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12-Lead electrocardiography training via YouTube: How is it reliable?

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ABSTRACT

Objectives: The aim of this study was to investigate the adequacy and quality of video trainings on electrocardiography (ECG) recording on YouTube for the training of healthcare professionals based on the uploader source.

Materials and methods: Between May 19th, 2020 and May 25th, 2020, a total of 72 videos that were found to be eligible on YouTube were included. Two physicians independently assessed each video and scored the videos. The quality of the ECG recording was determined by giving 1 point for each of the 14 stages determined according to the current guidelines, and a total of 14 points was defined as maximum.

Results: In the first stage, the videos were divided into two groups based on the total score: compatible (≥8 points) and non-compatible (<8 points). Significant differences were found between the groups in the global quality score (GQS) ($p<0.001$) and total score ($p<0.001$). In the next stage, videos were divided into four different categories according to the uploader source: hospital or university, training site for healthcare professionals, physician or non-physician healthcare personnel, and unknown. A significant difference in the total score ($p<0.001$) and GQS ($p<0.001$) among these groups.

Conclusion: In the YouTube database, the scientific quality of the videos for standard 12-lead ECG recording training is highly variable. Training videos uploaded by hospitals and corporate healthcare training sites contain higher quality and scientific data than individual videos and videos of an unknown source.

Keywords: Electrocardiography, training, YouTube.

Electrocardiography (ECG) is an inexpensive, simple, and reproducible non-invasive diagnostic tool that was first developed in 1900 by Willem Einthoven[1] and still occupies an important place in our daily practice. It contains important diagnostic information that is routinely used for clinical assessment and it is the method used to detect the electrical state and instability of the myocardium.[2] Despite the advancement of many other techniques, ECG remains a reference diagnostic tool for some conditions such as transient myocardial ischemia.[3]

Determination of recording standards and the quality of recording are of utmost importance in the correct interpretation of the ECG. It is similarly important that the healthcare professional who is charged with ECG recording has sufficient training and a good command of ECG recording standards.[4]

The Internet has become an easily accessible educational resource in healthcare, as in every field in our era.[5] Training of various health procedures on live cases with video support is used as a very popular training tool. Training on 12-lead ECG recording is also widely used.

YouTube is the most popular video sharing site all over the world, and training videos shared from many different sources reach millions of individuals around the world. Freely available video streaming sites such as YouTube are widely used by medical students, practitioners, and all healthcare professionals, and YouTube offers an opportunity for educational use.[6] However, the quality and accuracy of medical information on the Internet is highly variable. Many of the videos on YouTube are based on personal experiences, but some come from professional sources such as universities, hospitals, and healthcare training sites.[4] Unlike rigorously reviewed magazine articles or textbooks, videos uploaded to YouTube are not subject to any control. Therefore, research is necessary to

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determine the accuracy and reliability of these training videos.

In the present study, we aimed to investigate the adequacy and quality of video trainings on ECG recording on YouTube for the training of healthcare professionals based on the uploader source.

MATERIAL AND METHODS

This cross sectional study was conducted at Kartal Koşuyolu Yüksek Ihtisas Training and Research Hospital, Department of Cardiology between May 19th, 2020 and May 25th, 2020. A total of 72 videos that were found to be eligible among 221 videos scanned on YouTube were included. Scanning words were as follows: "how to perform ECG", "how to record ECG", "ECG lead placement", "12-lead ECG", and "how to do ECG". Videos detected in a scan and detected again in a scan with another word were excluded. The study included only videos shot on live cases and models and excluded virtual videos. The study also excluded specific ECG measurements such as posterior ECG, dextrocardia, child ECG, and training videos in languages other than English. No personal YouTube or Google account was used for scanning. Scanning was done by logging out of personal Google and YouTube accounts and deleting account history. Two physicians independently assessed each video and scored the videos. The flow diagram of the videos is shown in Figure 1.

The quality of the ECG recording was determined by giving 1 point for each of the 14 stages determined according to the current guidelines[7] and a total of 14 points was defined as the maximum score. According to the ECG recording criteria, each stage was scored 0 (absent) and 1 (present). The stages determined for ECG scoring are shown in Table 1. One point was given for mentioning the procedure verbally during recording, even if the procedure was not performed. Each video was evaluated statistically based on the total score obtained from these stages. The upload date and duration of the video, total number of views, and the number of likes and dislikes were recorded.

The videos were divided into two groups by educational adequacy based on the total score: compatible (≥8 points) and non-compatible (<8 points) (Table 2).

In the next stage, to evaluate the quality of the videos in the study by their source, the videos were divided into four different categories according to the uploader source: hospital or university: 1, training site for healthcare professionals: 2, physician or non-physician healthcare personnel (individual): 3, and unknown: 4. The videos in four different groups were compared statistically according to the number of views, likes, dislikes, and global quality score (GQS) (Table 3). Finally, linear regression analysis was applied to the videos according to the total ECG score. Detailed findings are shown in Table 4.

