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Users as Developers and Entrepreneurs of Medical Treatments/Devices: The Case of Patients and their Families and Friends

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Abstract

The health care industry has experienced a proliferation of innovations aimed at enhancing life expectancy, quality of life, diagnostic and treatment options. Previous research has shown that users themselves innovate with respect to services they self-provide. In this study, we look at sources of health care innovations, in particular the role of users in the development of those innovations. We build our study upon previous work by Oliveira, von Hippel and DeMonaco (2011) and Oliveira (2012) and will empirically explore the role of patients and their families and friends (i.e. users) in developing new medical treatments and devices for themselves. We focus on chronic diseases, including respiratory diseases (Cystic Fibrosis, Asthma and Sleep Apnea), Cancer, Diabetes and medical devices and treatment for general purposes. For each of these chronic diseases we developed a sample of treatments and devices and show that patients with those diseases (or their families and friends) have developed a significant proportion of treatments and devices. Despite some sampling limitations we found that the majority (54%) of new medical treatment and devices for those diseases were developed by patients or their families and friends. Moreover, 53% of such patients who are user innovators have become entrepreneurs and created their own firms to produce their inventions.

Our empirical findings have important policy and managerial implications for health care management and entrepreneurship.

Key words: user innovation; health-care innovation; treatments and medical devices; user entrepreneurship.

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Users as Developers and Entrepreneurs of Medical Treatments/Devices: The Case of Patients and their Families and Friends

1. Introduction

In this paper we explore the role of patients (i.e. users) in developing medical treatments and devices for themselves. We show that in the health care industry there is a significant proportion of user innovators in addition to the producer innovators.

User innovators are individuals or firms which expect to benefit directly from using the product or service they create. *Producer innovators* are firms or individuals which expect to benefit from selling a product or service. In other words, a health-care innovation is *user-developed* if the developer expects to benefit from use and *provider-developed* if the developer expects to benefit from sales (adapted from von Hippel 1988, 2005).

Consider the example of Cystic fibrosis (CF), which is a chronic disease that causes the body to produce abnormally thick and sticky fluid called mucus, resulting in life-threatening lung infections. We analyzed a sample of CF treatments and found that patients (users) have developed a number of significant solutions. For example, the use of low frequency vibrations for bronchial drainage was developed by a CF patient named Louis Plante, who had to leave a concert because of excessive coughing while sitting in proximity to a large speaker. Using his skills as an electronics technician, Louis developed a device that could generate the low frequency vibrations (Oliveira, 2012). Louis is a user because his primary goal to develop the treatment was to benefit from using it. Later he created a firm to commercialize his solution, so he is also a user entrepreneur.

In line with the previous example, in 1969 type-1 diabetes patient Richard Bernstein came across an advertisement for the first blood glucose meter which would give a reading in 1 minute using a single drop of blood. The device was intended for

emergency staff at hospitals to distinguish unconscious diabetics from unconscious drunks. The instrument weighed three pounds, cost $650, and was only available to certified physicians and hospitals. Determined to take control of his own health, Bernstein asked his wife, a doctor, to order the instrument for him. Bernstein began to measure his blood sugar about 5 times each day and soon realized that his levels fluctuated wildly throughout the day. To even out his blood sugars, he adjusted his insulin regimen from one injection per day to two and experimented with his diet, notably by reducing his consumption of carbohydrates. Three years after Bernstein began monitoring his own blood sugar levels, his complications were still progressing and he began researching scientific articles about the disease. Bernstein, a user, is believed to be the first individual to self-monitor his blood sugar and was an early advocate for such monitoring by diabetics (Bernstein, 2007; Oliveira, 2012).

The remainder of the introduction is an industry analysis (1.1.) and a discussion of why user innovation is important for health care (1.2.). The paper which follows is structured in four parts. Chapter 2 presents the literature review, which aims to position the paper in the existing literature by introducing the scope of our research topic and integrating previous research finding. Chapter 3 presents the research methods, the two research hypotheses, the method for data collection and the description of our sample. Chapter 4 presents the results of our study that will be discussed in Chapter 5. After conclusions, limitations will be explained and future research directions are proposed.

1.1. Industry analysis: health care

Practitioners and researchers are keenly interested in understanding innovation in services, including health-care services (Oliveira and Roth, 2011). Notably, services represent almost 80% of employment and 76.9% of the gross value added in the USA in 2008 (OECD 2010; Oliveira and Roth, 2011).

Health is determined by a number of factors, one of which is health care. Health care includes the provision of care by any medical institution, either single medical assistant or those attached to hospitals or other establishments (Economy Watch, 2010). Health care differs from other industries because its product is ill-defined, outcomes are uncertain, the industry is dominated by nonprofit providers, and receipts are from third parties such as government and private insurers (Morrisey, 2008).

Health and the health care industries are clearly topics of critical importance for executives in every industry around the globe. According to statistics, health spending reached on average 9.5% of GDP of OECD[1] members in 2009, compared with 8.8% in 2008. Total health care expenditures around the world are difficult to determine, but $5.7 trillion would be a fair estimate for 2011. That would place health care at about 8.7% of global GDP, with expenditures per capita at about $800[2]. In the United States alone it provides 4.5% of jobs[3].

One of the main concerns in developed economies is the cost of health care. The Economist Report about the future of health care in Europe notices that its increasing cost cannot be covered by current levels of public funding, raised through taxation and insurance. Among the main reasons of rising healthcare costs are: ageing populations and the related rise in chronic disease; costly technological advances; patient demand driven by increased knowledge of options and by less healthy lifestyles; legacy priorities and financing structures. Health care industry is characterized by high regulation and bureaucracy. This makes medical research difficult and costly. It is important to appoint that citizens by themselves want to have a right of word in healthcare policy at both central and local government levels. It is also noticed that during last years, many individuals take more responsibility for their own health, adopt healthier lifestyles and research alternative courses of treatment on their own (The Economist Intelligence Unit, 2011).

[1] www.oecd.org/health/healthdata [Accessed 18.12.2011]
[2] By Plunkett Research®, Ltd, http://www.plunkettresearch.com/health-care-medical-market-research/industry-overview [Accessed at 16.12.11]
[3] By US department of labor data, http://www.bls.gov/oco/cg/cgs035.htm#nature, [Accessed at 16.12.11]

In many ways, the health care industry is changing. Due to advanced technology, for example, hospitalization can be avoided in many cases and can be substituted with outpatient treatment. The pressure to improve medical service quality is increasing constantly and there is widespread outsourcing of the majority of non-clinical functions (Carlson & Russ, 2007). Healthcare today is mostly limited to the national market of one country, but that is likely to change in future as many patients now travel to other countries for treatment. Together with improved directives on services trade, this may lead to a single market of health care services for all of Europe (Røtnes & Staalesen, 2009).

Given these trends, some general predictions about the future of health care can be made. One of the most important is that health care spending will continue to rise, mainly due to the view that improved health is linked with greater national wealth. Governments will need to improve health data collection and analysis in order to make better and less costly investment decisions. This will also require reviewing bureaucracy and restrictions rules which influence the artificial rise of medical research and investment costs. Patients will be more empowered to make decisions concerning their own health, combining treatment and care with fundamental lifestyle changes aimed to encourage good health. The general health care model will be rationalized with improvement of services and consolidation of healthcare facilities (The Economist Intelligence Unit, 2011).

1.2. Why user innovation is important for health care

As noted earlier, technological advances are a part of increasing health care costs. But technological innovation is important to sustain the industry. Today (and likely in the future), innovation in the health care sector is mainly driven by R&D. However, focusing on user/market needs can be a valuable supplement to traditional producer-driven innovation methods. Best practices and experiences from the market or even an individual customer can be used in the health care sector in order to

provide better services and make efficient use of the available resources (Røtnes & Staalesen, 2009).

If often happens that existing solutions in healthcare can not satisfy heterogenic user/patient needs. There are innumerable cases of rare diseases ("micromarkets"), and it is too costly and too difficult in the health care industry to find the solution for such patients. These are users who, when do not have an appropriate solution for their needs, try to resolve the problem by themselves. This behavior can be easily applied to general health care services. If doctors cannot provide a patient (user of a service) with proper treatment (solution offered), a patient, who wants to be cured (have a strong need), start to look for the solution by himself (innovate). Von Hippel was the first to show that users innovate, especially those who have needs ahead of the market and "live in future" (von Hippel, 1976, 1986, 1988).

Traditionally it was thought that users in the health care industry could only come up with incremental innovations. This was justified by their assumed incapacity for understanding complex technologies and simply the absence of desire from users to innovate. A recent study shows that, on the contrary, users are able to develop their own solutions for radical innovations. Many surgeons innovate and even become entrepreneurs. For example, such technologically advanced devices as Robotic system for neurosurgery, biocompatible implant and computer-assisted navigation were originally developed by users (Lettl, 2005). Lüthje (2003), in a study of surgeons working at university clinics found that 22% of these surgeons had developed new products for in-house use.

User innovation in health care has not been sufficiently studied yet. If necessity is the mother of invention[4], then users should obviously innovate. They have a high problem pressure and that makes them innovate, even without resources or technical knowledge. Users, however, know their needs better than anyone. The problem arises due to the bureaucracy inherent in the health care industry. Because it is associated with human life, it is highly regulated and all innovations are carefully studied at great

[4] *Plato*

expense. As a result, many producers do not even take into consideration user innovations.

Although medical treatments have made astonishing advances in the past decades, the sources of those innovations have been understudied. Considering the importance yet ignorance of user innovation in health services, the following research problem arises: ***What is the role of users in developing new medical treatments or devices?***

2. Literature Review

In this chapter, the importance of innovation for business is discussed in section 2.1, and open innovation is described in 2.2. User innovation is presented in 2.3. as follows: evidence on the economic importance of user innovation (2.3.1.); use for business (2.3.2.); user entrepreneurship reality (2.3.3.) and important issues to consider when study user innovation (2.3.4.). In the last part of the chapter, health care innovation will be reviewed (2.4).

2.1. Innovation and its importance

Economic development, technological progress, competitiveness and even business survival can be dependent on innovation. The ability to be innovative is a hot topic among both politicians and business people today (Denning, 2012). Moreover, firms in many industries estimate that products developed in the last 5 years account for more than 1/3 of their sales. With the widespread globalization of markets and foreign competition pressure, the importance of innovation increases (Schilling, 2008). With innovation the firm creates new wealth-producing resources or imbues existing resources with enhanced potential for creating wealth (Drucker, 2002). Such innovation includes new technologies, product design, production process, marketing approaches, better ways of competing, and simply new ways of doing things (Porter, 1990). To survive today, a company needs to perform its daily routine operations

effectively and quickly. Still, to be competitive in the future, new ideas and products need to be developed constantly (Trott, 2008). As a result, innovation should be presented in all the processes of the company. While introducing new products helps firms to protect their margins, the process innovation helps firms lower their costs (Schilling, 2008).

Rarely do innovations come as sudden insights. Usually they result from a conscious, purposeful search for innovation opportunities through an analysis of unexpected occurrences, incongruities, process needs, industry and market changes, demographic changes, changes in perception, and new knowledge (Drucker, 2002). Successful innovation which leads to market acceptance and profits is rare and difficult to achieve. Hard investment in R&D does not guarantee success. The key question within innovation is not how much to spend but how to spend. The companies that align their innovation strategy with their corporate strategy are most likely to succeed (Kandybin, 2009). Increased success and reduced wasted effort (time, resources and opportunities) are very important goals for firms. Business surveys reveal that only about 4% of innovation initiatives meet their financial objectives. Patent office statistics show that only about 0.2% of patents make a return on the inventor's investment (Denning, 2012).

In rapidly changing markets, instead of focusing too much on narrow, demographic segments and trivial product extensions, companies must start examining emerging technologies and what customers need to get done and so find innovation initiatives to meet those needs (Christensen, Cook & Hall, 2005). Innovation always involves investment in new skills and knowledge, as well as physical assets and brand reputation (Porter, 1990). The major asset within companies is knowledge, transformed into know-how or technology (Trott, 2008). This know-how, as Porter (1990) studied, can be transformed into competitive advantage of the company. Still, he noticed that innovations are not inimitable and if a company stops improving, upgrading and innovating, the competitors will leave it far behind.

2.2. Open innovation

While facing constant innovation challenge, many companies agree that internal R&D becomes expensive, slow and uncertain. More and more companies are looking for outside sources of basic technology, shortened product development time, or applied technology to avoid the costs and delay of research and development (Trott, 2008).

Chesbrough (2003) introduced the concept of *open innovation* and since then it has been viewed as a mainstream innovation process. He argued (2003, 2006) that treating internal R&D as a valuable strategic asset is not viable anymore for today's market. For most of the 20th century only large corporations could compete in their industries, because only they had the resources to invest in R&D. But rising costs and shorter product life cycle makes it difficult now for even large firms to rely only on internal resources. An organization cannot innovate in isolation. In his definition, Chesbrough (2003) says that "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology".

Free access to information, which spreads very quickly, also contributes to the diffusion of open innovation process. Bringing ideas into open domain can help companies to shift costs. Corporations like Adidas, BMW, Procter & Gamble, 3M, Merck, and Philips created platforms to help ideas flow freely inside and outside the organization and so incorporate open innovation into their product development process (Chesbrough, 2009; Ogawa & Piller, 2006). Other companies acquire technology from external sources and so strengthen and speed up their internal innovation processes. This is an inbound open innovation (Lichtenthaler, Hoegl & Muethel, 2011). Firms need to create synergies between their own processes and externally available ideas. Thus, firms can benefit from the creative ideas of outsiders and incorporate them into the generation of new profitable products and services (Dahlander & Gann, 2010).

In the Open Innovation Model, presented by Chesbrough in *The Era of Open Innovation* (2003), he states that a company needs to understand that there are many smart people outside and their knowledge is important. The company that focuses on building a good business model, while using internal and external resources, will win in the market. Then R&D is an open system, and ideas that generate additional value come from inside or outside the company (Chesbrough, 2006). In a challenging business climate and difficult market situation, companies are more likely to dedicate attention and resources only to the projects that give return in near-term periods. Still, less promising initiatives may be viable for the business in the future, when the market gets better. If short-term focus remains for a too long time, it can damage a company's potential for growth. Open innovation allows intellectual property, ideas, and people to flow freely both into and out of an organization, and so, to screen projects that may have commercial value in the future (Chesbrough, 2009). New technologies, improved regulation for intellectual property rights and venture capital, easier access to talented people and globalization allow new, different ways to collaborate and coordinate the innovation. The concept of open innovation has become a common currency (Dahlander & Gann, 2010).

