Quality of Electrocardiograms Obtained in Flight by Airline Flight Attendants

Paulo M. Alves; James A. Lindgren; David R. Streitwieser; Edmundo Anzola; Nomy Ahmed; Neil Nerwich

BACKGROUND: Handling cases of chest pain aboard commercial flights is challenging for crewmembers, onboard medical volunteers, and ground-based doctors providing remote advice. Obtaining an electrocardiogram (ECG) in-flight could help in dictating the management of such cases. The ability to diagnose or rule out ST-segment elevation myocardial infarction (STEMI) would have clinical and prognostic implications. The feasibility of obtaining good quality ECG tracings by flight attendants in flight is not known.

METHODS: A series of 200 consecutive ECG tracings transmitted to a ground-based medical support provider were independently reviewed by four observers who ranked the ECG tracings according to a quality score (QS) criteria, as well as trying to identify or rule-out cases of STEMI.

RESULTS: ECG quality was considered good enough to extract useful information in 170 of 200 tracings (85%). Seven cases of STEMI were identified. A STEMI was confidently ruled out in 104 cases. Additional abnormalities of variable clinical importance were also detected.

DISCUSSION: ECGs are essential in the prehospital management of chest pain cases. ECGs obtained in flight by airline flight attendants were mostly of diagnostic quality, allowing confirmation or ruling out of STEMI, as well as detecting arrhythmias of clinical significance in case management.

KEYWORDS: electrocardiogram, in-flight medical events, ST elevation myocardial infarction, chest pain.

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According to the World Bank, it is estimated that more than 3.2 billion people fly every year.[1] Coronary heart disease is the leading cause of mortality in the United States, with a general prevalence of 6.3% in U.S. adults at 20 yr of age or older.[2] The estimated annual incidence of myocardial infarction is 580,000 new and 210,000 recurrent events.

It is therefore not surprising that a number of passengers can develop acute coronary syndrome (ACS) while traveling by air. While statistical likelihood alone can explain some cases observed, it is also possible that certain events are precipitated by stress factors peculiar to air travel. Predisposing factors may include the mildly hypoxic environment of the aircraft cabin at cruising altitude and immediate pretravel unusual physical stressors, such as walking briskly for long distances in airports and carrying more weight than usual before boarding. Managing passengers presenting with chest pain constitutes a major challenge to all involved, including, crewmembers, onboard medical volunteers, and the ground-based medical support (GBMS) provider.

In a large retrospective study, suspected cardiac events were not infrequent and were associated with high odds of aircraft diversion and subsequent hospital admission.[7] Obtaining a prehospital electrocardiogram (ECG) in cases of chest pain has been demonstrated to direct further care and expedite treatment for ST-segment elevation myocardial infarctions (STEMI).[6] It has also been associated with reduced short-term mortality.[8]

The ability to obtain ECGs could benefit passengers with suspect coronary events while in flight. Today a few airlines carry multiparameter monitors which include the ability to obtain 12-lead ECGs, which can be transmitted to a GBMS provider or be interpreted by a qualified medical volunteer traveling on the flight.

To maximize its utility, it is essential that a diagnostic quality ECG tracing be obtained by the flight attendant, who usually receives limited training and uses the device infrequently. The

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Table I. Quality Score Criteria.

SCORE	DESCRIPTION	CRITERIA
5	Excellent	Flawless
4	Good	Readable. Minor baseline fluctuation / noise artifact / missing lead
3	Fair	Readable. Technical problems, relevant information can be extracted
2	Poor	Important technical problems, some information can be extracted
1	Very poor	Not readable
0	No tracing	Mostly blank tracing

purpose of this study was to assess the overall diagnostic quality of ECG tracings obtained in flight by a flight attendant and transmitted to a GBMS provider. Additional focus was given to the possibility of ruling STEMI in or out and the occurrence of technical problems in obtaining the tracings.

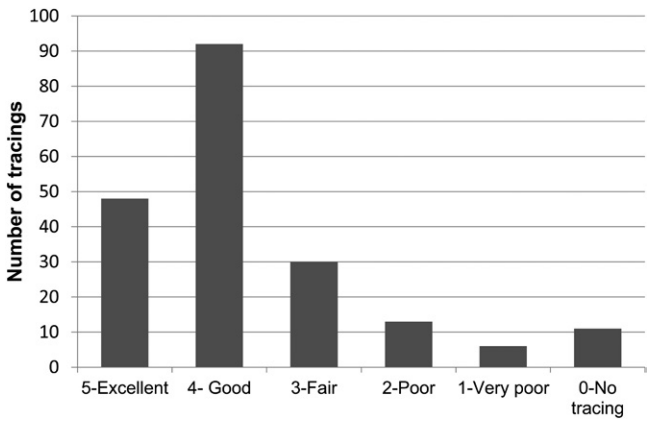
METHODS

A series of 200 consecutive ECGs transmitted to a ground-based medical support provider (MedAire Inc.) was obtained from two airlines using a commercially available multiparameter telemedical device (Tempus IC, Remote Diagnostic Technologies, Basingstoke, UK). The device uses an electrode harness system which is strapped around the patient's thorax to obtain precordial leads with three additional cables for the peripheral leads. All data were collected noninvasively as part of the care provided by crewmembers in flight and not specifically for this study. Patient consent was obtained in every case the device was used in flight as per the standard procedure of the airlines.