Global quality score description

All videos were also rated using GQS that uses a five-point scale to rate the overall quality of the video (Table 5). The GQS is an assessment to ensure that the quality of information and the reviewer decides how useful a particular video would be for a patient.[8]

Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data

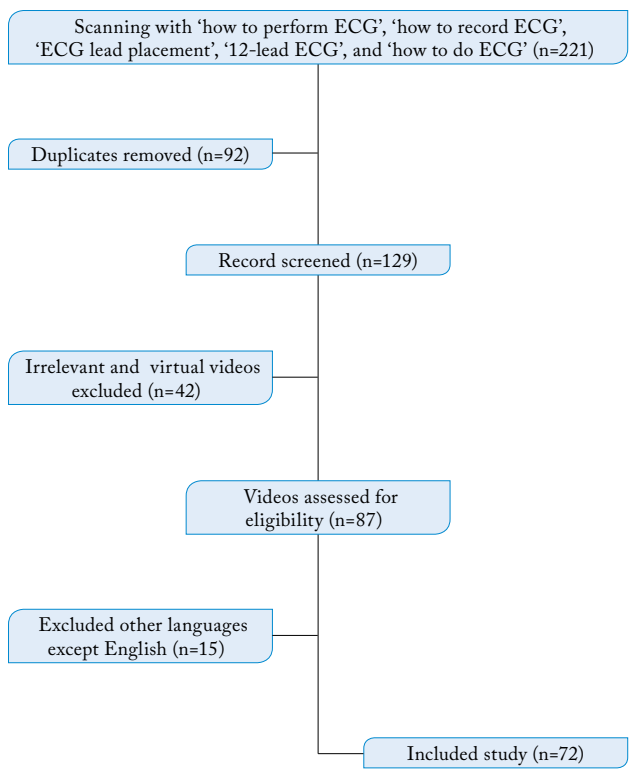

Figure 1. Flow diagram of study videos.
ECG: Electrocardiography.

Table 1
ECG checklist according to consensus reports

	Question	Rating
1	Patient identification	0 1
2	Communication and informed consent	0 1
3	Level of undressed	0 1
4	Patient position (lay down, semi-recumbent)	0 1
5	Skin preparation	0 1
6	Limb electrode position	0 1
7	Chest electrode position	0 1
8	Technique for locating chest electrode positions	0 1
9	Variations of standards (Have the device battery and standard values been checked ?)	0 1
10	Equipment specification	0 1
11	Environmental considerations	0 1
12	Infection control (hand wash ?)	0 1
13	Documentation, processing, storage and confidentiality of ECG recordings	0 1
14	Is the ECG quality checked?	0 1

ECG: Electrocardiography.

were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The chi-square test and Fisher's exact chi-square test were used to compare categorical variables between the groups. One-way analysis of variance (ANOVA) test was used to compare the means between the groups. In case of non-normal distribution, the Kruskal-Wallis test was used. A p value of <0.05 was considered statistically significant.

RESULTS

In the first stage, the videos were divided into two groups by educational adequacy based on the total score: compatible (≥8 points) and non-compatible (<8 points). No statistically significant differences were detected between the groups in the number of likes (compatible: 300±528 point, non-compatible 132.2±295 point; p=0.114), dislikes (compatible: 31.4±57.8, non-compatible: 11.4±22.4; p=0.062) and

Table 2
Features of the videos included in the study

	Non compatible (0-7 points) (n=41)	Compatible (8-14 points) (n=31)	
	Mean±SD	Mean±SD	p
Total score	4.7±1.5	10.3±1.8	<0.001
Views (*1000)	36.1±77.7	82.3±149.6	0.117
Duration of video (min)	4.0±2.8	6.7±4.7	0.005
Like	132.2±295	300±528	0.114
Dislike	11.4±22.4	31.4±57.8	0.062
GQS	1.6±0.6	3.4±0.9	<0.001

SD: Standard deviation; GQS: Global quality score.

Table 3
Video properties by uploader source

	Group 1 (n=6)	Group 2 (n=23)	Group 3 (n=13)	Group 4 (n=30)	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*
Total score	12.2±2.1	8.9±2.8	6.3±2.7	5.2±2.1	<0.001
Views *1000	105.3±9.1	80.1±12.2	129.8±19.7	28.2±5.6	0.069
Duration	6.6±3.3	5.1±3.1	4.5±3.0	4.6±3.1	0.603
Like	452±460	310±563	261±440	37±75	0.057
Dislike	33±35	20±31	42±80	5±10	0.080
GQS	4.3±1.0	3.1±1.0	2.1±1.0	1.6±0.6	<0.001

SD: Standard deviation; GQS: Global quality score; Duration: duration of videos.