Despite the advantages of open innovation, a company should be prepared for the challenges of applying it. Cultural, political and organizational challenges need to be faced. Outside issues with partners, clients, suppliers and customers need to be negotiated (Chesbrough, 2009). With open innovation, companies start to outsource something that was traditionally proprietary and might have derived some value simply because nobody else could use it. Such institutional changes can be traumatic if internal R&D has long been a major source of competitive advantage (Thomke & von Hippel, 2002). The "not-invented-here" established culture inside the company may mean that employee attitudes could impede open innovation. It takes time to change employees' perception. So the companies that want to profit from open innovation cannot oversimplify its implementation (Lichtenthaler, Hoegl & Muethel, 2011).

2.3. User innovation

When companies attempt to succeed in innovation, they create new products and services that correspond to user needs. User needs can be quite heterogeneous. It is a very costly and inexact process for companies to understand users' needs deeply and well, which is why companies fail. On the other hand, users can often explain with accuracy their current and future needs to a manufacturer. Market researchers, being aware of that, divide the market into several target segments, each containing customers with somewhat close needs. They then create different product to satisfy the needs of average customers in a given segment. Such segments are large because in many cases it is too costly to produce for small number of customers. This "a few sizes fit all" philosophy will leave many users dissatisfied. So non-average users who have their needs not served, may search for custom suppliers to create precisely what they want. There are other users who will "serve themselves" by modifying existing products or even creating new products from scratch. If many users want something different, and if they have adequate interest and resources to get exactly the product they need, they will be driven either to develop it for themselves or to pay a custom manufacturer to develop it for them (von Hippel & Katz, 2002; Franke & von Hippel, 2002; Thomke & von Hippel, 2002; von Hippel, 2005; Churchill & von Hippel, 2009).

Von Hippel found that approximately 80% of innovations of different scientific instruments were invented by users. He defined *lead users* as those who are ahead of a market trend and expect significant benefit from innovating. The uniqueness of users who innovate is that they expect to directly benefit from innovation. The important part is also user's enjoyment or simply need for learning and challenging when innovate (von Hippel, 1976, 1986, 2005).

When a consumer has higher education (Bachelor's, master's or Ph.D. degrees), precisely in technical area (in science or engineering or as a technical professional) and is male, the likelihood that he will innovate in consumer product is 260% higher than likelihood that the average citizen will do so un UK, 210% higher in US and 140% higher in Japan (countries in which research took place) (von Hippel, Ogawa & de Jong, 2011).

2.3.1. The economic importance of user innovation

Most studies on the economic importance of innovation have ignored user innovation. Only recently empirical evidence on the incidence of user innovation at a macro/national-level started being collected. Studies showed that 6.1% of the UK's population over 18 have at least once created or modified a consumer product. In the USA it is 5.2% and in Japan 3.7% (von Hippel, Ogawa & de Jong, 2011).

Some empirical studies over the years have examined the frequency with which users innovate in different field, such as:

- PC-CAD Software - 23% of users innovated (Urban & von Hippel, 1988).
- Library Information Systems - 26% of users innovated (Morrison, Roberts & von Hippel, 2000).
- Sport products (Canyoning, Boardercross, Handicapped Cycling, and Sailplaning) - 32% of users innovated (Franke & Shah, 2003).
- Apache Web server software - 23% of users innovated (Franke & von Hippel, 2003).
- Surgery at university clinics – 22% of users innovated (Lüthje, 2003).
- Consumer Outdoor Products industry - 37% of users innovated (Lüthje, 2004).
- Kite Surfing - 31% of users innovated (Franke, von Hippel and Schreier, 2006).
- Rodeo kayaking – 100% of user innovation of new techniques (Baldwin, Hienerth & von Hippel, 2006).
- Mountain bikes – 84% of users innovated (Lüthje, Herstatt & von Hippel, 2006).
- Banking services – 44% of computerized retail banking services and 92% of corporate banking services provided in manual form were developed by users (Oliveira & von Hippel, 2011a, b).

2.3.2. Use for business

Lead users can provide research data for manufacturers and be part of a forecasting laboratory. They use the product and so have real-world experience. They

are ahead of the market and so have “tomorrow’s needs today” and can also provide useful solution, new product concept and design. A company should systematically identify lead users (von Hippel, 1986, 1988). Lead user method was found to be almost twice as fast and less costly as traditional methods of identifying new product opportunities (Herstatt & Von Hippel, 1992).

Producers should monitor user innovations. If any design is diffused quickly between many users and communities, it is strong signal that this can be the basis of new profitable commercial products or product lines. As empirical study shows, innovations by users often become commercialized. Even if they do not, it can show the manufacturer how the innovation process works and enable better performance. With the volume of user innovation, companies can have more exact information on the size of potential market (Morrison, Roberts & von Hippel, 2000; von Hippel, 2005; von Hippel, Ogawa & de Jong, 2011).

2.3.3. User entrepreneurship

There are different sources of entrepreneurship. *User entrepreneurs* obtain benefits from using the product and/or service, and in addition decide to profit from it. As a result, they differ from other types of entrepreneurs who just want financial benefit from the product and/or service. User entrepreneurs are economically important and should be considered as such (Shah & Tripsas, 2007). Users may decide to commercialize their inventions, if there are sufficient indicators for demand. Nowadays, huge effort on the part of the innovating consumer is not needed in order to become a “casual entrepreneur” (von Hippel, Ogawa & de Jong, 2011). User innovators may choose to sell the potential idea to manufacturer, do a venture with him, or simply make a firm and sell the product by themselves (von Hippel, 2005).

User entrepreneurship is the commercialization of a new product/service by an individual or group who are also users of that product/service. Shah and Tripsas (2007) define two types of user entrepreneurs: those who are professional-users and end-

users. In the first category are those who work in organizations and innovate in their professional life. When they have invented a product/service, they may leave their firm in order to start own business to commercialize the invention. The end-users are those who use the product in their everyday life.

Researchers find examples of user entrepreneurs in different industries. It can be seen in a rodeo kayaking (Baldwin, Hienerth, & von Hippel, 2006), mountain bicycle (Lüthje, Herstatt & von Hippel., 2006) or juvenile products (Shah & Tripsas, 2007).

In terms of resources and capabilities, user-manufacturers have natural information advantages with respect to user needs and desires and they also may obtain free assistance from members of their communities. Manufacturers, from their side, may have complementary resources in the form of distribution channels, established brands and existing manufacturing facilities. It has been noted that users are more likely to enter in the industries where use provides enjoyment (and not only pure economic benefit in case of producers) and where opportunity costs are lower (Shah & Tripsas, 2007).

2.3.4. Important issues to consider in user innovation topic

Often, it is costly to transfer information from users to manufacturers completely and with good fidelity, in a useable form. This means that information is *"sticky".* When this happens, it can be more convenient to do problem solving at the user site rather than attempting to transfer sticky user information to a manufacturer for manufacturer-based innovation activities (von Hippel, 1998).

Sticky information is not unchangeable. To decrease stickiness, manufactures can provide a *toolkit* for users, a design tool that makes it possible for users to create or modify products by themselves. Such toolkits are not general but are specific for fields of product design. Trial-and-error is very costly for producers. By providing toolkits, they transfer this part of production to users, and so make it faster and

cheaper. As von Hippel shows, toolkits should be user-friendly and have an interface and language easily understood by users. Users, while designing, have to understand the capabilities and limitations of process. At the same time, the language should be able to be easily converted into the manufacturing process, and thus be functional. Among other advantages of toolkits, authors specify: the creation of a client database; the ability to work with small customers and so reduce the number of unnerved/unsatisfied customers; creating brand loyalty, since other companies cannot produce the same; and increasing levels of customer satisfaction. One disadvantage should be mentioned: a toolkit cannot provide every kind of design. Companies need to invest resources to provide well-made toolkits and educate customers to work with them (von Hippel, 2001; von Hippel & Katz, 2002, Tromke & von Hippel, 2002).

Users are exposed to diffuse their innovation in order to make it valuable for society. Research shows that it is usually *freely revealed:* that is, the innovation becomes a public good, so there are no intellectual property rights registered and access is free to all. If innovations were not freely revealed, then many users with similar needs would (re)develop the same products. This would not be beneficial to the social welfare. The reason for free revealing may also be in network effects. When innovation is free to use and is adopted by others, it becomes a trend and so creates advantages for the innovator. Another reason is that others can use, modify and improve the initial innovation. Free revealing is very functional for manufacturers, too. Since they have free access to a developed prototype, they no longer need to study users' needs and find solutions (Harhoff, Henkel & von Hippel, 2003; von Hippel, 2005; Hassan, 2008).

2.4. Health care innovation

Innovation is an essential driver for health care. Genetics, nanotechnology, and increased general understanding of biological processes have made radical changes in the innovation process of industry. Many products which are on the market today (e.g.

human insulin, new vaccines, technologically advanced equipment) were unthinkable 50 years ago (Enterprise and Industry, European Commission, 2011).

Reducing payment levels of existing products and providers is not the solution for ever-increasing health care costs. Instead, the innovation of new products and processes that use lower-cost material, staff, equipment and places of care can be a key. Examples include generic drugs, self-administered tests for pregnancy or urinary tract infection and rule-based diagnostic kits that measure blood sugar. Process changes allow less trained but still sufficiently competent workers to substitute more highly trained and expensive staff. The most important thing is that innovations help to create synergies in the changes between different dimensions of care (Robinson & Smith, 2008).

The current health care system rewards innovation which prolongs life. This was appropriate when infections and short-lived decisions dominated the landscape. Because chronic diseases have taken a leading role now, the challenge is to develop treatments and technologies to improve the quality of patients' life (The Economist Intelligence Unit, 2011). As a result, technological advancement is a major driver of health care costs. These advances improve quality of health care but create major increases in expenditures. Improvements should be done carefully and technology can be overused if it is offered to patients for whom the innovations provide no benefit (Bodenheimer, 2005).

Herzlinger (2006) summed up innovations that can make health care better and cheaper. Consumer-focused innovation changes the way of buying and using health care by providing convenient, more effective, and less expensive treatment. Technology develops new products and treatments or otherwise improves care, making it less costly and painful (e.g. new drugs, diagnostic methods, drug delivery systems and medical devices). New business models, particularly those that involve the horizontal or vertical integration of separate health care organizations or activities increase efficiency, improve care, save consumers time and create economies of scale. Due to the specificity of the industry, innovation in the health sector has several barriers, such as size and complexity, mainly non-profit sector of activity, specific

demands, the buyer is not necessarily the user, risk aversion, and a deep technical knowledge requirement. Often one barrier may cause another and as an effect this creates even more complexity. The investment in innovation is enormous, but still too many efforts fail and the outcome is never certain. Innovators must strive to address their often unclear demands and overcome obstacles, because sustainable health care development is vital for this industry (Røtnes & Staalesen, 2009; Cunningham, 2005; Herzlinger, 2006).

2.5. Chapter summary

The literature review presented here was aimed to provide the conceptual scope for our research. It meant to explain important concepts of innovation, in particular user innovation, and to introduce the health care industry.

The main take away to consider are the following: 1. User innovation exists, it is significant and widespread in different industries; 2. Innovation in the health care industry is essential but due to various barriers is slow and costly.

3. Research context and methods

For our exploratory empirical study on the sources of treatments, therapies or medical devices, we elected to focus on major diseases including respiratory diseases (Cystic Fibrosis, Asthma and Sleep Apnea), Cancer, Diabetes, medical devices and treatment for general purposes.

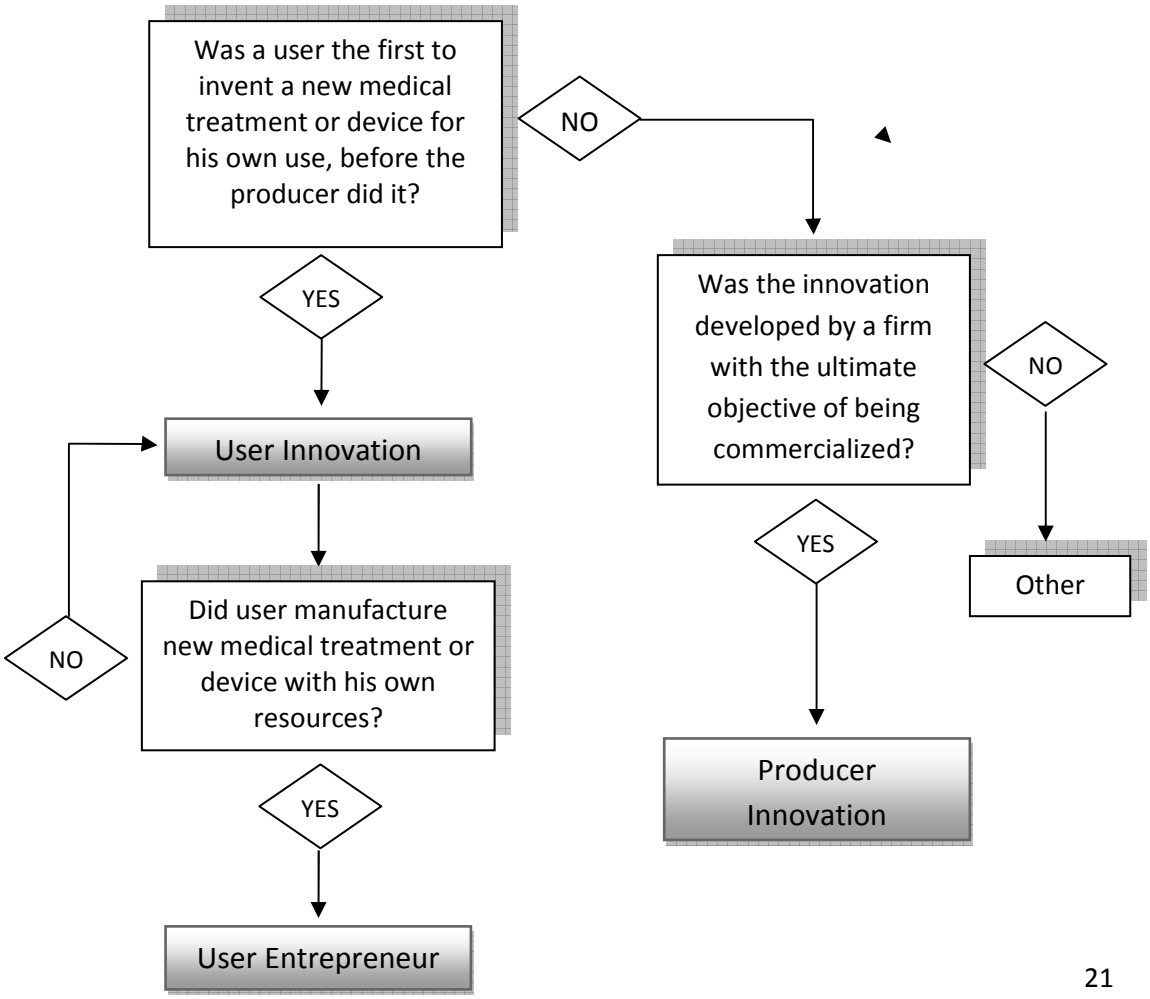
Our research approach follows four steps approach, namely:

Step 1. Sample of treatments, therapies or medical devices;

Step 2. Identification of date of commercial introduction (we browsed the internet, scanned trade journals and/or articles for dates of introduction);

Step 3. Identification of the sources of innovation and coding (we identify user practices through literature searchers and internet browsing);

Figure 1: Coding of treatments/medical devices as user and producer innovations



3.1. Set of Hypotheses

Our first hypothesis derives from the idea that patients with chronic diseases have developed a significant number of treatments, therapies or medical devices with the objective of directly benefiting from those innovations.

