An Infrastructure for Retrieving Passengers' Medical Records in Case of in-flight Emergencies

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Abstract

In this paper, we present the concept of a telematics system that not only opens an audiovisual communication channel to ground-based doctors, but also provides them with medical background information on the patient (e.g. contraindication of certain medicaments, affliction with haemophilia, diabetes). This information can be a vital supplement to the diagnostic data (e.g. electrocardiogram, oximetry) relayed to the specialist by the cabin crew, aiding the doctor in deciding on the right therapy, instructing the crew appropriately and monitoring the treatment.

Keywords: Aeromedicine, remote diagnostics, health records

1. INTRODUCTION

When traveling on commercial airliners, passengers are subject to reduced air pressure and humidity; limited space and opportunity for movement; vibrations, noise and stress. While healthy passengers can adapt to this environment, passengers with pre-existing cardiac, circulatory, respiratory, gastrointestinal or other problems may not be able to tolerate it (especially on long-distance flights), potentially leading to an aggravation of their condition or even the occurrence of acute emergencies.

Although the cabin crew is trained to handle a number of medical incidents, has first aid supplies and equipment on board, and doctors happen to be among the passengers on quite a few flights, emergency response can obviously not be as swift and comprehensive as on the ground, where a tight infrastructure of paramedics and hospitals is available in many countries. Today, there are no methods available to assess a passenger's condition or monitor his vital signs from the ground during an in-flight medical emergency. This may make costly unscheduled landings necessary.

To improve the on-board diagnosis, especially in critical cases that are beyond the cabin crew's training and require the knowledge of medical specialists, airlines are looking into research on systems that facilitate communication and cooperation between the cabin crew and doctors on the ground.

In order to provide the crew and ground-based doctors with medical background information on a passenger in case of an emergency (e.g. regarding pre-existing conditions or contraindication of certain medicaments), we suggest that passengers have a special health record in an internationally standardized format on file with their insurance company and provide the ID of this record to the airline when booking a flight. In case of an in-flight emergency, the airline can then retrieve the passenger's record and forward it to the ground-based specialist supervising the treatment on board.

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In this paper, we present the coarse architecture of a distributed system for storage and retrieval of such records.

2. RELATED WORK

The complexity of the telemedicine field is reflected by the richness of research areas, methods, and software. Researchers are working on a number of techniques to solve the communication problems between the crew and ground-based specialists.

For example, Cluzel [2] describes a project with the goal to set up a mobile telemedicine workstation (consisting of a PC with telecommunications capabilities) connected to a portable ultrasound station. This telemedical device could be used in isolated areas such as islands, rural or conflict areas: The doctor in the field would scan the patient, and by means of the built-in mobile telecommunications device (e.g. a satellite phone), the acquired 3D dataset would be transferred to a remote expert virtually anywhere in the world.

The SILC project presented by Mayer et al. [6] aims to develop an intelligent wrist-worn system to increase the bearing patient's safety and independence. The SILC wrist watch will be equipped with a range of biometric sensors and a telecommunications device which can be programmed to trigger alarm calls automatically when a critical condition is detected.

Auer [1] works on creating and evaluating adequate network solutions for transmitting various kinds of medical data such as laboratory results and biosignals, regardless of their format (e.g. alphanumeric information, images, complex datasets or multimedia content), possibly also from airborne to ground-based stations. Another area of interest is the development of tools for teleradiology software.

Further ideas and insights might also be gained from the human spaceflight field: On space missions, medical help in an emergency is even further away, so advanced telemetry and telemedicine methods already had to be developed by space agencies which may be applicable (albeit in modified form) to commercial air traffic [4].

3. EXISTING PROBLEMS

Depending on the nature and severity of medical incidents on board a commercial airliner, a different reaction is required of the cabin crew. While there are routine procedures for a range of light and medium incidents, more severe cases may require individual diagnosis and treatment that is beyond the training and competence of the crew [8].

On-board handling of medical emergencies is usually characterized by the following conditions:

- Some emergencies may reach or even go beyond the limits of the crew's competence and training.
- Emergencies need to be handled in a very confined, crowded space with virtually no privacy. This can aggravate the crew's stress and thus impair their competence and judgment.
- In severe cases, medical emergencies may make unscheduled stops necessary, which incur a high cost to the airline. Weighing the pros and cons of an unscheduled landing objectively may be a challenge for the people in charge.