Table 4
Effects of predictors in predicting total ECG score presented by linear regression

Predictor	β-coefficient and 95% CI	*p*
Intercept	2.38 (1.12/3.64)	0.001
GQS	2.05 (1.62/2.49)	0.001
Source (unkown *vs.* known)	-1.03(-1.99/-0.07)	0.035
Duration (min)	0.067(-0.04/0.18)	0.244
Like	-0.0001 (-0.0001/0.0001)	0.843
Dislike	0.035 (-0.007/0.07)	0.106
View	-0.0001 (-0.0001/0.0001)	0.115

ECG: Electrocardiography; GQS: Global quality score; Unknown: Unknown source (Group 4); Known: Known source (Group 1, 2, and 3).

Table 5
Global quality scoring

Description of quality	Score
Poor flow, poor quality of the video, most information missing, not at all useful for healthcare professionals.	1
Generally poor quality and poor flow,some information listed but many important topics missing, very limited use of healthcare professionals.	2
Suboptimal flow, moderate quality, some important information is adequately discussed but others poorly discussed, somewhat useful for healthcare professionals.	3
Good flow and good quality. Most of the relevant information is listed, but some topics not covered, useful for healthcare professionals	4
Excellent flow and quality, very useful for healthcare professionals.	5

video duration (compatible: 6.7±4.7, non-compatible: 4.0±2.8; p=0.005). The relationship between video duration and total score is shown Figure 2.

In the next step, the videos were divided into four different groups according to the uploader source.Statistically significant differences were found between the groups in GQSs (compatible: 3.4±0.9 point, non-compatible: 1.6±0.6 point, p<0.001) (Table 2). A significant difference was found between these groups in the total score (group 1: 12.17±2.13, group 2: 8.87±2.71, group 3: 6.31±2.65, group 4: 5.17±2.1, p<0.001) and GQS (group 1: 4.33±1.03, group 2: 3.09±0.99, group 3: 2.08±1.03, group 4: 1.63±0.61, p<0.001). No statistically

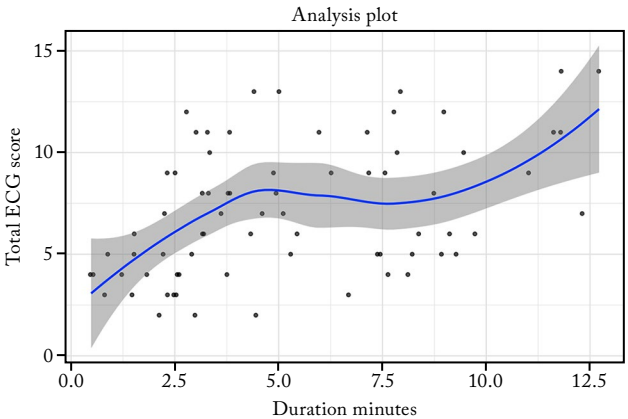

Figure 2. The relationship between video duration and total score.
ECG: Electrocardiography.

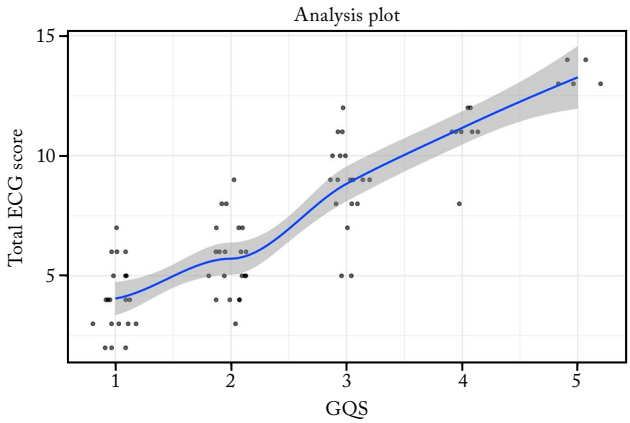

Figure 3. The relationship between total score and GQS.
GQS: Global Quality Score.

significant difference was detected between the four groups in video duration, the number of likes, dislikes, and views. The relationship between the total score and GQS is shown Figure 3.

The Cronbach alpha method was used for inter-rater reliability analysis. Values for GQS and ECG score were found to be 0.896 and 0.796, respectively.

DISCUSSION

In the present study, we investigated the adequacy and quality of video trainings on ECG recording on YouTube for the training of healthcare professionals based on the uploader source. According to the results, GQS was associated with the total ECG score (β-coefficient 2.05, 95% confidence interval (CI): 1.62 to 2.49; p<0.001), and videos uploaded from an unknown source were associated with lower total ECG scores (β-coefficient -1.03, 95% CI: -1.99 to -0.07; p=0.035 (Table 4).

