ANAMT Technical Guideline (TG #4): accidents, sudden death, syncope and work: screening with electrocardiogram

Diretriz Técnica da ANAMT (DT 04): acidentes, morte súbita, síncope e trabalho: rastreamento por eletrocardiograma

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METHODS FOR EVIDENCE COLLECTION

The present guideline is a review based on methods for article search and selection compatible with the approach to systematic reviews developed within evidence-based medicine. This procedure ensures adequate impartiality, reproducibility, transparency and sensitivity in the selection and evaluation of scientific articles for elucidation of the efficacy of health technologies. Detailed information is provided in Appendix 1.

Even when their results are inconclusive, systematic reviews have potential to attain higher levels of scientific certainty relative to a given clinical question. The degree of certainty and strength of recommendations in systematic reviews depend on the quality of the scientific evidence available in the retrieved primary articles.

AIM

To investigate the efficacy of resting electrocardiogram as screening test for heart disease aiming at preventing accidents, sudden death and syncope among the asymptomatic adult population.

GRADE OF RECOMMENDATIONS AND LEVELS OF EVIDENCE

A: experimental or observational studies with better consistency;
B: experimental or observational studies with less consistency;
C: case reports/uncontrolled studies;
D: opinions without critical evaluation, based on consensus, physiological studies or animal models.

INTRODUCTION

The aim of heart disease screening with resting electrocardiogram (ECG) in the asymptomatic population is to achieve early diagnosis in association with interventions to reduce cardiovascular risk and modify outcomes of interest, such as sudden death, syncope and accidents. Within the occupational

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setting, including athletes and military personnel, unfitness for work is one of the interventions used to reduce the risk of occupational accidents and sudden death.

Medical Administrative Measures Suggestion #01 (Sugestão de Conduta Médico Administrativa 01–SCMA 01) recommends including ECG as a part of the medical examination of employees who work at height. Published in 2015, SCMA 01 was later repealed due to the lack of scientific evidence to support this recommendation. Regulatory Standard no. 35, on working at height, does not indicate any diagnostic test nor defines fitness criteria, but decision making on both diagnostic tests and fitness criteria is an attribution of occupational physicians[1].

Resting ECG is also indicated for other professional categories which work includes critical activities, such as professional diving, aviation and the armed forces. As concerns the brazilian civil aviation, institutional cardiologic examination and fitness criteria are established in the Brazilian Civil Aviation Regulation no. 67[2]. Regulatory Standard no. 15, appendix A, determines ECG as a mandatory part of cardiovascular examination to assess the fitness of professional divers[3].

RESULTS

There are no primary studies that demonstrate the efficacy of resting ECG screening of the asymptomatic adult population to promote the following benefits: reduction of accidents, sudden death or syncope in the workplace. This lack of evidence on the efficacy of this method agrees with the results of other systematic reviews that targeted the overall population or athletes[4-8] (**B**).

While the scientific evidence on the prevalence and cause of sudden cardiovascular death in the workplace is scarce, it suffices to demonstrate that this event occurs only seldom. A systematic review published in 2015 sought to elucidate the epidemiology and outcomes of cardiac arrest in the workplace for which purpose it retrieved retrospective studies conducted in industrial sites and offices in Asia, Europe and North America. The results evidenced an incidence of 1.3 to 23.8 events per million people per year, corresponding to 0.3 to 4.7% of all cases of out-of-hospital cardiac arrest (OCHA). The survival rate was higher when OHCA occurred in public sites, probably due to higher odds of immediate aid and selection bias — inclusion of a healthy population[9] (**A**). A retrospective cohort study published in 2004 investigated cardiovascular causes of nontraumatic sudden death among young military recruits aged 18 to 35 years old along 25 years. The prevalence of nontraumatic sudden deaths was 13.0/100,000 recruit-years, corresponding to a total of 126 for the full 25-year period relative to a population of 6.3 million male and female military recruits. Of the 126 nontraumatic deaths, 108 (86%) were related to exercise, 64 (51%) to some cardiac abnormality and 44 (35%) remained unexplained even after autopsy[10] (**B**). Relative to the cardiovascular causes, 21 military recruits exhibited coronary artery abnormalities, 13 myocarditis and 8 hypertrophic cardiomyopathy[10] (**B**). This association with exercise or strong physical effort was also found in risk studies with other professional categories, such as firefighters[11] (**B**) and police officers[12] (**B**).

