degenerative changes in the conducting cells and myocardial fibrosis [24]. Many previous cross-sectional population studies investigated the impact of age on QT interval [12,25]. Additionally, hypertension [11], heart failure [10] and diabetes [9] were related to QT interval disturbances. In our previous study, performed in acute geriatric settings [15], we found that heart failure, hypomagnesemia and use of hypnotics were correlated with QTc prolongation. Short QT interval was rare in the present study and was not correlated with relevant clinical parameters. In the literature, the risk factors for short QT are genetic predisposition, hypercalcemia and hyperkalemia.

An overall look at the results of this study and those in acute settings [15] reveals considerably high and quite similar rates of disturbed QT intervals. However, whereas acute elderly patients were evaluated during an active medical event at the end of which most of them were released to the community, residents of LTC remain under the ongoing surveillance of the medical staff. As mentioned earlier, medical directors and staff of such settings are expected to be aware of and to minimize the overt risk factors that endanger the stability and life of their residents.

Therefore, more attention should be given to this threatening condition in elderly patients with significant comorbidity and multiple medications, either in acute or LTC geriatric settings or in general hospital wards (internal medicine, surgery, urology, etc.). Their QT interval should be periodically recorded and closely watched, as are other vital signs.

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## References

1. Schouten BG, Dekker JM, Meppelimk P, et al. QT interval prolongation predicts cardiovascular mortality in an apparently healthy population. *Circulation* 1999; 84: 1516-23.
2. Cowan CJ, Yusoff K, Moore M. Importance of lead selection in QT measurement. *Am J Cardiol* 1988; 61: 83-7.
3. Yeragani VK, Pohl R, Balon R, et al. Twenty-four hour QT interval variability: increased Qt variability during sleep in patients with panic disorder. *Neuropsychobiology* 2002; 46 (1): 1-6.
4. Roden DM. Drug-induced prolongation of the QT interval. *N Engl J Med* 2004; 350: 1013-22.
5. Lasser KE, Allen PD, Woolhandler SJ, et al.Timing of new black box warnings and withdrawals for prescription medications. *JAMA* 2002; 287: 2215-20.
6. Makkar RR, Fromm BS, Steinman RT, et al. Female gender as a risk factor for torsades de pointes associated with cardiovascular drugs. *JAMA* 1993; 270: 2590-7.
7. Khan IA. Long QT syndrome: diagnosis and management. *Am Heart J* 2002; 143 (1): 7-14.
8. Yang T, Roden DM. Extracellular potassium modulation of drug block of IKr: implications for torsades de pointes and reverse use dependence. *Circulation* 1996; 93: 407-11.
9. Veglio M, Bruno G, Borra M, et al. Prevalence of increased QT interval duration and dispersion in type 2 diabetic patients and its relationship with coronary heart disease: a population based cohort. *J Intern Med* 2002; 251: 317-24.
10. Pai RG, Padmanabhan S. Biological correlates of Qt interval and QT dispersion in 2,265 patients with left ventricular EF < or = 40%. *J Electrocardiol* 2002; 35 (3): 223-6.
11. Oikarinen L, Nieminen MS, Viitasalo M, et al. Relation of QT interval and QT dispersion to echocardiographic left ventricular hypertrophy and geometric pattern in hypertensive patients. The life study. The losartan intervention for endpoint reduction. *J Hypertens* 2001; 19 (10): 1883-91.
12. Piccirillo G, Cacciafesta M, Lionetti M, et al. Influence of age, the autonomic nervous system and anxiety on QT-interval variability. *Clin Sci (Lond)* 2001; 101 (4): 429-38.
13. Curtis LH, Ostbye T, Sendersky S, et al. Prescriptions of QT-prolonging drugs in a cohort of about 5 million outpatients. *Am J Med* 2003; 14: 135-9.
14. Gaita F, Giustetto C, Bianchi F, et al. Short QT syndrome: pharmacological treatment. *J Am Coll Cardiol* 2004; 43 (8): 1494-9.
15. Lubart E, Segal R, Yearovoi A, et al. QT interval disturbances in hospitalized elderly patients. *IMAJ Isr Med Assoc J* 2009; 11 (3): 147-50.
16. Jones AL, Dwyer LL, Bercovitz AR, et al. The National Nursing Home Survey: 2004 overview. National Center for Health Statistics. *Vital Health Stat* 2009; 13: 167.
17. Ward DE. Prolongation of the QT interval as an indicator of risk of a cardiac event. *Eur Heart J* 1988; 7: 139-44.
18. Bazett HC. An analysis of time-relations of electrocardiograms. *Heart* 1920; 7: 353-70.
19. Straus SM, Kors JA, De Bruin ML, et al. Prolonged QTc interval and the risk of sudden cardiac death in a population of older adults. *J Am Coll Cardiol* 2006; 47: 362-7.
20. The assessment of the Potential for QT Interval Prolongation by Non-Cardiovascular Medicinal Products. London: Committee for Propertiary Medicinal Products, 1997.
21. Van Noord C, Rodenburg EM, Stricker BH. Invited commentary: sex-steroid hormones and QT-interval duration. *Am J Epidemiol* 2011; 174 (4): 412-15.
22. Van Noord C, Dorr M, Sturkenboom MC, et al. The association of serum testosterone levels and ventricular repolarization. *Eur J Epidemiol* 2010; 25 (1): 21-8.
23. Pecory Giraldi F, Toja PM, Michailidis G, et al. High prevalence of prolonged QT interval duration in male patients with Cushing's disease. *Exp Clin Endocrinol Diabetes* 2011; 119 (4): 221-4.
24. Reardon M, Malik M. QT interval change with age in an overtly healthy older population. *Clin Cardiol* 1996; 19: 949-52.
25. de Bruyne MC, Hoes AW, Kors JA, et al. Prolonged QT interval predicts cardiac and all cause mortality in the elderly. *Eur Heart J* 2006; 20 (4): 278-84.