Telecommunications technology may support and improve the handling of medical emergencies on board of commercial airliners. While a telemedicine system cannot be a full substitute for an on-board specialist, it can allow the cabin crew to work more efficiently: By providing a ground-based specialist with stored background information and live medical telemetry about the patient, and relaying the doctor's experience, competence and authority back to the crew, a telemedicine system could let the flight attendants focus on treating the patient while relying on the doctor's directions, instead of having to diagnose the patient, figure out the treatment and administer it themselves.

Implementing a telemedicine system is a challenge since it relies on the transmission of digital data between the aircraft and the doctor on the ground. However, such data cannot be transmitted over the aircraft's regular two-way radio connection, which just provides an analog audio link. As demonstrated in [3], cellular phone technology may be a solution to that problem, provided that its use is allowed by aviation agencies for emergency situations, and that the aircraft is within range of a cellular network. If that is not the case, satellite links have to be employed, as described in [5] and [7].

The cost of developing and operating a telemedicine system for passenger airliners should be weighed against the cost of unscheduled landings with all their consequences (accommodation of passengers, refueling, delays etc.), as well as the airlines' responsibility to improve passenger safety and their goal to increase customer service.

4. SYSTEM ARCHITECTURE

A number of actors and entities both on the airliner and on the ground are involved in case of an in-flight emergency. Figure 1 illustrates how they are involved in the process of diagnosing and treating an affected passenger using the system suggested here.

In case of a medical emergency, the crew notifies the air traffic control station that is currently responsible for the airliner about the incident, and transmits the health record ID of the affected passenger (1). All passengers who are registered with the system should have provided their ID upon check-in for this purpose. Using the ID, authorized air traffic control staff can retrieve the patient's health record (2, 3 - see the following section for an overview of the infrastructure necessary for this step). The health record is forwarded to a doctor on the ground, who may be a general practitioner on standby for such emergencies, or a specialist for a certain pre-existing condition indicated in the patient's health record (4). Using a satellite uplink, the doctor can then enter a video conference with the crew on board the airplane, diagnose the patient based on telemetry of his vital signs and his health record, and instruct the crew about how to treat the patient accordingly (5, 6).

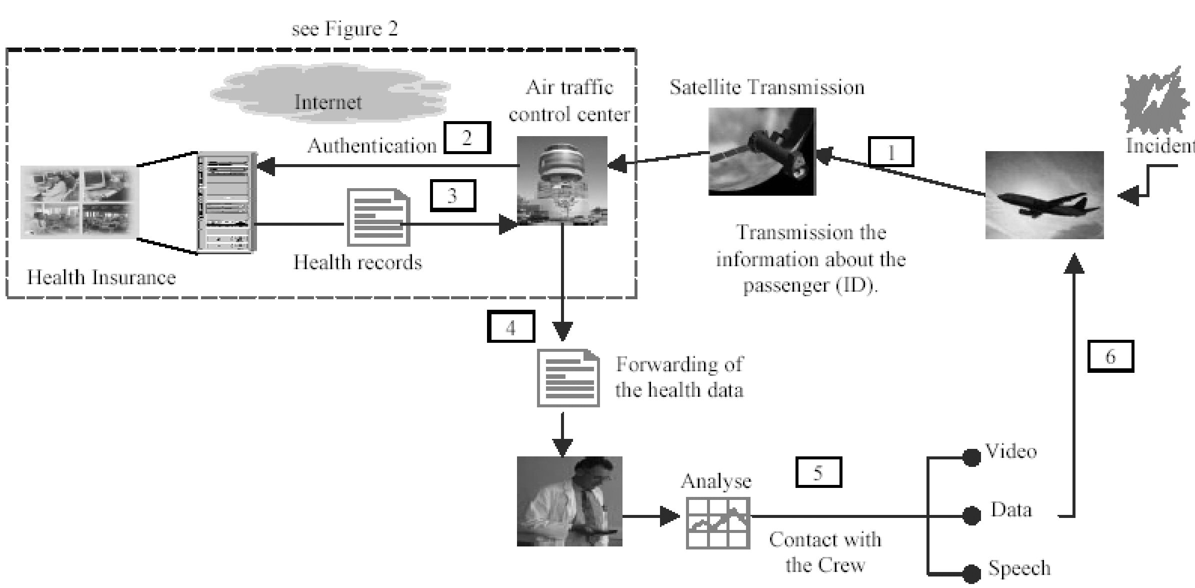

Figure 1. Process for requesting ground-based medical support

Besides the choice of communication technology for the videoconferencing and telemetry component of the system, another challenge is the infrastructure required to store and retrieve passengers' health records. In the design of this system, we must consider technical issues such as the geographic distribution of the records, as well as privacy and security concerns since we are working with sensitive medical information.