H1: Patients developed and self-provided a significant number of treatments, therapies or medical devices before providers of medical services introduced them.

Our second hypothesis derives from the idea that user innovators often develop new firms to commercialize their innovations (Shah and Tripsas 2007). In this context, we hypothesize that:

H2: Patients who developed new treatments, therapies or medical devices before providers of medical services introduced them have often created new ventures/firms to commercialize their innovations.

3.2. Sample

Chronic diseases are those of long duration and usually slow progression. According to WHO data in 2008, heart disease, stroke, cancer and chronic respiratory diseases represented 63% of all deaths, 25% of which were people under 60 years old.

Considering the most frequent chronic diseases, the following were chosen for the research:

a) Respiratory diseases

a_1) Cystic fibrosis

a_2) Sleep apnea

a_3) Asthma

b) Cancer

c) Diabetes

a) Respiratory diseases.

From the long list of respiratory diseases, we have chosen to study one rare disease and the two of the most frequent ones.

a_1) Cystic fibrosis is a chronic disease that affects respiratory, digestive and reproductive systems. It is a genetic problem, "involving the production of abnormally thick mucus linings in the lungs and can lead to fatal lung infections". Cystic Fibrosis has a global occurrence, but is considered a rare disease. In 2004 only 1 in 2000-3000 newborns in the EU were affected, and 1 in 3500 in USA (WHO, 2011).

Cystic fibrosis medical treatments are those which clear mucus from the airways. There are different clearance techniques, including inhalers, medications, and implanted devices. Besides these, the correct nutrition is very important[5].

a_2) Obstructive Sleep Apnea is a clinical disorder which is characterized by "recurring episodes of upper airway obstruction that lead to markedly reduced (hypopnea) or absent (apnea) airflow at the nose or mouth". It is usually accompanied by loud snoring and leads to sleep fragmentation (arousals). Patients are usually unaware of such abnormality while they sleep, but feel excessive sleepiness while awake. Sleep apnea is estimated (2004) between 1% and over 6% of adult population. The prevalence increases with age (WHO, 2011).

Sleep apnea can be treated in different ways. Sometimes simply a change of lifestyle or sleep habits can help. The most frequent treatment of sleep apnea is the use of breathing devices which provide supplementary oxygen while sleeping.

[5] http://www.cff.org/treatments/Therapies/#Alternative_Therapies [accessed 30.12.11]

a_3) Asthma is a chronic disease which is characterized by attacks of breathlessness and wheezing. This varies in frequency and severity from person to person. "During an asthma attack, the lining of the bronchial tubes swell, causing the airways to narrow and reducing the flow of air into and out of the lungs". Asthma has a low mortality rate (mainly in low and lower-middle income countries), but causes insomnia, fatigue, and reduced activity level and absenteeism. Asthma is the most frequent chronic disease among children. The current estimate is 235 million asthma patients worldwide (WHO, 2011).

Asthma cannot be cured, but it can and should be controlled. A person should adjust his or her lifestyle to include preventive treatment. Among many different treatments, inhalers and medicine are the most common[6].

b) Cancer (tumor, neoplasm) encompasses a group of chronic diseases which may affect any part of the body. It "is the rapid creation of abnormal cells that grow beyond their usual boundaries, and which can then invade adjoining parts of the body and spread to other organs. This process is referred to as metastasis". Cancer is a major cause of death worldwide, with 7.6 million mortalities, or 13% of all the deaths, mainly in low and middle-income countries (2008). This number is expected to grow to 11 million by 2030. About 30% of cancer deaths are due to behavioral and dietary risks: high body mass index, low fruit and vegetable intake, lack of physical activity, tobacco and alcohol use (WHO, 2011).

Cancer treatment is complex. Often it damages not only cancerous but also normal cells and has a range of side effects. The most frequent treatments are surgery, chemotherapy and radiotherapy. With the development of new technologies, bone marrow and stem cell transplantation, laser and target cells therapy (among others) are more widely used these days. Complementary medicine helps to increase immune function and the quick recovery of the patient.[7]

[6] http://www.acaai.org/allergist/asthma/asthma-treatment/Pages/default.aspx [accessed on 29/12/11].
[7] http://www.cancer.gov/cancertopics/treatment/types-of-treatment [accessed 30/12/11]

c) "*Diabetes* is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar". High blood sugar is a common consequence of diabetes can lead to serious damage of many bodily systems, especially the nerves and blood vessels. There are 346 million people worldwide with diabetes. In 2004, an estimated 3.4 million people died from the consequences of high blood sugar (mainly in low and middle income countries). This number will double by 2030 (WHO, 2011).

Diabetes patients need to monitor their blood sugar levels at different times during the day. The only existing treatments are a strong, healthy diet, regular physical activity, maintaining a normal body weight and insulin injections. There are some alternative treatments, but they are complementary[8].

[8] http://www.diabetes.co.uk/treatment.html [accessed on 29/12/11].

4. Analysis and results

According to our empirical evidence, the amount of patient innovation in treating these diseases is very significant. Building upon Oliveira, von Hippel and DeMonaco (2011), table 1 presents a sample of Cystic Fibrosis medical treatment and device innovations. Sometimes the invention is accidental and patients simply notice it, rather than search for it. Louis Plante, a 26-year old cystic fibrosis patient, had to leave a concert because of strong coughing. After different trials at home, he discovered the cough may have been generated by a big speaker which had been positioned near him. Using his skill as an electronics technician, he started working on a device which would generate low frequency vibrations that could be a means to clear mucus from his lungs. The results were so exceptional that he decided to produce and sell the *Frequencer*^{TM} (Figure 2). It is now approved in different countries as a treatment for those who suffer from respiratory chronic diseases, including cystic fibrosis.

Figure 2: Frequencer^{TM}

Table 1: Sample of Cystic fibrosis medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	***Year of intro***
Use of trampolines in children	U	
Inhaling hypertonic saline	U	
Low frequency vibrations for bronchial drainage (Frequencer)	U	2002
Chest percussion with electrical precursor	U	2006
Use of the Flutter for mucus clearance device	P	1989
Postural Drainage	P	1901
Vest therapy / Chest compression	P	1988
Pedi-neb pacifier	U	2008
Implanted devices - PICCs	P	1975
Chest Physical Therapy (CPT or Chest PT)	P	1959
Positive Expiratory Pressure (PEP)	P	1984, 1986
Active Cycle of Breathing Technique (ACBT)	P	1979

Table 2 presents a sample of Sleep Apnea medical treatments and devices innovations. Harry Cutler did not want to help anybody except himself. His problem was absence of medical insurance. Harry has Sleep Apnea. He experienced 54 apneas per hour. While searching the solution, he found that every device available on the market was expensive and uncomfortable. So he decided to find another solution by himself. He invented *RespireAide* (Figure 3), cheap and small, which is a mixture of CPAP and MAD devices. Harry is now a producer of RespireAide, which has been approved by physicians and the FDA.

Figure 3: RespireAide

Table 2: Sample of Sleep Apnea medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	**Year of intro**
CPAP machine	P	1981
Klear way way (Mandibular Advancement Device)	P	1995
OPAP	P	
Thornton Adjustable Positioner (TAP)	P	1994
Quietos CPAP Liners	U	2010
TrueFIT mask	U	1999
Buzz POD	U	2002
Respire Aide	U	2010

Table 3 presents a sample of Asthma medical treatments and devices innovations. In some of these examples, the innovation was developed with the help of a family member. A case in point, Paul Watson's daughter was diagnosed with asthma when she was 6 months old. One day, when she had asthma attack, Paul realized it looked like it was creating an allergic reaction and so decided to stop her medication. The effect was expected: her symptoms stopped. After examination, he

realized that the medication was not taken properly and was stuck in the back of his daughter's throat, which caused the allergic reactions. He decided to make a device which would prevent such situations and make the asthma medication use more efficient, especially for children. *PocketFlow Spacer* (Figure 4) will be produced in 2012 by Vivo Smart Medical Devices.

Figure 4: PocketFlow Spacer

Table 3: Sample of Asthma medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	**Year of intro**
Corticosteroids	P	1928
Nebulizer	P	1858
Dry powder inhaler	P	1894
Pressured metered dose Inhaler for asthma	U	1955
PocketFlow Spacer	U	2012

In table 4 some examples of cancer treatments and devices are provided.

John Kanzius did not survive to see his invention. He was diagnosed with leukemia. While undergoing chemotherapy, he was shocked by the number of young people who were dying. He came up with an idea: "I wondered if I could make the cancer cells act like little radio receivers … and when they picked up the signal, they would get hot, they would create a fever, and the cancer cell would die". He showed it to oncologist and to cancer surgeon. They developed the prototype and after long and difficult modifications and approvals, the clinical trials of *Kanzius Machine* will start in 2012. The Kanzius Therapy is now viewed as a real alternative for chemo and radiotherapy in cancer cure.

Lisa Crites had breast cancer. After her mastectomy operation, the doctor said that she should not shower for a few weeks. "After being told that I could not shower, I immediately began looking for a water-resistant garment to protect myself", Lisa says. To her surprise, no garment existed for such purpose. She created the *ShowerShirt* (Figure 5), which enabled her to shower while protecting herself from post-surgical infections. She is now the founder of the company that produces the garment. It is still in approval stage, but it can be already bought in the USA.

Figure 5: ShowerShirt

Table 4: Sample of Cancer services and treatment medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	**Year of intro**
Chemotherapy	P	1965
Radiation Therapy	P	1895-1900
Targeted cancer therapies	P	2000
Antiogenesis	P	1787
Bone Marrow and Stem Cell Transplantation	P	XX cent.
Gene Therapy for Cancer	P	XX cent.
Hyperthermia (thermal therapy or thermotherapy)	P	1779
Laser Therapy	P	1916
Cancer Vaccines	P	2008
The Kanzius Machine and Therapy	U	2012
Chemotherapy care packages	U	2011
Catheter that blocks blood flow to the tumor	U	2001
Shower Shirt Mastectomy Garment	U	2011
Med-Track 360	U	2011
Vegetable Soup	U	
Abnostrain	U	2006
Ring (for prosthesis to enable voice restoration)	U	2009

Table 5 presents a sample of diabetes medical treatments and devices. Many inventions are strongly correlated with new technologies. Smartphones, for example, contain nearly all possible information about their users. So why not add an application that saves glucose data for diabetes' patients? One of the *Glooko* (Figure 6) inventors has pre-diabetes and works hard to control his blood sugar levels. It was in his particular interest to develop the first plug-in cable between popular glucose meter models and I-Phone/I-Pad. It is a simple app, but helps to make the life of diabetes' sufferers easier.

Figure 6: Glooko

Table 5: Sample of Diabetes medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	**Year of intro**
Frequent self-monitoring of blood sugar	U	1969
I-Port Injection Port	U	2004
Diabetes Medical Watch (CADEX 12)	U	2000
Insulin pen	P	1985
Insulin Pump	P	1979
Log for life	U	2009
Maximum Slide	U	2008
BLOB	U	2011
Hanky pancreas	U	2011
Diabetes education online	U	1995
Omnipod	U	1992
Joe's Small-in-One - Diabetes Kit Bag	U	2008
iBGStar	P	2011
Glooko	U	2011

When confronted with a chronic disease that has a high mortality rate or changes day-to-day habits, a person may simply accept "fate" and give up. That was

not a case of Amit Goffer. He was paralyzed in a car crash, but instead of accepting his disability, he used his skills as an engineer to invent a device which could help him get out of his wheelchair. He invented electronic trousers *ReWalk* (Figure 7) that, with computer and complex construction, help paraplegics to stand and walk. It is now available in rehabilitation hospitals and centers in Europe and in the USA. He is also the founder of a company that produces the device.

Figure 7: ReWalk

Among patient innovations, there are "old" examples of devices we take for granted in our daily life since they have become so common. *Bifocals* (Figure 8) were invented by Benjamin Franklin, one of the Founding Fathers of the United States, who started to have trouble seeing both up-close and at a distance as he got older. Being tired of switching between two types of glasses, he thought of a way to have both types of lenses in one frame.

Another interesting example is the *band aid.* Earle Dickson's wife often cut herself while doing housework and cooking. Dickson found that the gauze stuck to a wound with tape didn't stay on her active fingers. One day, he took the gauze and placed it in the center of the tape and covered it with crinoline to keep it sterile and safe. This was the invention of the *band aid* (Figure 9).

Louis Braille was blinded in an accident when he was very young. As a child he learned of a communication system of a French army, known as "night writing". He thought the military system rather complex and so decided to develop his own. He

invented the *Braille* system of writing/reading which is common accepted by blind or visually impaired people worldwide.

