ABSTRACT
This paper looks at the emergence of Medicine 2.0, its key features and its use. Example medical applications utilizing a wide range of Web 2.0 technologies are presented together with consideration of the issues facing Medicine 2.0 and its potential for both formal and informal education of students, practitioners and the wider public.

KEY WORDS
Medicine 2.0, Web 2.0, Apomediation, Education

1. Introduction

The broad adoption of Web 2.0 technologies/approaches and the more recent emergence of Personal Health Application platforms and Personally Controlled Health Records (PCHR) are significant steps in the development of eHealth [1]. Mandl, Szolovits and Kohane [2] argue that these developments represent “tectonic shifts in the health information economy” with far-reaching consequences for patient involvement, as the gravity shifts away from health care providers as the sole custodian of medical data. As for education in other areas, Web 2.0 opens up the possibility for more flexible learning with respect to medicine and health including informal learning which results when anyone is able to participate and contribute.

The expectations of users have changed as well since the emergence of Web 2.0 applications and contributed towards changes in the architecture, appearance, usability, and spread of Web applications. Users expect the applications to be open and interoperable [1]. Open Web standards improve collaboration and communication across applications. Collaboration between users is especially popular in social networking approaches. Users can communicate with each other, connect to other users in the network, and can find helpful information. Finally, Web 2.0 technologies like AJAX improve the Web interfaces and transform web applications into desktop like applications with real-time responsiveness.

In September 2008, the first Medicine 2.0 Congress took place in Toronto, Canada. One of the goals of this congress was to introduce the idea behind the term, and also to encourage the participants to do more research in this new area of health informatics. Figure 1 presents a graphical framework for Medicine 2.0, developed at this congress, comprising five major aspects that have become apparent from Web 2.0 in combination with eHealth [1]:

1. Social Networking involving the explicit modelling of connections between people, forming complex networks of relations that in turn facilitate collaboration and collaborative filtering processes. The social networking approach enables: automated selection of relevant information; reputation and trust management; accountability and quality control; and fosters viral dissemination of information and application.

2. Participation is especially important for patients as consumers, but is also important for producers such as researchers and health specialists. The concept of participation involves opening up electronic health records for patients, known as Personal Health Records (PHR), so that they can access their data, a new and radical concept made possible through the growth of Internet technologies. Not only can PHR be used to support participation of patients with each other and health professionals, patients may choose to provide scientists with access to their data for research purposes, blurring the distinction between consumer and producer.

3. Apomediation is a term that characterizes an alternative to acquiring information from an intermediary such as a health professional or the use of disintermediation which involves bypassing the middleman to obtain the information yourself. A third approach is the Web 2.0 way, a special form of disintermediation referred to as apomediation. Apomediation uses approaches such as networked collaborative filtering to allow individuals to get information from a third party, for example, via medical databases connected to a search engine or via the use of social book-marking tools to find relevant articles based on the opinion of the users who saved and tagged
the bookmarks. However, there are also drawbacks in the apomediation approach. Eysenbach [1] states, that it “requires a cultural shift as well as strong incentives” to make it interesting for parties to contribute actively. For applications with this approach, the people have to see an immediate benefit for them as well finding the information trustworthy and secure, in order for them to participate.

4. Collaboration connects people together who have not yet or have insufficiently worked together in the past. This includes patients, healthcare workers, researchers and the public who can engage in debate over research issues. This collaboration for example is also useful to get better communication between both sides and to translate the knowledge to turn the research findings into practice.

5 Openness is the basic tenet of Web 2.0. Transparency, interoperability, open source and open interfaces are all philosophies that are mentioned and practiced in the Web 2.0 context. So for example the Personal Health Applications HealthVault and Google Health both have open Application Programming Interfaces (APIs) for other applications to connect to. Furthermore, the openness concept also enables access to research data (e.g. open data, open access journals) and even engages the public in the research process itself (open peer review).

The corners of the triangle in Figure 1 depict the three main user groups of Medicine 2.0, who are:

1. Consumer/patients,
2. Health professionals, and
3. Biomedical researchers.

The “formal” education and training of these users are different. However, the consumer/patients (end users) are recognized as teachers as well, because according to the philosophy of Web 2.0, their collective wisdom can and should be harnessed [1]: “The health professional is an expert in identifying disease, while the patient is an expert in experiencing it” [3].