Electrocardiography is a procedure that requires a long time and repetitive training to learn the recording, understand its physiology and interpret it clinically, and it still presents many unknowns for healthcare professionals.[9] It can only be correctly assessed, if the electrodes are placed in the correct anatomical positions and the recording is of good technical quality. It may be also necessary to compare serial ECGs to identify dynamic ECG changes over time, particularly in ischemic conditions, and it is important that all recordings should be made using a technique consistent with the same standard.[3]

Various studies have shown that differences between individuals and centers in ECG and departure from the standard technique cause clinically significant differences.[10,11] Many factors and technical problems in ECG recording can change the interpretation of ECGs, leading to erroneous diagnoses and putting patients at risk by making therapeutic interventions inappropriate. It is critical for patients and healthcare professionals to perform ECG recording at appropriate standards. Therefore, ECG training programs should include correct electrode placement and differences between normal and pathological patterns, and focus on recognizing ECG patterns derived from electrode misplacement, artifacts, and other technical problems that cause misinterpretation.[12]

There may not always be practical training opportunities for healthcare professionals for ECG recording, and repeated training may be needed. Depending on learning types of individuals, the principles learned from lectures or books can be difficult to apply to real-life situations. It is evident that the closer the educational environment or material is to the real one, the more effective would be the learning tool for the student.[13] In addition, online and distance learning has become much more important in these days of the novel coronavirus 2019 disease (COVID-19) pandemic and the transition to the digital age has accelerated.

In the pre-Internet era, books and articles were the main source of information.[14] As a result of the rapid advancement of technology and the widespread use of the Internet all over the world, training videos have

become very popular in healthcare, as in all areas.[15] Currently, sources of access to information in many areas have become almost unlimited and it is often possible to access these information sources even from our home. However, the information age that we live in may bring unique difficulties. Therefore, we should question the accuracy, source and adequacy of the information we have reached. As in many other areas, healthcare training videos are shared a lot on video sharing and training sites; however, there is no specific tool to determine the adequacy and quality of the uploaded video. Some of the tools used to assess websites have been used in YouTube research, but the fact that they are not produced for specific online video media such as YouTube limits the use of these tools.

Founded in 2005, YouTube is the most popular social media platform. In addition to providing unlimited information, some of the videos are loaded from reliable sources (i.e., hospitals, universities, healthcare training sites) and some from uncontrolled non-scientific sources based on personal experiences. Unsupervised videos on YouTube and resource diversity can lead to false or misleading health information.[4] This resource diversity considerably restricts the quality of training and reliability of information and may negatively affect the learning skills of those who are willing to receive training in this field.[13]

Considering the number of views of videos, it is obvious that incorrect or incomplete information would have serious consequences, particularly in healthcare training videos.[9] As shown in our study, individual training videos that do not follow a specific guide or source are quite inadequate than the training videos that follow the current guidelines in hospitals and healthcare training sites. In addition, inadequate videos do not differ in the number of views compared to highly adequate videos. This may point to the risks of incomplete and inadequate videos that reach large audiences. Therefore, healthcare professionals who are trained on these videos should be strongly advised to question the video sources and the identity of the uploader. Encouraging educational institutions and universities to be a part of this education and accessing online ECG teaching videos by medical professionals or students directly from reliable scientific and institutional sources can contribute to the solution of this problem.[4]

Another remarkable finding of this study is that the videos mostly focus on the placement of the chest leads, and the other stages of ECG recording are not paid the same amount of attention. As this is the most important and difficult-to-learn stage of ECG recording, video uploaders probably have focused on this stage most with a similar thought. However, no sufficient emphasis has been placed on the basic steps of ECG recording, such as entering the patient's identity information correctly, reducing the patient's stress by informing them about the procedure, infection control, which we appreciate much better in the pandemic, and determining the recording standards of the device.

The exclusion of online video sites other than YouTube (e.g., Dailymotion) and languages other than English can be counted among the limitations of our study. All 72 videos included in this study only via YouTube may not reflect all the online training videos. In addition, the fact that some tools that measure the quality of the data published on the websites are not suitable for online video sites can be considered as another limitation in our study; however, to avoid this limitation, the GQSs were used.

In conclusion, in the YouTube database, the scientific quality of the videos for standard 12-lead ECG recording training is highly variable. Training videos uploaded by hospitals and corporate healthcare training sites contain higher quality and scientific data than individual videos and videos of an unknown source; therefore, healthcare professionals should question the source and scientific quality of the training videos. Specific tools need to be developed for healthcare training videos uploaded to YouTube; thus, it may be possible to prevent adverse conditions that may arise with online videos that are complimentary, but not alternative to classical training.

Declaration of conflicting interests

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