Figure 8: Bifocals

Figure 9: Band aid

Table 6: Sample of general medical treatments and devices innovations

Medical treatments and devices	**Innovator U=User P = Producer**	**Year of intro**
Band aid	U	1920
Robotic trousers	U	2010
Laughter therapy	U	1979
Bifocal glasses	U	1784
Braille System	U	1821
Disposable Diapers	U	1950
Cast Coolers	U	1998
Waterbike	U	1999
Accessible Child Proof Latch	U	2008
Ai-Live	U	2010
Hemodialysis Safety Device	U	?? 2008
On your feet	U	?? 2005
Programmable turning bed	U	2009
Ezy-as pressure Stocking applicator	U	2006
Stabi-Line (Uni-Line)	U	2009
Flyan Chair	U	2009
Snapit ampoule opener	U	2008
Tucker Sling	U	1990s
FLAVORx	U	1994
Positional Therapy Pillows	U	1998
E-Cue (+ Intelliject)	U	2011
Hydrant	U	2005
U-Flow	U	2010
Dignity commode	U	2010
Comfort Hand Pads	U	2010
Biffy Bidet	U	2000
PerfIC Cath (C3 iCath)	U	2008
Ortho-Glide	U	2002
Seasonal Affective Disorder (SAD) and Light therapy	U	1970-1984
AutoMedic Pressure Relief Bed	U	1993
Mechanical hand	U	2011

5. Conclusions

Following the analysis of the treatment data presented in Chapter 4, the results are summarized and discussed in the conclusions.

5.1. Patients as innovators

In the research, we observed strong evidence of user innovation in health care. As illustrated in table 7, 56% of the treatments and devices for these health issues were developed by patients or their families and friends, who are user-innovators. This shows our *H1* as valid.

Table 7: Proportion of medical treatments and devices developed by users and by producers

Medical treatments and devices	***User first***	***Producer first***	***Total***
Cystic Fibrosis	5 (42%)	7 (58%)	12
Asthma	2 (40%)	3 (60%)	5
Sleep Apnea	4 (50%)	4 (50%)	8
Cancer	8 (47%)	9 (53%)	17
Diabetes	11 (79%)	3 (21%)	14
Total	**30 (54%)**	**26 (46%)**	**56**

Our results also show that patients have mainly created complementary treatments. Their work does not generally find a cure, since that would require research on the disease at the cellular level which is beyond the average patient's knowledge and resources. In many cases, patients simply want to improve their quality of life during their illness or recovery period. This confirms the von Hippel (1986, 2005) hypothesis that “one size fits all” theory used by producer innovators is creating a place for users/patients that are ahead of the market. Treatments and medical devices are created by scientists and doctors to reach the root of the disease and so to sustain patients’ lives. Such therapies may create uncomfortable feelings or situations, even as they help and cure. They could be difficult to use, or simply of an inconvenient size. In such cases, patients are shown to take the initiative to improve these treatments/medical devices. As an example, we found different types of asthma

inhalers or insulin delivery devices developed by users. Health care producer innovators need to hear what patients want, because the search for treatment may be not enough.

In a more complex disease such as cancer, patients create things that make their treatment or recovery period easier. Such issues are evident for patients, because they face disease day by day. Doctors generally do not undergo these treatments themselves, and so know only about the effects from their patients' responses. When a patient is a doctor or researcher, however, and so has a deep and applicable knowledge, he may create a radical treatment. This is an example of a *lead-user expert* (von Hippel, 2005). Such cases should be carefully studied, as they provide very valuable information and data. Clearly, the main driver of invention is a strong need.

"Many times I was thinking about a simple solution, which would deliver a good physiotherapy and wouldn't require a caregiver" (Hanna Boguslawska, inventor of treatment for CF).

"Katherine was not taking her medication properly; it was getting stuck in the back of her throat, which had caused the allergic reaction. It was at that point that I decided a new product was needed to prevent this from happening to other children" (Paul Watson, inventor of Asthma treatment).

"Every time I tossed and turned it exacerbated the problem. It was driving me insane. I was awake all the time. I had to find a solution" (Kesner, inventor of treatment for Sleep Apnea).

"I wanted to help my sister as much as I could" (Robert Goldman, inventor of treatment for Cancer).

"Using injection therapy, Patton quickly grew tired of giving herself an injection each time she needed insulin. The multiple daily injections often left her skin bruised" (Catherine Patton, invention of Diabetes treatment).

"Over time, however, they became increasingly frustrated that the epinephrine delivery systems available were not designed with users like them in mind. In the twins' opinion, the devices were awkward to carry and difficult to use" (Eric and Evan Edwards, inventors of different Allergy solutions).

As the evidence shows, recent innovations in health care are mainly technological once (apps, software, devices). As was concluded earlier, the main problem of the healthcare system is increasing costs, the important part of which is technological cost. Many innovations fail, and this is also applicable to healthcare system. Users, creating their solutions, automatically take into consideration what are usually very limited time and resources, especially as compared to a health care firm's R&D departments. Such limitations seem to foster cheap but functional solutions, expending not many resources but exhibiting a deep understanding of the patient problem and need.

Patients innovate, and producers should assume this Hypothesis as valid. We have found examples of different organizations which are open to listening to patients. User innovators need to share their ideas, because only after revealing them may they become a trend and adopted by others (Harhoff, Henkel and von Hippel, 2003; von Hippel, 2005). Producers, by creating special platforms or places where users can freely diffuse ideas (toolkits), can make users more motivated to innovate:

- P_2I care is a Sweden research network. One of its projects is "The Patient Innovation system", which allows a patient to share its "self care interventions" online and show statistical data on results[9].
- Ashoka Changemakers jointly with the Amgen Foundation created the Patients|Choices|Empowerment competition in order to hear patients' suggestions for healthcare improvements[10].
- Diabetes Mine design Challenge is an open innovation contest, where all new designs for diabetes services are posted, both user and producer innovated. (Winners of the past years are mainly user innovators)[11].

[9] http://www.p2icare.se/en/default.aspx
[10] http://www.changemakers.com/empower-patient

- Patients Like Me is a data-sharing platform, that works as a network, where patients can register, share their problems and see reviews of others about any disease and its treatment. The idea came about when the brother of one of the creators, became ill.[12]
- Inspire me[13], Daily Strength[14], Cure Together[15], Rare Disease Communities[16], CancerConnect[17] are examples of patient online communities that are gaining popularity. The power of knowledge sharing helps promoting such sites. Patients can easily share their problems, ideas and thoughts.

5.2. Patients as entrepreneurs

Table 8 presents the proportion of user innovators who have developed new firms to commercialize their medical treatments and devices.

Table 8: Proportion of user innovators who have developed new firms to commercialize their medical treatments and devices

Medical treatments and devices	*Created a firm*	*Did not created a firm*	*Total*
Cystic Fibrosis	2 (40%)	3 (60%)	5
Asthma	0 (0%)	2 (100%)	2
Sleep Apnea	3 (75%)	1 (25%)	4
Cancer	4 (50%)	4 (50%)	8
Diabetes	7 (64%)	4 (36%)	11
Total	**16 (53%)**	**14 (47%)**	**30**

Our results show that 53% of user innovators became user entrepreneurs. This is an obvious example of end-user entrepreneurship, i.e. those who create and use the product in everyday and not in professional life. User entrepreneurs are economically important and should be considered as such by producers (Shah & Tripsas, 2007).

[11] http://www.diabetesmine.com/designcontest
[12] http://www.patientslikeme.com
[13] http://corp.inspire.com/
[14] http://www.dailystrength.org/
[15] http://curetogether.com/
[16] http://www.rarediseasecommunities.org/en
[17] http://news.cancerconnect.com/

The difficulty of user entrepreneurship may be the high opportunity costs and low expectation of innovation usability for other users (Shah & Tripsas, 2007). Users do not have sufficient resources to push the product to the market, unlike the manufacturer has. Still with new technologies and venture opportunities it becomes easier to be an entrepreneur.

The main obstacle to user entrepreneurship in the case of patients is high regulated industry. One treatment or device should pass through various stages of approvals to be agreed upon as a general treatment for a specific disease. This creates a strong barrier to a patient who wants to manufacture his idea.

When looking at the list of created medical treatments and devices, it becomes obvious that users usually innovate in order to simplify their lives. The innovation may be radical or incremental, but it takes place and cannot be ignored. Some of them go even further and produce their inventions. This is an important issue not only for users, but for producers and the whole industry. Health care may be improved and enriched if patient innovation is recognized as important.

5.3. Limitations

The findings of our study are limited by certain choices made during the research design, and these limits offer opportunities for future research. The limitations include:

- The sampling method for the treatments and devices of each disease has some limitations and may, in some cases, be incomplete;
- Limited data availability. Because many inventions by users were patented by producers, quite often the “real” history of the inventions is either very hard to find or unknown;
- Often, users do not disclose their innovation because they consider it unimportant for others, or because of scarce resources;

- Until recently (before the internet) it was difficult to spread an idea cheaply and rapidly. So innovators sometimes did not have a way to show others with similar needs what they had created;
- Our researched was focused on random diseases, chosen without specific pattern. With other diseases we may have obtain different results;
- Our results still need to be further validated by medical experts.

5.4. Future research

As pointed out previously, the sampling of treatments and devices of each disease has some limitations and may, in some cases, be incomplete. Future research should confirm if our samples are representative of the different diseases' treatments and devices. Also, one additional step in our research methodology (**Step 4**.) is the informal validation by medical experts and patients.

Also, apart from studying the sources of treatments and medical devices, there is a clear need for studies on the role of users in the development of additional types of health care services. There is also a need for studies exploring the role of medical doctors and nurses in developing new products and services.

More detailed research should be done, including information provided from research centers, hospitals, and medical literature.

An important issue is a discussion with producers about the history of their inventions. Usually they do not disclose where the initial idea came from, but show only the end product to the market.

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- Sleep Apnea: http://www.who.int/gard/publications/chronic_respiratory_diseases.pdf [accessed on 29/12/11].
- Asthma: http://www.who.int/mediacentre/factsheets/fs307/en/index.html [accessed on 29/12/11].
- Cancer: http://www.who.int/mediacentre/factsheets/fs297/en/index.html [accessed on 29/12/11].
- Diabetes: http://www.who.int/mediacentre/factsheets/fs312/en/ [accessed on 29/12/11].

Appendix

Table 1-3: Respiratory diseases

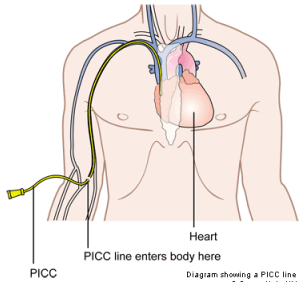
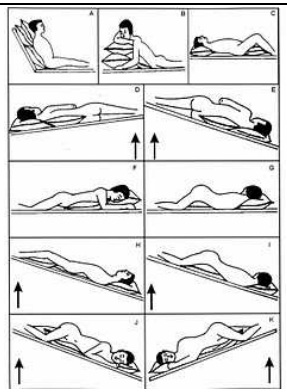
Table 1: Sample of Cystic Fibrosis medical treatments and devices innovations

Medical treatments and devices	*Description*	*User innovation history*	*Innovator U=User P = Producer*	User entrepreneur	Year of intro	*Type of evidence*
1. Use of trampolines for children	The use of trampolines is considered physiotherapeutic tool for enhancing cardiopulmonary performance, encouraging sputum production, and improving general well-being.	Did a patient or patient's family have any involvement in the initiation of the study? The answer is YES! We were performing different studies with physical exercise and cystic fibrosis (CF) at that time, and this was a time when it became growing interest for such therapy, contrary to "normal medicine" these days. We were discussing in several form what kind of exercise that could be fun and effective for children with CF, and we got to hear about a young girl with CF that had a trampoline that she wanted to use many times a day for long times, and the parents observed that she didn't need to use extra treatment for lung drainage in addition. Parallel we happened to meet with a former top athlete, who had started his own business selling trampolines, and he became so eager to hear about this little girl that he offered us trampolines free of cost to perform the mentioned study on the effect of trampoline training in CF-children."	U			Report from expert in the field Dr. J. K. Stanghelle

2. Inhaling hypertonic saline	"A new treatment inspired by Australian surfers who told their doctor they felt better after a session on the board. Respiratory physician Peter Bye used combined the experience of his surfer patients at Sydney's Royal Prince Alfred Hospital (RPAH) to develop a cheap, natural therapy based on inhaled salt water."	Emily Haager was born with the genetic disease Cystic Fibrosis and engaged in a lifelong battle with the ailment. She championed the cause by becoming a global ambassador for Pipeline To a Cure after discovering that the act of surfing provided measurable benefits to those who suffer from the disease. The New England Journal of Medicine verified the benefit of hypertonic saline therapy, where patients inhale sterilized saltwater to rid the lungs of mucus, ultimately mitigating the effects of Cystic Fibrosis by clearing respiratory pathways. As Haager demonstrated, for Cystic Fibrosis patients, a session in salt water truly does right by the mind, body, and soul – wholly embracing surfing's restorative effects. "Everyone understands how important saltwater is," Haager told LA Yoga Magazine, "not just to ride waves but the benefits mentally and physically."	U Emily Haager, CF patient			Literature
3. Low frequency vibrations for - bronchial drainage DYMEDSO 	Bronchial drainage by inducing vibrations in the chest wall of a patient. The Frequencer, applied to the chest of a patient delivers low-energy resonant (acoustic) vibrations, reduces mucus viscosity and thereby promotes mucus flow	"Louis Plante, a 26-year old cystic fibrosis patient woke up one morning wondering why he had to leave concert months earlier because of excessive coughing. He believed that his coughing may have been related to the fact that he was sitting in proximity to a large speaker. Being a skilled electronics technician, Louis began the process of developing a device that could generate low frequency vibrations (similar to the frequencies generated by the speaker) that could be used as a means of airway clearance therapy. Louis' results using this newly developed device were so astonishing, even his physician was surprised. Based on this technology, Dymedso was created in 2002 and the company introduced its digitally-controlled acoustic airway clearance device, the FrequencerTM, following 4 years of R&D and clinical trials".	U Louis Plante, CF patient	E Co. "Dymedso", commercialize a device Frequencer™.	2002	Literature http://www.dymedso.com/site_usa/patient/en/patient_louis.htm

4. Chest percussion with electrical precursor 		"My daughter, 26 with CF, depended for most of her life on us, her parents to do her chest physiotherapy. So her independence was constantly compromised and she hated it. On other hand, we not always delivered the best physiotherapy, simply because we were tired, or didn't have all this time required or were sick. Sure, you know all of this ... Many times I was thinking about a simple solution, which would deliver a good physiotherapy and wouldn't require a caregiver. And I am very happy, I could do it. My daughter uses my EPER100 (stands for electrical precursor, and 100 symbolizes all my percussion ideas which were never realized) all the time. According to her it is much better than the human hand and she can do it alone. I got good reviews from the hospital for sick children in Toronto. Hopefully, I'll soon be able to put them on Eper's web page. It can be gentle, so it is suitable for quite young children and firm as it is required for teenagers and adults".	U Hanna Boguslawska mother of a Patient	E Co. EperLda	2006	http://ehealthforum.com/health/topic57409.html#b http://www.eper.ca/
5. Use of the Flutter for mucus clearance device	Flutter helps to create positive air pressure to force out mucus.		P Patrick Althaus, Swiss physio-therapist		1989	http://www.cfri.org/news/94summer/trtm194su.html
6. Postural Drainage	Postural Drainage removes mucus from certain parts of the lungs by using gravity and proper positioning to bring the secretions into the throat where it is easier to remove them.		P Dr. Ewart		1901	Ewart W. 1901. The treatment of bronchiectasis and of chronic bronchial affections by posture and by respiratory exercises, *Lancet*, 2, pp.70–72.