The current Medicine 2.0 applications are situated somewhere in the triangle, depending on which user group is targeted. The goal of an ideal Medicine 2.0 application would be to connect different user groups and foster communication between them. This could be done by engaging the public in the biomedical process, for example. The result would be that the applications would move more towards the centre of the triangle [1].

Hughes, Joshi and Wareham [4] carried out an extensive literature review of Medicine 2.0. They concluded that there is a broader idea behind Medicine 2.0. In their opinion healthcare systems need to move away from hospital-based medicine, and should focus on promoting health, provide healthcare in people’s own homes, and empower consumers to take responsibility for their own health instead. Thus, Medicine 2.0 contributes towards a new and better health system, which focuses on collaboration, participation, apomediation, and openness, contrary to the traditional, hierarchical, closed structure within health care and medicine [4].

2. Medicine 2.0 Applications
The following section introduces some Medicine 2.0 applications that are currently available, many of which concern the education of medical students. However, we extend the notion of who is a learner to include not only formally enrolled students but also medical practitioners and the general public. The applications have been structured to cover a range of Web 2.0 technologies including: second life; user-based sites, wikis, communities, blogs, blog-carnivals, search engines and podcasts and videocasts.

2.1 Second Life
One interesting example for the use of Medicine 2.0 in Second Life is the Ann Myers Medical Center (AMMC) (see Figure 2). The centre was founded by Doctor Ann Buchanan to test the possibilities of virtual training for First Life medical and nursing students. The AMMC is designed to teach medical students to listen to their patients more closely. AMMC currently has several voluntary staff consisting of psychologists, hematologists, oncologists, radiologists, etc. The vision is to create an “open” medical arena for all to collaborate and learn [5].

![Figure 2. Case Presentation at the AMMC](image)
Another interesting example of Second Life using Medicine 2.0 is Gene Pool (see Fig 3). Gene Pool is a site, created by Prof. Max Chatnoir from the Texas Wesleyan Institute. He teaches classes in genetics with the help of simulated experiments that students can use to enhance their online class work. On the ground floor of the six storey high rise building a complete Watson-Crick DNA model is replicated showing the double helical structure of the DNA. The second floor contains some experiments showing the relationship between DNA to Proteins. On the third floor, students can see fruit flies and examine them under a microscope. However, the creator Chatnoir commented that “the experiments in the Gene Pool do not take the place of what students might experience in a lab class. The main value would be practice in data analysis. A real lab is never this cut and dried” [6].

Medical students are the target group of the last two examples. Other applications are designed to empower patients coping with their disease/disability. In 2006, Simon Stevens [7], a British disability consultant and trainer, created the first disability themed virtual nightclub in Second Life which is known as Wheelies (see Figure 4). Disabled and non disabled users can meet in this friendly environment and dance without fear of prejudice. Located right next to the nightclub is the Stevens Center for disability training. The whole philosophy of Wheelies is to demonstrate that the visitors are not disabled, but are differently abled. The user can do anything anyone else can do, just differently. As a result, there are volunteer escorts in Wheelies to assist users through the premises.

The virtual world includes: PubMed search; an artificial intelligence (AI) experiment with the “Healthy” chatbot who answers medical questions; virtual workshops on the evaluation of health information on the internet and trial access to EBSCO’s Consumer Health Database and to Reuters Consumer Health News accompanied with workshops on the Consumer Health Database. Future projects include a Second Life health directory.

2.2 User-based sites

User-based sites are basically web pages that are community driven. A lively community actively evolves knowledge as they collectively create and update content which can be followed by members of the community. Social Networks like MySpace or Facebook are popular user-based sites. Flickr, YouTube, or del.icio.us are further examples of the exponentially increasing number of user-based web sites.

A good example for a user-based site in the medical domain is SugarStats.com [9] (Figure 5). The system is a web-based blood sugar tracker and diabetes management system that was developed by diabetics for diabetics. The interface is completely web-based and can track, monitor and access users’ glucose levels and diabetic statistics in order to spot dangerous trends and to better manage diabetic health [9].