The system architecture needs to take into account that users[1] can be at home in any country in the world and may use any airline to fly out of and into any airport in the world.

In transit, their aircraft will be in contact with a series of air traffic control stations in different countries (for example, a Japanese user might fly with Delta Airlines from Seattle, Washington, to Leipzig, Germany, passing over a number of air traffic control stations in the United States, Iceland, Great Britain, the Netherlands and Germany). This global coverage, combined with the high number of users traveling by plane every day, suggest that only a decentralized architecture can be an efficient and feasible approach.

Figure 2 illustrates a possible architecture: For privacy reasons, the users' health records should only be transmitted over the network when necessary, but otherwise remain with an institution that the user trusts.

This might for example be the user's health insurance, as shown in the "Germany" part of the architecture. Another approach (illustrated in the "Japan" part) might require all users living in a country to sign up with a central institution that manages all records for that country. Either way, a "central office" is required in each country which answers incoming requests for health records directly or delegates them to the institution (e.g. health insurance company) that keeps them on file.

Health records need to be identifiable by a globally unique ID, so air traffic control stations can request them when they are notified of a medical emergency on board an airliner that is currently under their responsibility.

In order for a traffic control station somewhere in the world (e.g. Keflavik, Iceland) to retrieve a health record somewhere else in the world (e.g. Tokyo, Japan), the health record ID should contain a code indicating the country in which the record is stored. Based on this country key, the control station can look up the appropriate central office where the record must be requested.

For the storage and transmission of the health records, we suggest an XML-based format. XML [9, 10] has a number of characteristics that are advantageous in this context: It allows the creation of documents containing hierarchically structured data that can be read by anybody who knows the rules governing the document structure (i.e. the Document Type Definition). This makes it easy for the various subsystems of our concept to handle, interpret and display the data without conversion. Since XML documents are plain text documents, they can also be easily transmitted over various communication links, such as the existing network infrastructure of the Internet, as well as satellite links connecting airliners to control stations.

[1] In the following discussion, we will consider "users" to be passengers who registered with the system and have their health records on file somewhere. This is to distinguish them from airline passengers who did not sign up with the system and thus do not have a health record available.

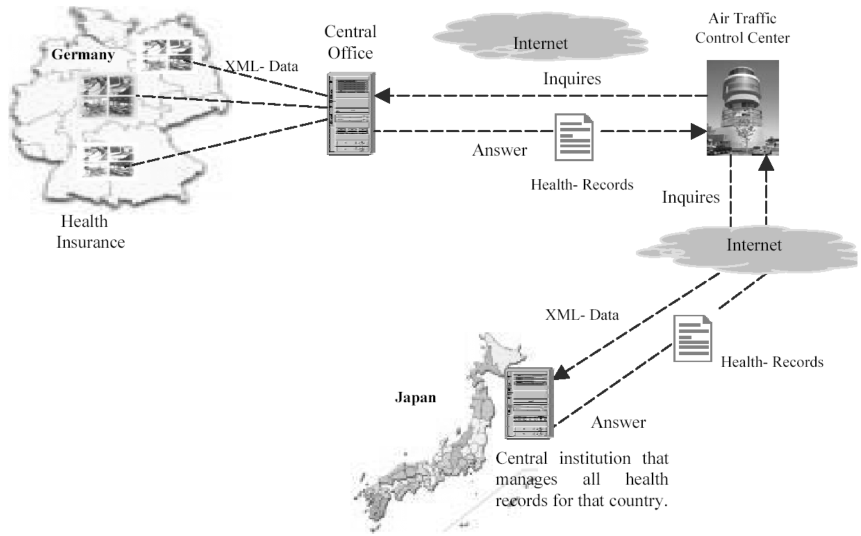

Figure 2. System Infrastructure

5. Summary and Opportunities for Further Research

In the previous sections, we presented the concept of a system that not only opens an audiovisual communication channel from commercial aircraft to ground-based doctors in case of an emergency, but also provides doctors with medical background information on the affected passenger. This information can be a vital supplement to the diagnostic data relayed to the specialist by the cabin crew, aiding the doctor in deciding on the right therapy, instructing the crew appropriately and monitoring the treatment.

Further research must go into the selection of technologies that can be employed to implement the various components of the system, such as medical telemetry, broadband telecommunications, and health records retrieval.

For the latter, a concrete data format that can contain all necessary medical information, an identification scheme that is scalable and human-readable while guaranteeing the uniqueness of IDs, and a protocol for retrieving health records from the internationally distributed storage facilities must be devised.

The feasibility and effectiveness of these concepts, as well as the suitability of any chosen technologies, must be validated thoroughly using prototypes.

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