7. Vest therapy / Chest compression 	High frequency chest compression uses an inflatable vest (ThAIRaphy vest) with hoses connected to a high frequency pulse generator. The pulse generator delivers air to the vest, which vibrates the chest. The high frequency air waves clear all lobes of the lungs.		P Dr. W. Warwick, CF researcher		1988	Hansen LG, Warwick WJ, 1990. High frequency chest compression system to aid in clearance of mucus from the lung. *Biomed.Instrumentation & Technology*, 24, pp.289-294. Chest compression apparatus, Warwick WJ et al, Application number: 11/204,547, Publication number: US 2006/0036199 A1
8. Pedi-neb pacifier 	Nebulizer administration tubing.	"We were giving 10 to 12 nebulizer treatments each day and not having a lot of success with our smallest patients, who often cried during treatment. We had to make do by letting them suck on their pacifiers while we directed the aerosol treatment to their noses... Wouldn't it be easier if we had a contraption we could insert into the baby's mouth? When they cry, most of the [aerosol] medication ends up in their stomachs."	U Elizabeth McGoogan, nurse		2008	http://nursinglink.monster.com/news/articles/3946-inspired-by-patients-invented-by-nurses?page=5

9. Implanted devices - PICCs	Implanted devices allow repeated and long-term access to the bloodstream for frequent or regular administration of drugs as an alternative to shots. Peripherally inserted central catheter (PICC) is a tube that goes into a vein of the arm. It helps carry nutrients and medicine into a body. It will also be used to take blood when blood tests are needed.		P Hoshal		1975	http://www.cff.org/treatments/Therapies/#Implanted_Devices http://www.cff.org/UploadedFiles/treatments/Therapies/Respiratory/PICC/PICC%20Fact%20Sheet.pdf http://www.nlm.nih.gov/medlineplus/ency/patientinstructions/000159.htm Hoshal, V.L. Jr., 1975. Total intravenous nutrition with peripherally inserted silicone elastomer central venous catheters, *Archives of Surgery*, 110(5), pp. 644-646
10. Chest Physical Therapy (CPT or Chest PT)	It is an Airway Clearance Technique that often includes postural drainage and chest percussion. With postural drainage, the person gets in varied positions (postures) that drain mucus from different lung parts.		P Dr. Barbara Doyle		1959	http://www.cfmedicine.com/history/topics/physiotherapy.htm http://www.cff.org/treatments/Therapies/Respiratory/AirwayClearance/#Airway_clearance_techniques

11. Positive Expiratory Pressure (PEP) 	Positive Expiratory Pressure (PEP) therapy gets air into the lungs and behind the mucus using extra (collateral) airways. PEP holds airways open, keeping them from closing. A PEP system includes a mask or mouthpiece attached to a resistor set by your CF care team. The person breathes in normally and breathes out a little harder against the resistance.		P Tønnensen P and Støvring S; Tyrrel JC		1984, 1986	http://www.cff.org/treatments/Therapies/Respiratory/AirwayClearance/#Chest_Physical_Therapy_(CPT_or_Chest_PT)_or_Postural_Drainage_&_Percussion_(PD&P) Tønnesen P, Støvring S. 1984. PEP as lung physiotherapy in cystic fibrosis-a pilot study, *Europ. J. of Respiratory Diseases*, 65, pp. 419-22. Tyrrell JC, Hiller EJ, Martin J. 1986. Face masks physiotherapy in cystic fibrosis. *Arch. of Diseases in Childhood*, 61(6), pp. 598-600
12. Active Cycle of Breathing Technique (ACBT)	It is a set of breathing techniques. It can be changed to meet each person's needs. It gets air behind mucus, lowers airway spasm and clears mucus.		p Pryor *et al,* 1979		1979	http://www.cff.org/treatments/Therapies/Respiratory/AirwayClearance/#Chest_Physical_Therapy_(CPT_or_Chest_PT)_or_Postural_Drainage_&_Percussion_(PD&P) http://www.cfmedicine.com/htmldocs/CFText/physiotherapy.htm Pryor *et al,* 1979. Evaluation of the forced expiration technique as an adjunct to postural drainage in treatment of cystic fibrosis. *British med J,* 18; 2/6187, pp. 417-8

Table 2: Sample of Asthma medical treatments and devices innovations

Medical treatments and devices	*Description*	*User innovation history:*	*Innovator U=User P = Producer*	User entrepreneur	*Year of intro*	*Type of evidence*
1. Corticosteroids	Inhaled corticosteroids (ICSs) are very similar to a chemical that the body naturally produces to combat inflammation. They go directly to the airways of the lungs to help reduce swelling. Because ICSs go right where they are needed, there is less risk of the side effects that may occur with the same medicine taken in pill form, where the medicine has to go throughout your body.		P Dr. Hench and Dr. E.Kendell		1928	le Fanu, J., 1999. *The rise and fall of modern medicine,* Carroll & Graf Publishers http://www.asthma.com/treat/different-treatment.html
2. Nebulizer 	Nebulizers use compressor and pump to deliver a fine mist of medication into your lungs. This comes through either a mask that fits snugly over your nose and mouth or a tube through which you breathe. Nebulizers are made for people who can't use an inhaler.		P Dr. Sales-Girons		1858	http://www.inhalatorium.com/page148.html hhttp://www.asthma.com/treat/different-treatment.html Sanders, M., 2007. Inhalation therapy: an historical review, *Primary Care Resp J.,* 16(2), pp.71-81.

3. Dry powder inhaler (DPI) 	This type of inhaler delivers medication directly into your lungs, where it's needed, but it does not require hand/breathing coordination or the use of a spacer device. More and more asthma medications are becoming available in DPI form.		P A.Newton		1894	http://www.asthma.com/treat/different-treatment.html Sanders, M., 2007. Inhalation therapy: an historical review, *Primary Care Resp J,* 16(2), pp.71-81
4. Pressured metered dose Inhaler for asthma 	This type of inhaler uses a gas propellant to deliver medication right into your lungs. The use of this device requires hand/ breath coordination. Some patients may find this difficult and may benefit from the use of an accessory device called a spacer.	The Respiratory Care Journal of 2005 reported that in 1955, 13-year-old Susie Maison, the daughter of Riker Laboratories President Dr. George Maison, originated the idea for the inhaler. Susie complained to her father that her asthma medication should be as uncomplicated as her mother's hairspray can.	U Dr. George Maison, father of patient		1955	http://www.thepcrj.org/journ/vol16/16_2_71_81.pdf http://www.ehow.com/about_5616094_invented-inhalers_.html http://www.asthma.com/treat/different-treatment.html
5. PocketFlow Spacer 	A new type of pocket–sized 'spacer', a piece of equipment used by people with asthma. This invention could make it easier for patients to efficiently use their asthma medication.	"My youngest daughter was diagnosed with asthma aged six months, and had been using inhalers since. When she was five, she became very ill, suffering from a nasty asthma attack. Rushing her into hospital, it looked like an extreme allergic reaction to me, so I made an executive decision to stop giving her the medicine that night and the symptoms stopped right then. It turned out that Katherine was not taking her medication properly; it was getting stuck in the back of her throat, which had caused the allergic reaction. It was at that point that I decided a new product was needed to prevent this from happening to other children".	U Paul Watson, father of patient		Expected in 2012	http://www.nursingtimes.net/opinion/my-invention-pocket-flow-spacer-inhalers-for-children/5038799.article http://www.wellbeingnorfolk.co.uk/2011/10/west-norfolk-school-nurse-receives.html http://www.hee.org.uk/Commercialised-Innovations/pocket-flow-spacer.html

Table 3: Sample of Sleep Apnea medical treatments and devices innovations

Medical treatments and devices	*Description*	*User innovation history:*	*Innovator U=User P = Producer*	User entrepreneur	*Year of intro*	*Type of evidence*
1. CPAP machine	Continuous Positive Airway Pressure (CPAP) is a mask-like machine that provides a constant stream of air which keeps your breathing passages open while you sleep.		P Dr. Colin Sullivan		1981	http://www.powerhousemuseum.com/australia_innovates/idea.php http://helpguide.org/life/sleep_apnea.htm
2. Klear way (Mandibular Advancement Device)	The appliance works non-surgically to realign the jaw and/or tongue in relation to the head. Its intention is to prevent the apnea and/or snoring from occurring during sleep and it must be worn each night to produce the desired effect.		P Alan A.Lowe		1995	http://www.klearway.com http://www.docstoc.com/docs/47160767/Mandible-Repositioning-Appliance---Patent-5409017 http://sleepapnea-treatments.net/mandibular-repositioning-device/
3. OPAP	Oral Positive Airway Pressure is a device for those with intolerance to CPAP; eliminates the need for head straps.		P Dr. Jonathan Greenburg			http://sleepapneala.org/sample-page/ http://airuslife.com/products.php

4. Thornton Adjustable Positioner (TAP)	It is an oral appliance that is worn while sleeping. Developed with advanced technology, it alleviates snoring and sleep apnea by holding the mandible forward during sleep to prevent the tongue and soft tissue of the throat from collapsing into the airway. The airway must be open to allow air to pass through the throat.		P Dr. W. Keith Thornton		1994	http://www.amisleep.com/aboutami.html http://www.britishsnoring.co.uk/thornton_adjustable_positioner.php
5. Quietus CPAP Liners 	Improved CPAP machine, a solution for mask not to lose its seal during the night,	"The problem is that as the night goes on, the masks lose their seal. The air leaks and resulting noise got so bad they would wake the entire household so instead of getting more sleep I seemed to get even less," Kesner said. "Every time I tossed and turned it exacerbated the problem. It was driving me insane. I was awake all the time. I had to find a solution."	U Kesner	E Co. QuietusLiners	2010	http://www.dailylocal.com/articles/2010/11/21/business/srv0000010025718.txt?viewmode=default http://quietusliners.com
6. TrueFIT mask 	Modifications of CPAP machine.	The first night of using the CPAP air pump and mask was extremely stressful as Collin struggled to sleep with this equipment. The next morning he went straight out to his shed to try to come up with something better, something that was tailored to his own face. He reasoned, you don't buy a set of dentures off the shelf, so why would you wear a mask that wasn't personally fitted?	U Collin Anderson		1999	http://www.abc.net.au/tv/newinventors/txt/s3246976.htm http://www.acurest.com.au/truefit-custom-mask/

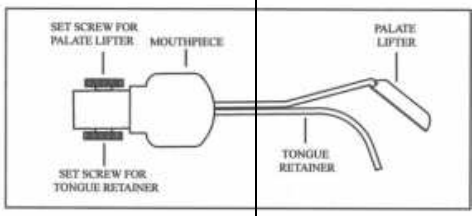
7. Buzz POD 	A novel body position orientating device that monitors sleep position and activates a vibration alarm to alert and discourage the patient from sleeping supine.	Michael was sitting in the backyard with his sister and she was complaining about her husband's snoring, especially when he had been drinking red wine. Michael is a good brother and immediately set out to resolve her problem. So he developed a device, that is a two-part system: **1.** A control unit attached to the sleeper's body with external buzzer. **2.** A dedicated computer program.	U Michael Gorman, brother of patient	E Co. BuzzPod	2002	http://www.abc.net.au/tv/newinventors/txt/s2885694.htm http://www.buzzpod.com.au/
8. Respire Aide 	An alternative way to big, not comfortable and expensive CPAP machines and Mandibular Advancement Device.	"My original intention was not to create a medical device to sell to other people, but rather, to address my own OSA that had increased in severity as I grew older. I decided to create my own device to address the root causes in a more direct, and more comfortable, manner. My approach was to create a device that would be held in place by the lips and teeth and extend back to support the soft palate to keep it from draping down into the airway… I only snored lightly and noticed that I was less tired and more energetic during the day. I continued to research sleep apnea and eventually decided that to improve the effectiveness, I needed to control rearward movement of the tongue… After a number of prototypes were tried, adjusted, and improved, the current configuration was born. I also researched and tested materials I could use for components to find those that worked the best and had been tested and proven safe for use inside the oral cavity. This was essential for ultimate approval by the FDA."	U Harry Cutler, patient	E Buy trough RespireAid site	2010	http://respireaide.com/id72.html

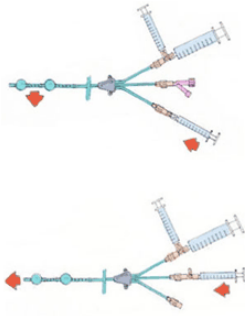
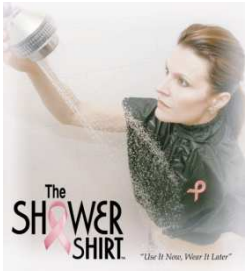
Table 4: Sample of Cancer medical treatments and devices innovations

