A Personal Handheld Device to Support People with Life-Threatening Anaphylactic Allergies (PervaLaxis)

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ABSTRACT

This paper presents PervaLaxis, a personal mobile health device designed to help anaphylactic people manage their life-threatening allergies. PervaLaxis was designed to support allergic patients both in everyday life and in emergency scenarios where an injection of adrenaline may be vital. PervaLaxis is implemented on a Smartphone platform and communicates wirelessly with adrenaline injectors. In emergency scenarios, PervaLaxis can detect an injection of adrenaline and send a message automatically to emergency services; in normal life PervaLaxis can support adrenaline injector training, for example with video demonstrations and can support medication management, for instance, managing adrenaline expiration dates. In this paper we present user requirements and evaluation results for PervaLaxis, furthermore we explore the issues associated with the patient-oriented focus of the device (as opposed to health devices designed for expert use) and how this could benefit personal health management. We evaluate usability performance and propose directions for future work based on user feedback.

Keywords: Allergies, Anaphylaxis, Handheld Computing, Mobile Learning, Mobile Technologies, Pervasive Healthcare, Wireless Networks

INTRODUCTION

The Anaphylaxis Campaign UK (2008) states that one third of the total UK population (around 19 million people) will develop an allergy at some time in their lives. A small but significant proportion of these, around a million people, suffer acute, severe symptoms that may be life-threatening. In this extreme form, this is known as anaphylaxis.

Warner et al. (2006) reported that allergic conditions are the most common causes of chronic illness in developed countries and that figures are rising. They also highlighted the global lack of specialists, the desperate need for improved patient care, training and expertise in this area, and the lack of appropriate clinical services to support sufferers. In addition,
they suggest that 22% (average mean) of the worldwide population surveyed (34 countries, 1.61 billion people) suffer from an allergic condition, being for instance Ukraine, Japan, The United Kingdom, Bulgaria and Sweden some of the countries with the highest allergy rates. The highest rates being close to 50% of the population.

The American Academy of Allergy, Asthma and Immunology (2009) reports that allergy is a very common disorder, more than 50 million Americans suffer from allergic diseases, and that 150 allergic people die annually from anaphylaxis in the United States. In addition, they say allergies are the 5th leading cause of chronic disease in that country, costing the health care system a large amount of money annually: one analysis estimated it at $7.9 billion per year, of which $4.5 billion was spent on direct care and $3.4 billion on indirect costs, related primarily to lost work productivity. The Royal College of Physicians (2003) also published that this is a major public health problem in developed countries which is growing every year. They suggest that it is probably caused by some environmental changes acting on a genetic predisposition to allergy, there is also the idea of the “Hygiene Hypothesis” (Strachan, 1989) which highlights the fact that declining in family size, better household amenities, and improved standards of personal cleanliness have contributed in the reduction for cross infection in young families and their lack of ability to educate their immune system to recognize and handle a real invader threat.

Anaphylaxis is a severe allergic reaction, the extreme end of the allergic scale, where the whole body is affected, often within minutes of exposure to the allergen but sometimes after hours. The Anaphylaxis Campaign (2008) states any allergic reaction, including the most extreme form, anaphylactic shock, occurs because the body’s immune system reacts inappropriately in response to the presence of a substance that it wrongly perceives as a threat. The allergic reaction is caused by the sudden release of chemical substances, including histamine, from cells in the blood and tissues where they are stored. The release is triggered by the reaction between the allergic antibody (IgE) with the allergen and this mechanism is so sensitive that minute quantities of the allergen can cause a reaction. So the released chemicals act on blood vessels to cause the swelling in the mouth and anywhere on the skin, causing a fall in blood pressure.

The symptoms of an allergy might include some of the following: Generalized flushing of the skin, nettle rash (hives) anywhere on the body, swelling of throat and mouth, difficulty in swallowing or speaking, alterations in heart rate, severe asthma, abdominal pain, nausea and vomiting, sudden feeling of weakness (drop in blood pressure) or collapse and unconsciousness.

The World Allergy Organization (2009) and The Anaphylaxis Campaign UK (2008) indicate that the most common causes of anaphylaxis include foods such as peanuts, tree nuts (e.g. almonds, walnuts, cashews, brazils), sesame, fish, shellfish, dairy products and eggs. And Non-food causes include wasp or bee stings, natural latex (rubber), penicillin or any other drug or injection. They make the point that in some people, exercise can trigger a severe reaction - either on its own or in combination with other factors such as food, drugs (e.g. aspirin) or asthma. Moreover, they point out fresh fruit allergy may occur in people who are allergic to pollen, and they say that this is frequently mild, but a doctor’s advice should be sought.

The treatment for a severe reaction includes the use of pre-loaded adrenaline injection kits (e.g. Epipen©, Anapen©, etc). The injection must be given as soon as a serious reaction is suspected and an ambulance must be called. If there is no improvement in 5-10 minutes, a second injection must be given. Adrenaline is used because during anaphylaxis, blood vessels leak, bronchial tissues swell and blood pressure drops, causing choking and/or collapse. Adrenaline (epinephrine) acts quickly to constrict blood vessels, relax smooth muscles in the lungs to improve breathing, stimulate the heartbeat and help to stop swelling around the face and lips (Anaphylaxis Campaign UK, 2008).
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