Figure 4. The Wheelies nightclub [7]

The Medical Library 2.0 at Health Info Island [8] is another example for a Medicine 2.0 application in Second Life. This virtual library is open to anyone. It was created by Namro Orman from the Central Medical Library of the University Medical Center Groningen, the Netherlands. The goal of the project was to make librarians and interested people work together to provide Library Services in Second Life. Specifically, the library offers displays, programs, and methods of access most libraries do not offer in real life spaces, but that patrons like and want or need, focused more on visual and audio exchange than on text. Experiments with innovative delivery of service can be done, while also exploring interactive possibilities between library & library staff and visitors.

Another community driven tool for patients is Traineo [10]. Traineo (Figure 6) is a weight loss community which combines a selection of weight loss tools and trackers with public profile pages, messaging and commenting. It is not a Facebook-style social network in the sense that the user can not add large numbers of friends. However, users can send a message and ask other users to add them to their contacts. The type of friendship can also be set up slightly differently: members can identify themselves as “motivators” and help others to achieve their goals. New motivators can be found by messaging users on the site or inviting friends via email. The site contains weight loss
tools too. These track the workouts, log the number of calories the member consumes (Traineo redirects to the USDA Food Database to get the calorific information) and plot the statistics on a graph. Other features include, for example, professionally written weight-loss articles and forums. On the profile pages there are commenting possibilities, RSS feeds and a progress meter that displays the weight loss.

Figure 6. Traineo Profile Page [10]

PimpNotes [11] is an open-source project for medical students and doctors in training. The site hosts free notes, guides, books, or any other materials created by and for medical students and residents. The site contains flash cards which are basically summaries of large texts that medical students have to read. The flash cards are created and edited from the medical students themselves to help them to put the large information that they are expected to learn into an easy-accessible format. It is possible to reduce a 30-page printed article into one flash card while communicating the same content and not losing important details. This format allows students to quickly trace every token of a disease, identify points to use intervention, and see clearer connections between the different aspects of medicine [11].

However, there are also issues with this kind of open, community driven structure. As Stephens [12] reports in his article “Will Technology Be New Media’s Legal Savior?” companies may try to sue the operator of Social Networking sites. Universal Music Group (UMG), the world’s largest music company, has taken on MySpace for copyright infringement of thousands of songs and videos as well as video sharing sites Grouper and Bolt. Similarly there are open legal suits against YouTube for the same reasons. The problem is that at the moment it is not clear who has the obligation to enforce the protection of copyrighted materials – copyright holders or web site owners. It is also uncertain if it is possible for a copyright owner to force sites to take down offending materials, or if the site owner has the responsibility to monitor and remove materials when she thinks they are offending. The problems with copyright issues could be a major drawback for medical systems seeking to be commercially viable.

Social network data is extremely sensitive. When people are being asked to disclose personal and sometimes intimate relationships it is natural for them to wonder what happens to these data and who has access to them. The privacy of every user must be ensured at any time. The accuracy of data has to be precise as well. Missing data can lead to wrong results. For example, it is crucial for a website like SugarStats to know all information about the patient. If only one fact is incorrect or missing, the site may come to a wrong conclusion which can be fatal for the user.

2.3 Medical wikis

Wikipedia created a portal called The Medicine Portal [13] (Figure 7). In this portal, users can get information on topics like anatomy, medical treatments, pharmacology, various diseases and disorders, and first aid tips. A section for physicians is available as well where there is information available about medical education and the different disciplines that students can study. A section for medical equipment shows which equipment is currently on the market for which kind of disease and shows how to use them.