Medical treatments and devices	*Description*	*User innovation history:*	*Innovator U=User P = Producer*	**User entrepreneur**	*Year of intro*	*Type of evidence*
1. Chemotherapy	It is the treatment of disease by chemicals especially by killing micro-organisms or cancerous cells.		P Alfred Gilman and Louis S. Goodman		1965	http://www.news-medical.net/health/History-of-Chemotherapy.aspx le Fanu, J., 1999. *The rise and fall of modern medicine,* Carroll & Graf Publishers. pp.112-113
2. Radiation Therapy	Use of high-energy radiations in the treatment to destroy cancer cells and to stop their further growth in the body.		P Wilhelm Rontgen, (x-ray) and Marie Curie (radium)		1895 - 1900	http://radiationtherapycomplication.com/history-of-radiation-therapy/ http://radiationtherapycomplication.com/radiation-therapy-for-cancer-treatment/
3. Targeted cancer therapies	These are drugs or other substances that block the growth and spread of cancer by interfering with specific molecules ("molecular targets"), involved in tumor growth and progression. Targeted cancer therapies may be more effective than other types of treatment, including chemotherapy and radiotherapy, and less harmful to normal cells.		P Different US researchers		FDA approvals since 2000	http://www.cancer.gov/cancertopics/factsheet/Therapy/targeted http://invent.ucsd.edu/technology/cases/2002/SD2002-020.shtml http://news.uchicago.edu/article/2009/08/19/argonne-university-scientists-develop-targeted-cancer-treatment http://www.aafp.org/afp/2008/0201/p311.html

4. Antiogenesis	Angiogenesis, the growth of new capillary blood vessels in the body, is an important natural process used for healing and reproduction. The body controls angiogenesis by producing a precise balance of growth and inhibitory factors in healthy tissues.		P Dr. John Hunter		1787	http://www.angio.org/ua.php http://www.cancer.gov/cancertopics/factsheet/Therapy/angiogenesis-inhibitors http://knol.google.com/k/history-of-cancer-treatment#
5. Bone Marrow and Stem Cell Transplantation	These are procedures that restore stem cells that were destroyed by high doses of chemotherapy and/or radiation therapy.		P		XX cent.	http://www.cancer.gov/cancertopics/factsheet/Therapy/bone-marrow-transplant http://emedicine.medscape.com/article/1014514-overview http://www.medscape.com/viewarticle/499049_2 http://stemcells.nih.gov/info/basics/basics4.asp http://knol.google.com/k/history-of-cancer-treatment#
6. Gene Therapy for Cancer	It is a treatment that involves introducing genetic material (DNA or RNA) into a person's cells to fight disease. It is not currently available outside a clinical trial.		P		XX cent.	http://www.cancer.gov/cancertopics/factsheet/Therapy/gene http://science.jrank.org/pages/2959/Gene-Therapy-history-gene-therapy.html

7. Hyperthermia (thermal therapy or thermotherapy)	It is a type of cancer treatment in which body tissue is exposed to high temperatures (up to 113°F). Research has shown that high temperatures can damage and kill cancer cells, usually with minimal injury to normal tissues.		P De Kizowitz		1779	http://www.cancer.gov/cancertopics/factsheet/Therapy/hyperthermia http://hyperthermia-treatment.com/aids_history.html
8. Laser therapy	Laser light can be used to remove cancer or precancerous growths or to relieve symptoms of cancer. It is used most often to treat cancers on the surface of the body or the lining of internal organs.		P Different scientists		1916	http://www.cancer.gov/cancertopics/factsheet/Therapy/lasers http://www.ehow.com/facts_5778575_new-laser-cancer-treatment.html http://robertbell.articlealley.com/history-of-laser-therapy-1213207.html
9. Cancer Vaccines	Cancer vaccines are designed to boost the body's natural ability to protect itself, through the immune system, from dangers posed by damaged or abnormal cells such as cancer cells.		P Harald zur Hausen		2008	http://www.cancer.gov/cancertopics/factsheet/Therapy/cancer-vaccines http://www.nhs.uk/Planners/vaccinations/Pages/historyofvaccination.aspx http://www.historyofvaccines.org/content/blog/fda-approves-cancer-vaccine

10. The Kanzius Machine and Therapy	The use of radio waves to kill cancer cells. The therapy aims to insert metallic nanoparticles in or around cancerous cells and then direct radio waves in. The energy from the radio waves creates heat which burns the cancerous cell cluster.	John Kanzius was diagnosed with leukemia. While getting chemotherapy, he found himself haunted by the faces of fellow cancer patients. He tells us, "I saw way too many young people die before their time." Kanzius started thinking and tinkering. He had worked in radio his whole life. He picked up some transmitters, as well as a few of his wife's pots and pans, and designed a machine to battle cancer. He says, "I wondered if I could make the cancer cells act like little radio receivers … and when they picked up the signal, they would get hot, they would create a fever, and the cancer cell would die." He showed it to his oncologist and the doctor then took his patient's invention to a cancer surgeon, who thought of using microscopic metal bits to conduct the heat from the radio waves.	U John Kanzius, diagnosed with terminal leukemia		Clinical trials expected in 2012	http://www.cbsnews.com/stories/2008/04/10/60minutes/main4006951_page2.shtml?tag=contentMain;contentBody http://www.accenthealth.com/Patients/Feature-Detail/156/ http://en.wikipedia.org/wiki/Kanzius_RF_Therapy
11. Chemotherapy care packages	ChemoCargo's mission is to provide first-time chemotherapy patients with a tote bag of personal care and comfort items to help ease the stress and anxiety of the treatments.	"I was diagnosed with cancer in December 2009. After surgery, my oncologist recommended chemotherapy. My first treatment happened in the middle of February, 2010. Fortunately for me, a friend of mine has a sister who has gone through extensive chemotherapy treatments, and she was able to advise me on what to bring that first day. Still, the unknown was very scary. Treatment days are long, boring and stressful. By my second treatment, I realized I was lucky to have had such good advice. I also realized there are many different resources available to cancer patients, but it can be hard to find them. The seeds of Chemo Cargo were sown that day."	U April Kunzelman, cancer survivor	E Co. Chemocargo	2011	http://www.rrstar.com/carousel/x286168484/Former-cancer-patient-creates-chemotherapy-care-packages http://chemocargo.org

12. Catheter that blocks blood flow to the tumor 	Catheter is a long very thin teal colored tube that is attached to three plungers. When inserted into a blood vessel the plungers inflate two balloons that produce a tight fit. This cuts blocks blood flow to the tumor. A separate plunger can then deliver chemotherapy directly into the tumor. The device can be used to treat any solid tumor, breast cancer, brain cancer, pancreatic, etc.	"I wanted to help my sister as much as I could. I went to Medline, where there are hundreds of thousands of documents describing clinical studies, to see what I could find … Tumors develop a feeder vessel that provides them with blood. I came up with an idea that if you could make a catheter small enough, you could thread it through a patient's blood vessels and directly into the tumor's feeder. You would then be able to direct chemotherapy straight into the tumor. I decided to design and make the device. I founded Vascular Designs in 2001." Robert Goldman.	U Robert Goldman, the brother of cancer patient	E Co. VascularDesign	2001	http://www.zdnet.com/blog/foremski/how-a-software-engineer-tried-to-save-his-sister-and-invented-a-breakthrough-medical-device/760 http://www.vasculardesigns.com/
13. Shower Shirt Mastectomy Garment 	"The first and only water-resistant garment to protect mastectomy patients post-surgery".	The inspiration behind the creation of her product, which helps protect against the risk of post-surgical infections following the removal of one or both breasts, came after Crites was told that she could not shower for two to three weeks after her mastectomy, and before her surgical drains were removed. "After being told that I could not shower, I immediately began looking for a water-resistant garment to protect myself. I could not find a product to purchase so I utilized a trash bag for protection," said Crites, The SHOWER SHIRT CO., president/CEO. "I then began speaking with other mastectomy patients who also utilized either trash bags or saran wrap for water-resistant purposes."	U Lisa F. Crites, breast cancer	E Co. ShowerShirt	2011	http://idea4invention.com/articles/cancer-survivor-lisa-crites-invents-shower-shirt-mastectomy-guard https://www.prbuzz.com/health-a-fitness/54800-the-shower-shirt-mastectomy.html http://www.theshowershirt.com/

14. Med-Track 360 	Med-Track 360 organizes, tracks, records, prints, e-mails and shares pertinent information such as medications, dosages, suppliers, appointments, medical contact numbers, side effects, test results, insurance claims, intakes and outputs. More than 200 detailed screens and 400 reports enable the patient to tailor the software to his/her needs.	Georg was a cancer patient when he created Med-Track 360 as a solution for the demands of information management and communication. "In the past three years I have had over 250 appointments, including radiation and chemo treatments, imaging studies, procedures and surgeries with 20 different physicians at 14 medical facilities, while taking 35 different prescriptions," Georg said. "I was inundated with things to know, share, do, order, take, measure, monitor and remember, and communicate with my caretakers when I was not up to fully caring for myself — without the Med-Track 360, I know I would not be alive today."	U Charles Georg, cancer patient	E Co. Wellmunitytechnology	2011	http://www.ehrwatch.com/blog/cancer-survivor-creates-patient-centric-tracking-software http://detroit.cbslocal.com/2011/10/17/new-software-organizes-cancer-care-for-patients/ http://www.wellmunitytechnology.com/
15. Vegetable Soup	When different vegetables carefully prepared in the soup, it is capable to boost the immune system and maintain an acid-alkaline balance of the human body.	Dr. Tateishi Kazu's father and brother both died of cancer, and then he found himself suffering from cancer of the duodenum and spreading. His stomach was removed, but the cancer cells had spread to his lungs. He resolved to fight for his life. Over twenty years he researched, studied and tested over 1,500 types of herbs and plants. On the basis of general health upkeep, strengthening of the immune system and slowing down of the aging process, he eventually discovered the right combination of ingredients from five kinds of vegetables and formulated a unique healing remedy. It was also experimented on animals where no side effects had been found. The whole of Japan was then shocked and amazed at its proven and incredible results that were not heard of in the medical field.	U Dr. Tateishi Kazu, cancer patient			enhttp://www.tateishikazu.com/eng.htm

16. Abnostrain 	Medical device to assist abdominal surgery patients in raising their upper body from a prone position, namely, invalid lift.	When cancer survivor Rene Armstrong was recovering from abdominal surgery, she stumbled upon an idea that may help other patients, and led to the formation of her company. "Abnostrain allows patients to manually pull themselves up from the lying position without assistance," Armstrong said. "The product helps reduce pain, the amount of medication needed, and the length of healing time, as well as helping patients to recognize that they aren't completely dependent on other people."	U Rene Armstrong, cancer survivor		2006	http://medgadget.com/2006/09/get_out_of_bed_1.html http://www.trademarkia.com/abnostrain-76451247.html
17. Ring (for prosthesis to enable voice restoration)	Improvement of the prosthesis to avoid its displacement.	A patient diagnosed with squamous cell carcinoma of the larynx underwent total laryngectomy. Upon completion of radiotherapy, a tracheoesophageal fistula was created and voice prosthesis inserted to enable voice restoration. Unfortunately, the patient presented subsequently with repeated episodes of dislodgement and an episode of potentially fatal aspiration of the voice prosthesis, despite various measures taken by the surgeons to overcome the problem. The patient subsequently developed a method enabling him to retrieve the voice prosthesis himself should it become dislodged. He attached a ring to the prosthesis, which was larger in diameter than the tracheal stoma, thus preventing ingestion or recurrence of aspiration.	U ?? Larynx cancer patient.		2009	Masaany, M., Marina, M. B., Asma, A., Sani, A., 2009. Prevention of aspiration following recurrent dislodgement of voice prosthesis: a patient's innovation, *Journal of Laryngology and Otology*, 123(6), pp. 680-682.

Table 5: Sample of Diabetes medical treatments and devices innovations

Medical treatments and devices	*Description*	*User innovation history:*	*Innovator U=User P = Producer*	User entrepreneur	*Year of intro*	*Type of evidence*
1. Frequent self-monitoring of blood sugar		In October 1969, Richard Bernstein, a type 1 diabetes patient, came across an advertisement of the first blood glucose meter that would give a reading in 1 minute, using a single drop of blood. The device was intended for emergency staff at hospitals to distinguish unconscious diabetics from unconscious drunks. The instrument weighed three pounds, cost $650, and was only available to certified physicians and hospitals. Determined to take control of his situation, Bernstein asked his wife, a doctor, to order the instrument for him. Bernstein began to measure his blood sugar about 5 times each day and soon realized that the levels fluctuated wildly throughout the day. To even out his blood sugars, he adjusted his insulin regimen from one injection per day to two and experimented with his diet, notably by reducing his consumption of carbohydrates. Three years after Bernstein began monitoring his own blood sugar levels, his complications were still progressing and he began researching scientific articles about the disease. Bernstein, a "user", is believed to be the first individual to self-monitor his blood sugar and was an early advocate for such monitoring by diabetics.	U Richard Bernstein, a type 1 diabetes patient	E	1969	Bernstein, R. K., 2007. Dr Bernstein's Diabetes Solution. New York, NY: Little, Brown and Company. ISBN 978-0-316-16716-1.