The data on the prevalence and cause of sudden cardiovascular death among young athletes — under 35 years old — derive from studies conducted in North America[13] (**B**) and Italy[14] (**B**). The prevalence of such deaths among athletes is estimated as 0.5-2/100,000/year[5] (**B**). Some evidence points to regional and ethnic differences in the prevalence of heart disease among athletes: hypertrophic cardiomyopathy was considered to be the main cause of death among athletes in the United States[13] (**B**) and arrhythmogenic right ventricular cardiomyopathy in Italy[14] (**B**). The low prevalence of sudden death among athletes led some authors to develop a model of intervention centered on tertiary prevention (Advanced Cardiovascular Life Support–ACLS; Basic Life Support–BLS)[15] (**B**).

Given that cardiovascular events occur seldom in the workplace, their contribution to the high prevalence of accidents and mortality associated with falls from height is highly unlikely. According to the Social Security statistical yearbook, among 612,632 work accidents reported in Brazil in 2015, 374 were unspecified falls (International Classification of Diseases — ICD W19), 328 falls on and from stairs and steps (ICD W10), 204 other falls from one level to another (ICD W17) and 198 accidents for being struck by thrown, projected or falling objects (ICD W20)[16] (**D**). In England[17] (**D**), the average number of fatal accidents in the period from

2012 to 2017 was 142 per year and the one of fatal falls from height 40 per year. In the United States[18] (**D**), 4,836 fatal accidents occurred in 2015, 648 of which involved falls from height, thus representing 40% of fatal accidents within private civil construction.

The multifactorial nature of this global problem was elucidated in a systematic review published in 2016, which listed the risk factors for falls from height in civil construction reported in cross-sectional studies. Associated factors were: individual (risk behavior, fatigue, lack of experience, others), organizational (lack of training, night work, lack of protective equipment, others), direct agents (ladders, scaffolds, others), worksite conditions (poor lighting, high-risk activities, others) and weather related[19] (**D**). These data agree with the results of another systematic review published in 2012 which sought to investigate the efficacy of interventions to reduce accidents in civil construction, and found limited evidence favorable to multifaceted safety programs[20] (**A**). According to the aforementioned epidemiological evidence, the odds for a beneficial effect (accident reduction) of universal resting ECG screening on workers at height are doubtful. Retrospective studies to evaluate the predictive value of ECG in accidents involving falls from height, the quality of follow up and health benefits and harms for cases referred to cardiologists might contribute to the analysis of the effectiveness of ECG for cardiovascular assessment of employees who work at height.

Mass screening using resting ECG among athletes remains controversial and thus varies across the world. The first reason of controversy is the low incidence of events, which in Denmark[21] (**D**) was rated a sufficient motive not to perform universal screening for cardiovascular diseases among athletes[22] (**D**). Application of a questionnaire and clinical interview and physical examination by a trained specialist, without mandatory ECG, is the screening method used in the United States since more than 50 years. Contrariwise, resting ECG is mandatory for athletes in Israel, Italy and Japan[22] (**D**).

The second reason of controversy is the lack of studies that demonstrate the efficacy of screening in clinical trials. Relative to individuals under 35, including subjects under 18, only 3 cross-sectional time series — in Italy[14] (**B**), Israel[23] (**B**) and North America[24] (**B**) — analyzed reduction of mortality following inclusion of resting ECG. The results diverged; mortality reduction was only measured in the Italian study. In addition, outcome measurement was doubtful in all 3 studies. The Italian study was based on local journals and the help of local centers for measurement and investigation of deaths. Also the study conducted in Israel was based on local journals. In turn, the North American study had resource to records of catastrophic insurance, which is mandatory for athletes. None of the studies measured cardiovascular events that did not culminate in death, included a control group or discriminated the effects of tertiary prevention programs. These methodological shortcomings notwithstanding, the European Society of Cardiology[25] (**D**) recommends ECG for evaluation of athletes on the exclusive basis of the benefit reported in the Italian study. Differently, the American Heart Association[22] (**D**) rated the available evidence insufficient.

Within the screening model for critical work activities, athletes and military personnel, unfitness for work is used as intervention to reduce the risk of occupational accidents and sudden death. The efficacy and disadvantages of unfitness as a way to prevent accidents in the workplace are controversial and have been scarcely studied. A systematic review published in 2016 did not find any evidence that pre-employment examinations and unfitness for work prevent cardiovascular events or work accidents[26] (**B**). The individual economic and psychosocial harms, as well as the occupational benefits of unfitness for work for several professional categories need to be better measured in prospective studies.

An alternative option to the aforementioned model to be discussed among occupational physicians, specifically for the case of coronary artery disease, is screening for and treatment of modifiable risk factors in the workplace. For example, excess weight[27] (**B**), dyslipidemia[28] (**B**), smoking[29] (**B**) and hypertension[30] (**A**) which benefits for promotion of health have been established in systematic reviews and meta-analyses.