Figure 7. Screenshot of The Medicine Portal [13]

In the portal, there are also wiki projects which encourage people to contribute articles to selected topics for example health and fitness, alternative medicine, or genetics. The medical projects have more than a hundred participants, and they maintain a collaboration that is refreshed every week with the aim to fill gaps in Wikipedia, to give users a focus and to improve an article even to featured level. It is also possible to rate medicine–related articles, which directly determines the main fields of work in the projects. Articles or fields with bad ratings get a higher priority to work on than articles with good ratings [14]. A similar concept to The Medicine Portal is a wiki called AskDrWiki [15] (Figure 8). AskDrWiki allows publishing articles, clinical notes, pearls, and medical images. The wiki is open, so anyone with a medical background can contribute or edit medical articles. Initially, the main focus has been on Cardiology and Electrophysiology, but they have started to expand to other specialties. AskDrWiki is a complete nonprofit educational website which is operated as a public service by the Open Access Medical Informatics Group [15].
The difference between the Medicine Portal and AskDrWiki is that the former is made for laypeople and the latter for physicians and medical students. This means that different levels of content are required. For example, a video of an angiography is not essential in a Wikipedia article but is appropriate for AskDrWiki.

Medical Wikis are especially useful for medical education. Students can write and review articles and learn more actively than just by reading their textbooks. The general public on the other hand can gain good information about their problems and can use it when consulting with a doctor. A potential problem with wikis is the reliability of the information it contains because a wiki is an open structure allowing anyone to edit articles. However, users can register to see changes in articles and can review them to improve the quality. In fact, wrong entries are very often corrected immediately, but still there is always the possibility that articles contain wrong information.

2.4 Communities

Online communities are groups that are interacting via the Internet. It does not necessarily have to be a group where there is a strong bond among the members. An email distribution list, for example may have hundreds of members and the communication taking place may be informational (questions and answers are posted), but members may remain relative strangers and the membership turnover rate could be high.

MDJunction [16] is an example of an online community (Figure 9). It is basically a meeting place for people with health challenges. People can give and receive help. MDJunction was initially founded in 2006 with only one support group and limited community features. In 2008, 630 Online Support Groups are within the site and each of these is dedicated to one health challenge. Categories include, amongst others, children’s health and parenting issues, men’s and women’s health, allergies, cancer, addiction, and infectious diseases. It was mainly created to fill a need for an online community of patients. Likeminded people can discuss their feelings, ask questions and share their hopes in order to get the needed information, comfort, support and friendship with people who have the same problems and therefore understand them best. Their motto is “People Helping People” [16]. Therefore, MDJunction created a community which is managed by the community, and strives to empower the members to lead, make a change and have a positive effect on their friends and fellow warriors. The core belief is that achievement is a crucial part on the way to recovery and a better life [17]. However, the site notes that MDJunction is not a replacement for traditional medical treatment.

Similar to MDJunction, the online community HealthBoards [18] contains over 150 message boards (Figure 10). Additionally HealthBoards offers a comprehensive Health Guide with valuable health information and health management tools. In the Health Guide users can choose the disease they are interested in to gain access to published articles, news, videos and Q&A section for the specific disease. A guide is available as well, where the affected patients can learn more about the symptoms, diagnosis, treatment, etc. The “Related to” section shows other diseases that have similar symptoms and links them directly to the main pages of these diseases.
For physicians and health care professionals, Tiromed [19] (Figure 11) is the first choice to connect with others. Tiromed is a free social networking, resource portal for physicians and students of medicine. Networking with colleagues, classmates, students, etc. is possible, as well as finding and sharing information. This information can be study guides, powerpoints, articles, or websites. The mission is to provide unique features and functionalities that allow members to research and learn, and connect with others in the same field [19].

2.5 Medical Blogs
Medical Blogs are simply blogs that provide content and express opinions on healthcare that are unlikely to be found in a medical paper. Patients as well as physicians have the chance to write in their own words about certain topics on healthcare.

Diabetes Mine [20] is a popular blog for people with diabetes (Figure 12). The author, Amy Tenderich, was diagnosed with Type 1 diabetes in May 2003 and in response began to write a blog about her life with diabetes. In her blog there is information of her own experience on every imaginable aspect of living with diabetes. From food scales to pharmaceutical news and book reviews, to the exasperating things that other people say about the disease. The blog covers all possible topics about diabetes. The author’s goal is to speak frankly about her experiences and furthermore encourage people with diabetes to take control of their disease [20].

Figure 12. Screenshot of Diabetes Mine [20]

Similar to Diabetes Mine, there are a lot of other personal blogs available from patients for patients such as: Chronicbabe: A blog for younger women with chronic health issues; TheFurryMonkey: A blog about living with Non Hodgkin’s Lymphoma; and FightPompe: A blog of a young boy suffering the Pompe Disease.