2. I-Port Injection Port 	It is an injection port that gives insulin injectors a mean to give themselves their doses without having to puncture the skin for each dose. It might also be useful for parents of small children with diabetes.	Using injection therapy, Patton quickly grew tired of giving herself an injection each time she needed insulin. The multiple daily injections often left her skin bruised. She then switched to insulin pump therapy where she only had to inject herself every three days. But she found the pump therapy to be inconvenient, uncomfortable and hindered with her active lifestyle. She then went on to research and experiment on a device that could meet her medical needs, yet have a minimal impact on her life. This led to her invention of i-port®, a medical device for diabetes patients who struggle with daily injections. Realizing an unmet need existed and that there are others like her faced with the challenges of managing diabetes, Patton founded Patton Medical Devices in 2004 to manufacture and distribute her invention.	U Catherine Patton, type 1 diabetes patient	E Co. Patton Medical Devices	2004	http://www.diabetes.co.uk/diabetic-products/iport-injection-port.html http://www.business-opportunities.biz/2009/07/08/catherine-patton-business-ideas-come-from-everyday-needs/
3. Diabetes Medical Watch (CADEX 12) 	Alarm watch and alert about what medication to take and when (useable in different diseases).	"The reason I invented this watch is because I had a mother with heart problems and she needed to take 4-5 medications during the day. Often she forgot to take a medication and she felt frustrated and humiliated because of that. We were used to receive phone calls telling out mother was in the hospital. The most frequent reason was because she missed her medication… I thought that I could find her watch that had different alarms, but no producer had invented that. I made a survey and found out that forgetting of medication was a problem for many people. So I developed idea of a watch that would have 10-12 alarms, and that would tell people what to take"	U Diane K. Barker, daughter of patient	E Co. CadexWatch	2000	http://www.cadexwatch.com/info.html http://www.medicalwatches.com/diabeteswatch.html

4. Insulin pen 	Insulin delivery system		P Novo Nordisk		1985	
5. Insulin Pump	Insulin delivery system		P Alfred E.Mann		1979	http://insulinguide.net/who-invented-the-insulin-pump.html
6. Log for life 	"an online logbook for glucose, medication, carb intake, doctor's instructions and more, that will interface with any cell phone via instant messaging (IM) and in particular with the new iPhone."	The idea of Log for Life came about when Gnoso's (software company) designer, Ethan Mullis, who has been living with diabetes for 11 years, was looking for a simple way of keeping track of his own diabetes. Log for Life is focused on helping diabetics easily gather their correct information to take action toward living a longer and healthier life. The beta release of Log for Life includes: • The ability to email or text numbers directly into Log for Life using any e-mail account or cell phone. A Special interface has also been developed specifically for iPhone users. • The option to share log with others including doctors, parents, caregivers, etc. • An analysis feature allowing users to make sense of their numbers with quick snapshots of their logging history.	U Ethan Mullis, a type 1 diabetes patient	E	2009	https://www.logforlife.com/ http://www.diabetesmine.com/2009/10/where-are-they-now-log-for-life-winners-of-the-diabetesmine-design-challenge.html

7. Maximum Slide 	It's a new Pez-candy-like dispenser for glucose test strips that has a disposal container built right in.	Every patient with diabetes carriers test strips with them everywhere he goes. Test strips containers are taller than strips and contain enough empty space so you can get a finger in to fish one strip out, or dump them all in your hand and be careful not to spill them. And you should always wash your hands before testing for not ruining the whole batch. Besides the containers just don't fit into the pocket. One day Max had an idea, to put into pez dispenser test strips instead of candies. He told his friend about that. "We decided we wanted to have a nice flat little case with a trigger that would slide out just one strip at a time… and then the strips are stacked instead of just loose in a round container, you can use the space more beneficently. The container wouldn't stick out of your clothes and it would be easy to get in and out of a pocket".	U Max Wieder, diabetes patient and his friend Ben Katz	(lack of information)	2008	http://pt.scribd.com/doc/3433592/Maximum-Slide-for-Test-Strips http://www.diabetesmine.com/2008/06/diabetesmine-design-challenge-meet-the-winners.html
8. BLOB 	A small, portable device that discreetly delivers insulin.	"I started thinking about all the ways that diabetes impacts me and how I manage it in my everyday life. I don't particularly have a problem with injections, but with carrying the pens. Many times I don't want to carry anything, like when I go out at night with friends, and I have to carry the bag with the cooler and all that. I wanted something small and resistant, because sometimes I want to put my pen in my pocket or in a bag without protection. And I wanted it to look nice! I started testing with plasticine. I tried many different shapes, trying to see which was the best shape to minimize the injection gesture, while at the same time looking for a nice shape. I was thinking about what problems with the pen I wanted to improve".	U Luciana Urruty, a type 1 diabetes patient	(lack of information)	2011	http://www.diabetesmine.com/2011/06/grand-prize-winner-blob-minimizing-insulin-injections.html http://www.diabetesmine.com/2011/11/diabetes-in-uruguay-good-support-but-few-choices.html

9. Hanky pancreas	Accessories for women who wear insulin pumps or CGMs. "transforming diabetes technology into a fashion statement"	Jessica is using an insulin pump. While her medical health improved, she struggled with the social inconvenience and wearability of the device. As a result, she began conceptualizing a way to improve the experience in terms of comfort and confidence. Jessica is currently creating handmade and custom solutions and stands behind the evidence that her products represent a movement toward a socially dynamic and new way of interacting with diabetes technology.	U Jessica Floeh, type 1 diabetes patient	E	2011	http://hankypancreas.com/
10. Diabetes education online	Founded in 1995 by Integrated Diabetes Services LLC is dedicated to helping you navigate the complexities of living with and managing insulin-dependent diabetes.	An award-winning Certified Diabetes Educator, Masters-level Exercise Physiologist and person with type-1 diabetes since 1985, Gary Scheiner has dedicated his professional life to improving the lives of people with insulin-dependent diabetes.	U Gary Scheiner, type 1 diabetes patient	E	1995	http://integrateddiabetes.com/primeserv.shtml?i1 http://www.diabetesmine.com/2011/05/gary-scheiner-on-turbo-charging-insulin-and-diabetes-tech-education.html
11. Omnipod 	A type of insulin pump. The world's first tubing-free system. Wireless and watertight. Easy to use. The Pod holds and delivers insulin.	In 1992 a young boy was diagnosed with diabetes. His father, hunting for the best possible treatment, did exhaustive research. He found that insulin pump therapy offered dramatically better control than injections, with far less risk of long-term complications. But all that tubing seemed like such a burden for a young boy—and where would the pump go during swimming lessons? The father thought there had to be a better way. He gathered the best diabetes and technology experts he could find, and in July, 2000, we formed a company, Insulet Corporation, to improve the traditional insulin pump. And we created the OmniPod System, a completely unique approach offering all the benefits of insulin pump therapy, with none of the issues."	U ?? ? Insulet Corporation (producer)		1992	http://www.myomnipod.com/about-insulet/

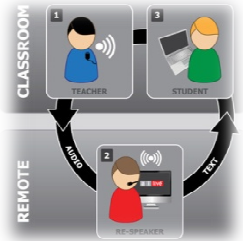
12. Joe's Small-in-One - Diabetes Kit Bag 	It carries all an insulin-dependent diabetic needs for one whole day of treatment: from injections and glucose testing to catering for a hypo, this carry-case takes everything. It is the smallest case that will take all a diabetic needs for a day's treatment.	"Having graduated from university in 2008 I decided to continue my work to make diabetics' lives better. Since then I've set up Joe's Diabetes Ltd. and have been developing products to this end. There's now a significantly expanded 2nd edition of the book ("Joe's Rough Guide to Diabetes"), with new and improved advice. I've also designed a new type of carry-case that takes all an insulin-dependent diabetic needs for 24 hours' treatment in the smallest space possible, Joe's Small-in-one. The idea is that you can take all your diabetic equipment around with you without being encumbered. Both products are designed to help you live your life in a way that means you're diabetically controlled, but as free and flexible as possible."	U Joe Fraser, type 1 diabetes patient	E	2008	http://www.diabetes.co.uk/diabetic-products/joes-small-in-one-diabetes-kit-bag.html http://www.joes-diabetes.com/diabetes-supply-cases.html
13. iBGStar	The device can be used independently of the iPhone to take readings and data will be transferred to the iPhone once the two are connected again (FDA approved).		P Sanofi Aventis and Agamatrix (Sonny Vu)		2011	http://medgadget.com/2011/12/ibgstar-blood-glucose-meter-for-iphone-now-approved-in-u-s.html http://www.bgstar.com/web/

14. Glooko 	Diabetes phone app It will be the first available plug-in cable between popular glucose meter models and the iPhone/iPad that automatically "sucks up" your data, and offers a very simple logbook-style app to view it.	"This is essentially the technology that we developed, but they never did anything with it," Anita says. "Our co-founder Yogan Dalal (a successful an entrepreneur and engineer) has pre-diabetes and works hard to control his glucose levels. His feeling was, 'Let's get something out there people can use now that actually makes their lives easier. It's a building block — it's one more step you've eliminated for me.' Right now it's functional, not sexy."	U Glooko	E Co. Glooko (jointly with others)	2011	http://www.glooko.com/product/logbook/ http://www.diabetesmine.com/2011/10/glooko-iphone-diabetes-logging-made-super-easy.html

Table 6: Medical treatments and devices for General Purposes

Medical treatments and devices	*Description*	*User innovation history:*	*Innovator U=User P = Producer*	User entrepreneur	*Year of intro*	*Type of evidence*
1. Band aid 		Dickson was a cotton buyer at the Johnson & Johnson company. His wife, Josephine Knight, often cut herself while doing housework and cooking. Dickson found that the gauze stuck to a wound with tape didn't stay on her active fingers. In 1920, he took the gauze and placed it in the center of the tape and covered it with crinoline to keep it sterile and safe.	U E.Dickson, husband of patient		1920	http://www.ehow.com/about_5079137_invented-bandaid.html http://pt.wikipedia.org/wiki/Earle_Dickson
2. Robotic trousers 	The device can help paraplegics to stand and walk - using crutches for stability - when they lean forward and move their upper body in different ways	Amit Goffer was paralyzed in a car crash in 1997 and immediately set out to invent a device that could replace the wheelchair.	U Amit Goffer	E Co. Argo Medical Technologies	2010	http://www.dailymail.co.uk/sciencetech/article-1335327/Paralysed-man-invents-robotic-legs-help-paraplegics-walk-again.html http://www.argomedtec.com/
3. Laughter therapy	Laughter therapy, also called humor therapy, is the use of humor to promote overall health and wellness. It aims to use the natural physiological process of laughter to help relieve physical or emotional stresses or discomfort.	Norman Cousins was taken ill with ankylosing spondylitis, a severe connective tissue disease where the body just wastes away. When doctors gave up on him, he cured himself with large doses of vitamin C and comedies starring the Marx Brothers. Cousins found that ten minutes of genuine belly laughter had an anesthetic effect and gave him at least two hours of pain-free sleep. He recorded his experiences in self-healing through laughter in a best-selling book, *Anatomy of an Illness.*	U Nornan Cousins		1979	http://www.indiadiets.com/alternative%20healing/Laughter.htm http://www.cancercenter.com/complementary-alternative-medicine/laughter-therapy.cfm http://en.wikipedia.org/wiki/Norman_Cousins

4. Bifocal glasses 		Ben Franklin was getting old and had troubles seeing both up-close and at a distance. Getting tired of switching between two types of glasses, he devised a way to have both types of lenses fit into the frame. The distance lens was placed at the top and the up-close lens was placed at the bottom.	U Benjamin Franklin		1784	http://inventors.about.com/od/fstartinventors/ss/Franklin_invent_4.htm
5. Braille System	A system of reading and writing used by people who are blind or visually impaired.	As a small child, Braille was blinded in an accident. In 1821, Braille learned of a communication system devised by Captain Charles Barbier of the French Army. In either case, Barbier willingly shared his invention called "night writing". A code of dots and dashes impressed into thick paper. The captain's code turned out to be too complex to use in its original military form, but it inspired Braille to develop a system of his own.	U Louis Braille		1821	http://www.ehow.com/facts_5164088_invention-braille-system.html http://pt.wikipedia.org/wiki/Louis_Braille
6. Disposable Diapers		Marion Donovan was a young mother in the post-war baby boom era. Unhappy with leaky, cloth diapers that had to be washed, she first invented the 'Boater', a plastic covering for cloth diapers. Marion Donovan made her first Boater using a shower curtain. A year later she carried her ideas further. Using disposable absorbent material and combining it with her Boater design, Marion Donovan created the first convenient disposable diaper.	U Marion Donovan, mother of patient		1950	http://inventors.about.com/od/dstartinventions/a/Diapers.htm
7. Cast Cooler 	CastCooler provides immediate cooling relief from itch and odor. It funnels cool air into the cast through a plastic tube, using a modified aquarium pump and a battery that powers an electric motor.	During the ninth grade, Morlan underwent close to a dozen surgical procedures to help correct the effects of diplegic cerebral palsy. After enduring hip to ankle casts in the California heat, with no way to alleviate the pain and discomfort, she invented the "Cast Cooler."	U Krysta Morlan, celebral palsy patient	(lack of information)	1998	http://web.mit.edu/invent/a-winners/a-morlan.html http://www.castcooler.com/

8. Waterbike 	This waterbike is a semi-submerged, fin-powered bicycle, which has a rudder for steering. It is made of light PVC tubing and foam to give it the correct buoyancy.	Krysta was inspired to invent the waterbike after enduring months of boring physical therapy in the pool after her surgeries. The waterbike is anything but boring—with bright pink foot pedals and orange "wings" for stability, it resembles a cartoon dragster more than a real bike.	U Krysta Morlan, celebral palsy patient		1999	http://web.mit.edu/invent/a-winners/a-morlan.html
9. Accessible Child Proof Latch 	It is a modification to a magnetic latch gate which allows a shorter adult or someone in a wheelchair to open the gate using a special key whilst maintaining the gate's normal childproof latch function for all other users.	Neville's inspiration was being faced with a gate at his son's school which he couldn't open. He immediately went home and started working on a solution. When he explained what he was trying to do, one of the makers of magnetic latch gates supplied him with a small model gate so he could test his ideas.	U Neville Brown, disabled	E	2008	http://www.aclatch.com.au/about.htm http://www.abc.net.au/tv/newinventors/txt/s2372351.htm
10. Ai-Live 	Ai-Live delivers real-time captions into classrooms.	Growing up deaf, Alex always wished he could have better access to the classroom without having to rely on lip-reading or guess-making skills. Having established a successful captioning business, Alex and Tony began to think about whether they could use their experience in this area to somehow stream captions to a deaf child's laptop. To use the system, a regular teacher uses a radio microphone when addressing the classroom. This audio is streamed using the Ai-Live software to a remote location where a 're-speaker' dictates the teacher's lesson using voice recognition software. The text is then streamed back to the laptops of deaf or hearing impaired students in the classroom in less than seven seconds. This system overcomes many of the problems that are holding deaf children back from reaching their full potential.	U Alex Jones, deaf	E	2010	http://www.abc.net.au/tv/newinventors/txt/s2930582.htm http://ai-live.com/

11. Hemodialysis Safety Device	The HSD is designed to secure the tubes attached to the patient's cannulas so that they don't become kinked or get knocked out. This gives the patient a sense of security and enables some patients to fall asleep while dialyzing.	A Dominic's inspiration came through a member of his family that had a kidney failure and has to dialyze 3 times a week for 6 hours each session. The problem with dialyzing is that it takes hours and its very time consuming. The patient has limited movement because the cannula needs to stay secure and the tubes cannot be allowed to kink or dislodge.	U Dominic Lozinski, relative of patient		?? (information lack) 2008	http://www.abc.net.au/tv/newinventors/txt/s3001922.htm http://mosman-daily.whereilive.com.au/news/story/student-has-designs-on-better-deal-for-patients/
12. On your feet	On Your Feet is a unique wedge shaped cushion that inflates to assist elderly, the infirm or disabled with rising or sitting in a domestic chair.	The inspiration for Samantha's science project resulted from a major lifestyle change that her grandmother recently experienced. In a 5 to 7 year period her grandmother suffered chronic arthritis, had two knee replacements, a heart bypass and this drastically changed her living arrangements at home.	U Samantha Guinn, granddaughter of patient		?? (information lack) 2005	http://www.abc.net.au/tv/newinventors/txt/s1441763.htm
13. Programmable turning bed	It is relatively affordable solution to the often painful and taxing problem of having to turn patients in bed in order to prevent pressure sores.	The catalyst for Hanna's invention was a night spent nursing a very ill young woman who, like so many patients, had to be turned every hour in her bed to prevent pressure sores. This patient was in so much pain every time she was moved that Hanna left the hospital that night determined to do something to improve the situation. She went straight to her brother Jacob, an engineer, and began to outline the invention which 7 years later has become the Programmable Turning Bed.	U Hanna Piazza, the nurse		2009	http://www.abc.net.au/tv/newinventors/txt/s1625367.htm http://www.ilcaustralia.org/home/search4.asp?state=SA&page=39&MC=21&MinC=10