Tracings did not include information on age, gender, presenting symptoms, or flight details. Reviewers were blind to the passenger's demographics and clinical aspects which were collected in a separate database and not taken into analysis. ECG tracings were independently reviewed by four observers (first four authors): two cardiologists and two emergency medicine physicians.

Whenever multiple ECGs were obtained from the same case, the best quality tracing was selected. ECGs obtained from the same passenger/flight were accepted as two tracings if obtained more than 1 h apart. A quality score (QS) system was developed. **Table I** summarizes the scoring system.

A QS was attributed for each tracing calculated from the simple round average of the individual scores from the four reviewers. Reviewers were asked to identify cases in which a STEMI could be positively identified or ruled out, as well as for the presence of additional ST-T abnormalities or other findings such as arrhythmias and bundle block patterns. Epi-Info version 7.2.2.2 was used to generate descriptive statistics.



Fig, 1. Distribution of averaged quality ECG tracing score.

RESULTS

Tracings had a QS of 3 or more in 170 of 200 cases (85%), implying they were considered of enough quality to glean useful information. Among those, the majority of tracings (140/200, 70%) were considered of good or excellent quality. **Fig. 1** summarizes the quality findings.

Seven cases of STEMI were identified. In three cases the inferior wall was affected (leads 2, 3, and F). Infero-lateral involvement (leads 2, 3, F, v5, and v6) was evident in three tracings. One case affected the anterior wall (v1 to v5). A STEMI was confidently ruled out in 104 cases. The ECG tracings also allowed the identification of other abnormalities which could be important in specific presenting scenarios such as atrial fibrillation (10 cases), atrial flutter (1 case), left bundle branch block (4 cases), right bundle branch block (15 cases), and supraventricular tachycardia (5 cases), and provided accurate measurement of heart rate.

Out of the readable cases, an unstable baseline was the most common problem, present in 43% of cases, followed by a noise artifact in 18%. Both conditions are possibly related to touching the patient during the ECG signal acquisition and/or patient motion. Missing or unreadable leads occurred in 10% and switched cables (R and L) in 5%. V3 was the most common missing/unreadable lead, which could be attributed to its peculiar position in relation to the breast, possibly causing poor electrode contact. Another important factor contributing to the few problems observed is that those tracings were usually obtained while the passenger was in a seated position.

DISCUSSION

The implementation of a successful in-flight ECG program requires two conditions to be met: diagnostic quality tracings should be obtained by minimally trained personnel present on every flight, and tracings should be analyzed by professionals familiar with basic electrocardiogram interpretation, including identifying a STEMI. Appropriately trained medical volunteers often cannot be found on commercial flights. Therefore, flight attendants must be the ones responsible for obtaining in-flight ECGs and transmitting to GBMS providers, who can then

verify the quality of the tracings, ask for additional tracings to be obtained in case of poor tracings and ultimately interpret the findings.

The ECG is essential in the management of chest pain cases. Risk stratification scoring systems like TIMI[4] and HEART Pathway[3] depend on the ECG findings as an important factor.

Cases of STEMI benefit from immediate reopening of the occluded culprit coronary artery, ideally by primary angioplasty or by systemic thrombolytic therapy,[5] which can reduce 1-yr mortality even when performed beyond the first hour of symptoms.[9] The identification of a STEMI case in flight would require landing the aircraft at the closest airport with suitable medical facilities nearby, ideally with interventional cardiology capabilities, which would imply a flight diversion in the vast majority of events.

On the other hand, ruling out a STEMI could also change the management of an in-flight chest pain event. In those cases, an attempt of clinical stabilization with aspirin and nitrates might be warranted to avoid an unnecessary diversion. Unwarranted medical diversions in cases of chest pain not associated with ACS are not in the best interest of any party involved, representing cost and disruption for the airline, to their passengers, and, above all, to the affected person who may end up unnecessarily in a hospital away from home. On the other hand, missing an early diagnosis of a STEMI and not expediting appropriate care could have severe prognostic consequences for the affected passenger. Last but not least, a normal ECG pattern in a case of atypical chest pain can be reassuring enough to allow a recommendation not to divert a flight and recommend symptomatic treatment alone.

It is noteworthy that a STEMI was identified in some tracings with missing or unreadable leads (**Fig. 2**). In the practical setting, to minimize crew's anxiety and expedite the medical recommendation, it did not make sense to try to obtain better tracings once the diagnosis was evident. Probably the majority of STEMI cases can be identified with less than 12 leads since alterations are usually seen in multiple leads.