Some findings on resting ECG are associated with risk of cardiovascular events due to coronary artery disease. However, the clinical meaning of these findings and corresponding measures have not yet been elucidated. A systematic review on coronary artery disease performed in 2011 by the US Preventive Services Task Force did not find any evidence of benefit, in terms

of change in risk or cardiovascular outcomes, for an intervention after screening with ECG. Based on the epidemiology of coronary artery disease, the authors considered screening for coronary artery disease with ECG to be iatrogenic for the overall population at low risk for cardiovascular disease. The authors also considered insufficient the scientific evidence of benefit for moderate or high-risk populations[4] (**B**).

Accuracy, risk stratification, measures and prognosis are uncertain as concerns asymptomatic individuals with ECG patterns suggestive of rare arrhythmias[5-8,31] (**B**). In the case of athletes and aviators, cardiology societies or regulatory agencies, such as the Civil Aviation Safety Authority (CASA) in Australia and the United Kingdom and the Civil Aviation National Agency (Agência Nacional de Aviação Civil–ANAC) in Brazil, publish recommendations on measures for these rare diseases and establish fitness criteria. Retrospective studies might contribute to improve the measurement of the occupational risk of some rare arrhythmias. One example is a study conducted with military personnel published in 2017, which analyzed 1.2 million ECGs of current and past aviators and applicants since 1957. A total of 840 cases with a diagnosis of either Wolff-Parkinson-White (WPW) pattern or syndrome were identified, corresponding to 0.298% of the analyzed population.

A total of 638 aviators were duly followed up along 10.5 years, on average. From this group, 574 aviators remained asymptomatic or with a low-risk pattern, and 64 progressed into a high-risk pattern. The high-risk group represented 0.038% of the analyzed population. The annual risk of sudden incapacitation for the asymptomatic population with WPW pattern was estimated as 0.95%[32] (**B**). The criteria to establish whether risk is (un)acceptable involve quantification of risk, evaluation and adaptation of workstations, cultural and subjective factors[33] (**D**).

Heart disease screening with resting ECG demands considerable resources and specialized personnel, in addition to other diagnostic tests and invasive interventions, such as Holter monitoring, echocardiogram, cardiac stress test and electrophysiology studies, among others, based on the ECG results[4-8] (**B**). Studies on economic viability and quality of implementation within the workplace are needed to establish whether the minimum service conditions are met.

The efficacy of resting ECG followed by unfitness for prevention of accidents and cardiovascular events remains uncertain and controversial in the literature. More studies assessing the quality of implementation, benefits, harms and cost-effectiveness of this screening model are needed.

RECOMMENDATION

There is no evidence in the scientific literature of the efficacy of resting ECG as screening test for heart disease in the asymptomatic adult population for the purpose of preventing of accidents, sudden death and syncope. Therefore, we do not recommend resting ECG as screening method for prevention of accidents, sudden death and syncope in occupational medicine practice.

APPENDIX 1

CLINICAL QUESTION

Does resting ECG screening of the adult asymptomatic population promote prevention of sudden death, accidents and syncope due to coronary artery disease or heart arrhythmia?

ELIGIBILITY CRITERIA

To be included as basis for the answer to the research question, articles ought to be compatible with the population, intervention and outcome — represented by acronym PICO (P: population or problem; I: intervention; C: control; O: outcome) — defined in the research question, i.e., asymptomatic adults subjected to resting ECG screening for prevention of sudden death and accidents caused by heart diseases.

ARTICLE SEARCH

Databases

The search began on 20 April 2017. Each database was searched by two reviewers who looked for relevant articles based on titles and abstracts. The selected articles were subjected to full-text analysis for their relevance vis-à-vis the research question. The articles retrieved from all databases were reunited, and two reviewers evaluated their methodological quality;

articles with poor methodological quality for the described evidence could be excluded also in this step.

Figure 1 depicts the absolute number of retrieved articles per database, those selected for review and the ones which were included or excluded.

Descriptor identification

P	Workers, athletes, military personnel, asymptomatic
I	Resting electrocardiogram
C	Non-screening with resting electrocardiogram
O	Sudden death, syncope, accidents, heart arrhythmia, coronary artery disease

Search strategy

MEDLINE and Cochrane Library: (Workers OR Worker OR Athletes OR Military OR Asymptomatic) AND (Electrocardiography OR ECG OR EKG OR Electrocardiogram OR Electrocardiograms OR Electrocardiograph OR Electrocardiography) AND ((Sudden Death) OR Syncope OR Fainting OR Arrhythmia OR Accidents OR (Coronary Disease));

LILACS: (trabalhadores OR trabalhador OR adulto OR atletas OR militar OR assintomático OR assintomáticos) AND (ECG OR eletrocardiograma) AND (morte OR síncope OR desmaio OR arritmia OR cardiopatias OR (doença das coronárias) OR (doença coronariana)).