14. Ezy-as pressure Stocking applicator 	Reduces the effort and pain when applying compression garments to both arms and legs.	Barry suffered serious leg damage in a motorcycle accident when he was 18. He had knee replacement surgery 2 years ago and the method of fitting the compression stocking caused tremendous pain. It would take him up up to 30 minutes to apply and quite often he'd just give up and not wear the compression stocking as the pain involved applying it was just too much. More recently he had to use compression stockings for the treatment of an ulcer, due to poor circulation in his leg. He had tried other applicators on the market without success. Barry knew he wouldn't be able to go through all that pain again so he went about creating something that would take the pain out of application.	U Barry Hilderbrandt	E Co. Ezy-As	2006	http://www.abc.net.au/tv/newinventors/txt/s1964994.htm http://www.ezyasabc.com/product-info.html
15. Stabi-Line (Uni-Line) 	It is a small plastic device shaped like a horseshoe that can be easily snapped on to IV lines, holding them securely so that they do not twist when patients move.	"I experienced at first hand the problems caused by kinking IV lines, which block the flow of blood infusions and drugs to patients and can increase the risk of infection. There is also a significant cost to the NHS as nurses are diverted from other tasks to change damaged drip lines, which are then discarded."	U Lise Kagenow, a nurse		2009	http://medgadget.com/2005/07/stabiline_no_mo.html http://www.novarix.co.uk/products.htm
16. Flyan Chair 	It is a light weight wheel chair that will fold up and can be used to travel over a variety of terrains.	Bryan's love of motocross riding and a desire to lead an active life led him to think about inventing a lightweight fold up power chair that could be used in all terrains. Part of inspiration for the Flyan Chair was the yearly beach holiday Bryan goes on with his family. After the accident Bryan would have to stay back and watch everyone else head down to the beach.	U Bryan (disabled) and Ed Flemming	(lack of information)	2009 (lack of information)	http://www.abc.net.au/tv/newinventors/txt/s3217850.htm

17. Snapit ampoule opener		Glen is an Emergency Nurse. After cutting himself several times on glass ampoules he asked others if they had had the same problem. He realized that most people who use ampoules cut themselves at some stage, if not regularly. He decided that there had to be a user friendly solution. 	U Glen Riverstone, a nurse	E ?? Co. SnapIt	2008	http://www.abc.net.au/tv/newinventors/txt/s1846348.htm http://www.snapit.com.au/snapit/index.html http://qlicksmart.com/English/prdsn.htm
18. Tucker Sling 	This product combination is designed to make your baby portable for today's "on-the-go" parents. The "Combo" can be placed anywhere there is a safe and sturdy surface in your home, office, or daycare.	When her son struggled with severe gastroesophageal reflux as a baby, she didn't just take care of him; she sat down at her sewing machine and made him a wedge and a sling to hold him upright. This home-made solution to her son's positioning needs lead to the birth of Tucker Designs, maker of the Tucker Sling.	U Terry Jarrett, mother of gastroesophageal reflux patient	E Co. TucherDesigns	1990s	http://www.tuckersling.com/ http://www.healthcentral.com/acid-reflux/c/96/3139/mother-invention
19. FLAVORx	It is a medical flavoring system that changes the flavor of over-the-counter and prescription medication .	Kenny Kramm was inspired to start the company when his youngest daughter Hadley was born with a seizure disorder and cerebral palsy. "The medicine that was so crucial to her existence was intolerable to her and made it impossible for her to take. My family was in the hospital repeatedly because Hadley was not getting the medication she so desperately needed and would start having seizures. So we took Hadley's Phenobarbital and some concentrated candy flavorings and started to work with them to see if they could make the medicine palatable enough for her to swallow. This was the start of FLAVORx".	U Kenny Kramm, mother of patient	E Co. Flavourx	1994	http://flavorx.com/ http://www.healthcentral.com/acid-reflux/c/96/3139/mother-invention

20. Positional Therary Pillows	The Positional Therapy Pillow products were designed to eliminate the need to raise a mattress with blocks or other materials, which generally cause the patient to slide down the bed, or the placement of several pillows under the head which can cause neck and back pain or subluxation of the spine. With the use of the Positional Therapy Pillow, the need for an expensive adjustable bed is eliminated.	"After three days in the hospital, I was released with instructions on diet and how to sleep. I was told to place two blocks under the posts at the head of my bed to elevate my head while sleeping. This, in turn, would help hold the stomach acid down away from my esophagus. That was the idea --but it didn't work! After fighting with this problem for three years I felt there had to be a better way to deal with the situation. There had to be a pillow that would fit my needs. I searched the stores, catalogs and the Internet for a pillow that would offer enough height with a comfortable, supportive design to do the job. To my surprise, I couldn't find one. The end result of my search was to design my own pillow and it works"	U Horacio Rubio, a patient	E Co. Positional Therapy Pillows, LLC	1998	http://www.acidrefluxpillow.com/ http://www.positionaltherapypillows.com
21. E-Cue (+ Intellijject) 	Allergy solutions.	As young children, twins Eric and Evan Edwards were diagnosed with life-threatening allergies to a wide range of items. They were supposed to have a dose of life-saving epinephrine close at all times. Over time, however, they became increasingly frustrated that the epinephrine delivery systems available were not designed with users like them in mind. In the twins' opinion, the devices were awkward to carry and difficult to use. In their late teens, Eric and Evan decided to develop a better solution for people just like themselves They conceived of a new epinephrine delivery system that was truly "developed by patients, for patients®." They shaped their education to provide the skills needed, and together with their family and some initial financial supporters, they formed a company to make this a reality; and so Intellijject was born.	U Eric and Evan Edwards, allergy patients	E Co. Intellijject	2011 (FDA approved)	http://www.intellijject.com/2011/08/01/fda-tentatively-approves-intellijject-lead-product-e-cue/ http://www.healthcentral.com/allergy/c/3900/42426/edwards-intellijject

22. Hydrant 	Drinking aids solution, for people who are disabled, recovering from some operation or simply have difficulties to move.	Recovering from a back operation three years ago, Mark Moran couldn't reach his drink 3ft away. “My throat felt dreadful after all the tubes they'd used in theatre. I wanted frequent sips to cool my mouth, but the nurses were busy”. So his girlfriend Lisa brought in the device she used when he was running - basically a water-filled pouch kept in his backpack and with a flexible tube to drink from. Back home in Bristol, Mark, 47, decided the idea shouldn't be wasted, so last year he gave up his management job, remortgaged his house and developed the Hydrant - a sports bottle which delivers water through a flexible hose with a valve, and which is now used in the NHS and care homes.	U Mark Moran	E Co. Hydrate for health	2005	http://www.hydrateforhealth.co.uk/background.html http://www.dailymail.co.uk/health/article-1169807/The-mother-invention-The-amazing-array-health-aids-dreamt-patients.html
23. U-Flow 	Solution to measure urine flow accurately in men with prostate problems.	Doug Newton, a science and technology professor had been referred to hospital for urine flow tests. But he was put off by the huge (and expensive) computer monitoring system placed on top of the lavatory to monitor flow as he passed water. His consultant agreed, saying many men felt too nervous to give an accurate sample. So Doug, 63, from Durham, developed the Uflow, a clear plastic funnel with markings. Men urinate into it to see if they can fill it faster than it empties. The higher the urine rises in the device, the higher the speed of flow, indicating to doctors whether they need treatment.	U Doug Newton, patient		2010	http://www.mdti.co.uk/Male-Health/uflow.html http://www.dailymail.co.uk/health/article-1169807/The-mother-invention-The-amazing-array-health-aids-dreamt-patients.html http://www.nhsinnovationsnorth.org.uk/stories/details.asp?cTag=1013

24. Dignity commode 	A solution for people with limited mobility that after a stroke or accident have difficulty wiping after using the toilet.	When singer-musician Andy Speechley, 60, called in to see his old friend Peter Smith, he faced utter chaos. Partly paralyzed by a stroke a year earlier and struggling to climb the stairs, Pete had soiled himself but was determined not to face the indignity of having his daughter clean him up. The portable commode by his bed downstairs was simply a chair with a hole in it and an uncovered bucket below; the bathroom was upstairs. So Andy, from Halifax, developed a mobile bidet-commode, with a toilet seat which incorporates an electronically controlled shower nozzle.	U Andy Speechley, friend of patient		2010	http://dignitycommode.co.uk/ http://www.dailymail.co.uk/health/article-1169807/The-mother-invention-The-amazing-array-health-aids-dreamt-patients.html
25. Comfort Hand Pads 	Solution for patients who use crutches or walking frames and get hand sores.	When sales manager John Turner tore his Achilles tendon playing squash in 2001, he needed surgery and spent ten weeks on crutches. But he soon developed red sores on his hands from the pressure of supporting his weight. When, by chance, he got a job with a rehabilitation supplies company three years later, he realized he could invent something to help other patients.	U John Turner, crutches patient		2010	http://www.dailymail.co.uk/health/article-1169807/The-mother-invention-The-amazing-array-health-aids-dreamt-patients.html http://www.nrs-uk.co.uk/Products/3661/Comfort-Hand-Pads-Pair.html
26. Biffy Bidet	A solution for people with limited mobility that after a stroke or accident have difficulty wiping after using the toilet.	At a routine office visit in 1997, Dr. Smith asked the patient and his mother how the teen accomplished daily activities, including cleaning himself after bathroom use. The patient's mother said she had to wipe her son each time after he went to the bathroom, and if she wasn't around, he had to ask friends for help. Dr. Smith couldn't stop thinking about the indignation the boy must have felt every day. Always somewhat of a tinkerer, Dr. Smith hit his home workshop and started creating what became the first Biffy Bidet, an automated bidet system that attaches to the rim of the toilet and doesn't require full dexterity to use.	U Dr. Smith, doctor	E Co. American Biffy company	2000	http://www.ama-assn.org/amednews/2008/08/04/bisa0804.htm http://www.biffy.com/about/about-biffy/

27. PerfIC Cath (C3 iCath)	Solution for disabled people that now may catheterize themselves without help.	Dr. House, a quadriplegic at the age of 20 after he injured his spinal cord skiing, said he quickly realized there had to be a better way for people like him to catheterize themselves because the old catheterization systems "were engineered for procedures, not people." He invented the C3 iCath, a catheter that made it possible for patients without full dexterity to catheterize themselves. Dr. House said the device not only improved the lives of patients but also made things easier for nurses because it cut the procedure time down from 10 minutes to one. The device was also more sterile than previous methods.	U Dr. Glen House, patient, quadriplegic with limited finger dexterity	E Co. Adapta Medical	2008	http://www.adaptamedical.com/about http://www.ama-assn.org/amednews/2008/08/04/bisa0804.htm
28. Ortho-Glide	A saucer-shape disc with replaceable adhesive pads to help patients exercise during recovery. It improves circulation in the lower limbs and also helps to prevent DVT (Deep Vein Thrombosis).	Lying in his hospital bed in 2002 recovering from lower leg surgery Philip Hankin was frustrated by the physiotherapy devices that were on offer to speed his recovery. "I couldn't help but notice that the devices the hospital used for physiotherapy were old fashioned and cumbersome. They amounted to little more than a doughnut-shaped bandage and a lump of plywood."	U Phillip Hankin, patient	(lack of information)	2002	http://www.ideaconnection.com/invention-success/Ortho-Glide-00026.html
29. Seasonal Affective Disorder (SAD) and Light therapy	SAD, also known as the "winter blues" is a mood disorder, a form of depression which occurs during the winter months. SAD sufferers experience a myriad of symptoms that include insomnia, anxiety, lethargy, irritability and a craving for carbohydrates.	Herb Kern realized that he would get depressed during winter… and discovered that the reason was lack of natural light. He collected data during 15 years and contacted the NIMH, but was ignored. Dr Norm Rosenthal at NIMH (also a SAD patient) got interested in his case He validated the knowledge and named the disease. Later he suggested the light therapy.	U Herb Kern and dr.Rosenthal		1970 - 1984	http://www.infobarrel.com/The_causes_of_Seasonal_Affective_DisorderSAD

30. AutoMedic Pressure Relief Bed	Bed that helps to avoid bedsores.	About two years ago, David Jurus had what inventors call a flash of genius. The 73-year-old Oak Forest resident, who volunteers at a hospital, saw a patient he had befriended suffering terrible pain because of a common ailment – bedsores. So Jurus, decided to work on his project. "Inventors take a lot of flak, a lot of abuse, and some people call us crackpots," said the man who had previously created the Potty Caddie, a device to alleviate the odor common in household toilets. "I'm willing to put up with all that abuse if I can bring something socially redeeming, something great into the world." He calls his patented invention the AutoMedic Pressure Relief Bed.	U David Jurus, hospital volunteer	(lack of information)	1993	http://www.business-opportunities.biz/2009/12/11/inventor-eliminates-bedsores-with-new-hospital-bed/ http://www.freepatentsonline.com/5233712.html
31. Mechanical hand (Stark Hand) 	A prototype provides an ingenious, comfortable, and very inexpensive alternative to the hook for people without hands	The idea first came more than 20 years ago when Stark wanted to help his friend, Dave Vogt, who was using a hook prosthetic for a hand. "Me and my friends used to play cards and he (Vogt) said he couldn't play because he couldn't hold a hand of cards with the hook - I wanted to change that," Stark said."	U Mark Stark, a friend		2011	http://www.popsci.com/node/54124/ http://www.southcountytimes.com/Articles-i-2011-06-24-175737.114137-STARK-HAND.html