A limitation of this study was that a better insight into the causes of bad tracings was not feasible. Case handling per se took precedence over any additional data collection under the circumstances of dealing with such challenging medical events. Nonetheless, the results serve as a baseline for future comparison.

In the majority of cases of chest pain the clinical presentation is not sufficient to make a positive diagnosis of an acute ischemic event, let alone to predict the prognosis. The addition of telemedical devices into the medical kits of some airlines provided a ground-breaking contribution to refining the ability to assess medical events occurring in flight and directing care. In particular, the possibility of obtaining ECGs provides for a better evaluation of cases of chest pain, as in other out of hospital scenarios.

ECGs obtained in flight by airline flight attendants are mostly of diagnostic quality, allowing confirmation or ruling out of STEMI, as well as detecting arrhythmias of clinical significance in case management. The few minor technical issues

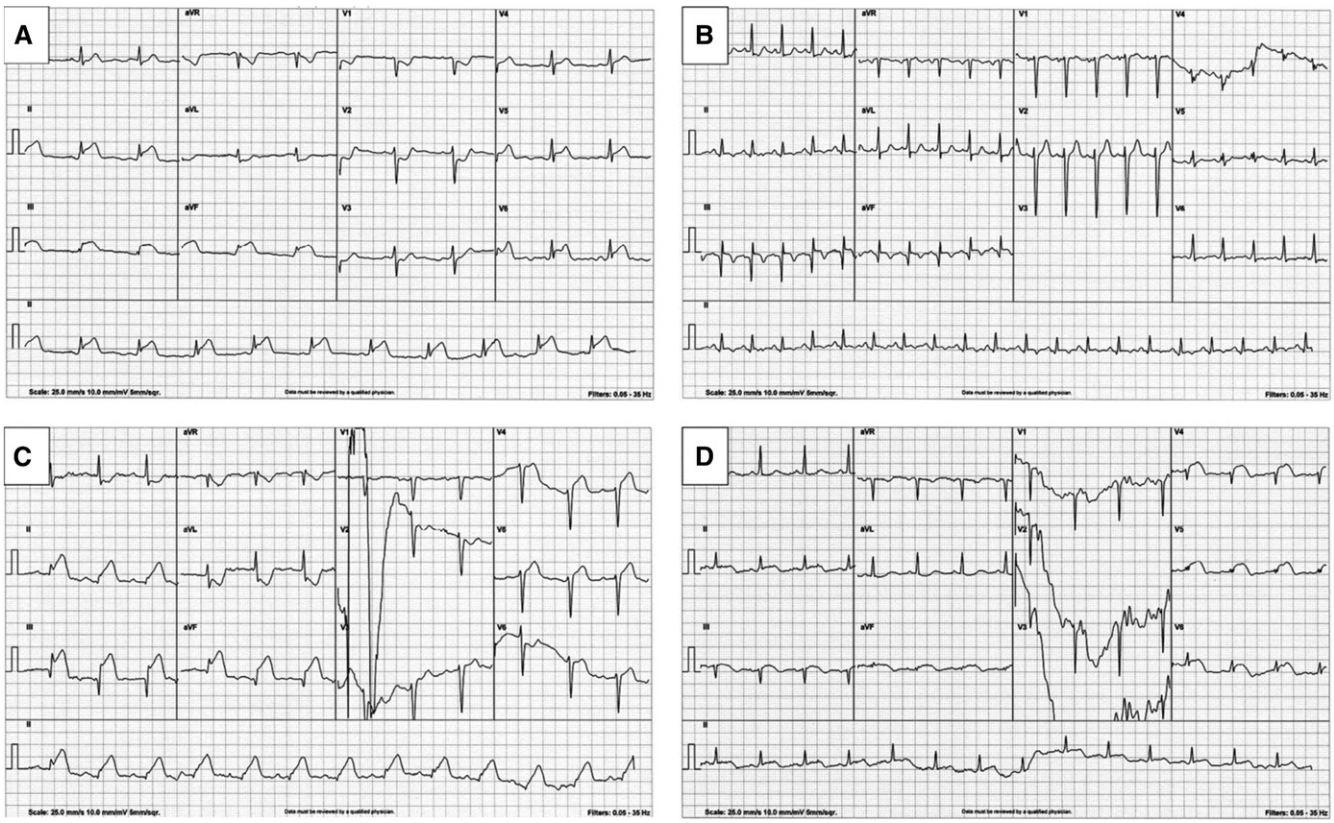


Fig. 2. ECG examples of ST-segment elevation myocardial infarctions. A) This tracing is considered flawless. Diagnosis was evident also in cases with B) missing lead or C & D) artifacts.

identified are also common in ECGs obtained by well-trained technicians on the ground and did not compromise obtaining useful information.

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