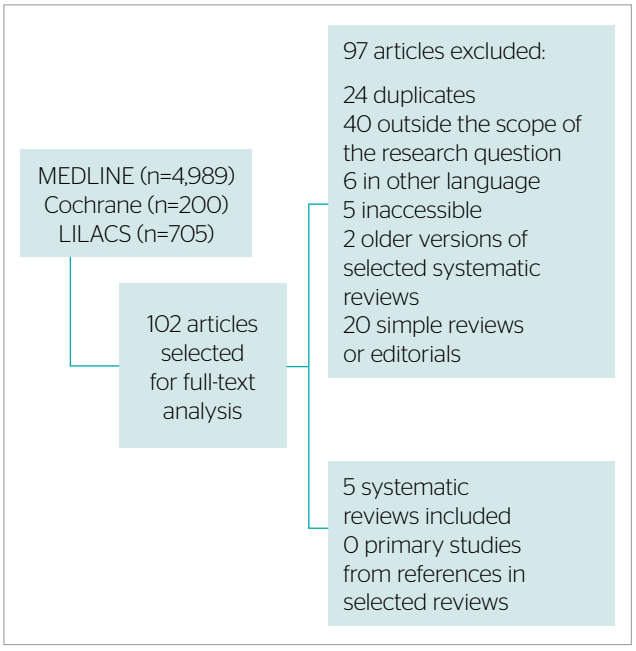

Figure 1. Absolute distribution of selected and excluded articles, São Paulo, 2017.

CRITICAL EVALUATION

Relevance: clinical implications

In the present guideline we sought to establish whether there is scientific evidence of benefit (reduction of accidents, sudden death or syncope) for heart disease screening with resting ECG.

Reliability: internal validity

The first step of the present guideline consisted in a preliminary search to contextualize and define the subject of interest. Next we formulated the research question following the PICO process. Based on PICO, health sciences descriptors (Descritores em Ciências da Saúde–DeCS) and synonyms we defined the search strategy for each database.

We exclusively considered articles published in English and Portuguese, with full-text available and published before 20 April 2017 with no lower date limit.

Application of results: external validity

The level of evidence was attributed based on the design of studies according to the Oxford classification[34] (Table 1).

Following application of the inclusion and exclusion criteria, the selected articles (Chart 1) were independently assessed by two reviewers as to their methodological quality according to the *Preferred Reported Items for Systematic Reviews and Meta-Analyses* (PRISMA) criteria. Since no primary studies evaluating efficacy were located, only the methodological quality of systematic reviews was analyzed.

Table 1. Grades of recommendation and levels of evidence.

A: Experimental or observational studies with better consistency
B: Experimental or observational studies with less consistency
C: Case reports/uncontrolled studies
D: Opinions without critical evaluation, based on consensus, physiological studies or animal models

5. Methods for extraction and analysis of results

Whenever evidence was available and was possible, results were specifically described per population, intervention, outcomes, presence or absence of benefits and/or harms and controversy.

The results were preferentially expressed as absolute data, absolute risk, number needed to treat (NNT), number needed to harm (NNH) and eventually as mean and standard deviation (Chart 2).

RESULTS

Description of results

Given the lack of primary studies, in the discussion we had resource to the epidemiological evidence described in the systematic reviews retrieved through application of the search strategy and also other manually selected systematic reviews or epidemiological studies to fill the gap in the literature on the subject of interest and stimulate future publications and the discussion of controversies.

Evidence application: recommendation

The measures suggested by the authors of the present technical guideline are based on the collected evidence. This suggestion was subjected for validation to all the members of the working group. The grade of the recommendation directly derives from the strength of the included studies as per the Oxford classification[34] and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach[35].

Chart 1. Evaluation of methodological quality according to the PRISMA criteria, São Paulo, 2017.

Author	Year	Methodological evaluation
Chou et al.[4]	2011	Meets all PRISMA methodological criteria
Alattar and Maffulli[5]	2015	Meets all PRISMA criteria, but there are uncertainties as to the process of mediation of the selected articles
Wingfield et al.[6]	2004	Describes database, search strategy, inclusion and exclusion criteria. Did not define PICO; there are uncertainties as to the process of mediation of the selected articles
Perez et al.[7]	2009	Describes database and some inclusion criteria only. Flaws in all other PRISMA methodological criteria.
Chandra et al.[8]	2010	Describes database and search terms only. Flaws in all other PRISMA methodological criteria.

Chart 2. Spreadsheet for description and presentation of the results of each study, São Paulo, 2017.

Included evidence
Study design
Selected population
Length of follow-up
Considered outcomes
Results expression: percentage, risk, odds ratio, hazard ratio, means

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