An interesting blog for physicians is Docinthemachine by MD Steven F Palter [21]. Palter is an internationally known pioneer in the translation of cutting edge high technology developments into surgical procedures and tools. In his blog he provides a unique perspective on new technology developments in medicine with a special focus on minimally invasive surgery, imaging, fertility, women’s health, and high tech innovations.

Other noteworthy physician blogs are: Emergiblog: The Life & Times of an ER Nurse; Eye on DNA: How will DNA change your life?; GrantDog: Ramblings of an Emergency Physician in Texas.

2.6 Blog Carnivals
A blog carnival can be seen as a blog event. There are similarities to magazines because blog carnivals are dedicated to a particular topic and are published regularly, weekly or monthly. A carnival is a form of a blog article that contains links to other blogs about the same topic. Blog carnivals are a way for bloggers to recognize each other’s efforts, to organize blog posts around important topics, and, most importantly, to improve the overall level of conversation in the blogosphere.

The big advantage of blog carnivals is that it saves time for interested users. They do not need to look through unrelated blogs and sites; they can just look at a carnival and see the best posts on a subject from time to time. Some examples of blog carnivals for medical topics are:

- Grand Rounds: A weekly rotating carnival of the best of the medical blogosphere.
- Mendel’s Garden: A carnival devoted to genetics.
- Gene Genie: Genes and genetic conditions are the topics of this carnival.
- BlogCarnival.com is a directory of carnivals listing many sites with medicine, health & fitness topics.

2.7 Medical Search Engines
The difference between a search engine like Google, or Yahoo and a medical search engine is that normal search engines do not select certain sources, which makes many of the medical search results irrelevant. The medical search engines however, use peer-reviewed sources and sites selected by experts and that provide the most relevant and reliable medical information of the best quality [22].

The following five medical search engines are, according to Boswell [23], the most useful to find medical information at the moment:

- OmniMedicalSearch.com: Search results are from 30 different sources, and it is possible to search up to 12 different medical search engines at one time. It is possible to set options to search only for news or images which then search only specific domains among the major search engines.
- WebMD.com: In addition to a search engine, WebMD includes interactive calculators, quizzes and other fun stuff to simplify the medical information.
- PubMed: Provides what is probably the most extensive medical search engine/database which is a service of the National Library of Medicine (USA). Currently there are over 15 million Medline articles and journal citations available, some are free to view, some are for purchase.
- Healthline: Healthline [24] (Figure 13) is very similar to WebMd and offers interactive tools and unique features like physician-filtered results and clustered “healthmaps”.
- HealthFinder: This site was put together by the US Department of Health and Human Services. The user can currently search through over 1500 health-related organizations.
Medical search engines offer better and more reliable search results than conventional search engines. The fact that these search engines only look at peer-reviewed articles and websites makes them trustworthy and offers a good instrument for people to find more information about their disease.

2.8 Medical Podcasts and Videocasts

Podcasts are downloadable audio files (videocasts are video files) that users can subscribe to and get regular updates when a new episode is released (usually weekly). Some examples of medical podcasts are:

- ACC Conservations with Experts: A podcast with the mission to advocate for quality cardiovascular care – through education, research promotion, development and application of standards and guidelines – and to influence health care policy.
- Journal of the American Medical Association: The editor in chief Catherine D. DeAngelis, MD, MPH, summarizes and comments on the issues of the current medical developments on a weekly basis.
- New England Journal of Medicine: A podcast version of its journal with interviews and article summaries of the current issue are offered.
- Lancet: A weekly medical journal which is renowned for the publication of high quality peer-reviewed research and reviews from around the world. In the weekly podcasts, the editors discuss highlights of the current issue, including interviews with authors of key articles.
- John Hopkins Medicine Podcast: The current top medical stories of the week are discussed in this podcast. The goal is to help people become informed participants in their own health care.

Examples of videocasts with medical topics are:

- National Institute of Health VideoCasting: This webpage is funded by the U.S. Department of Health & Human Services and broadcasts seminars, conferences or meetings in real-time streaming video.
- Cleveland Clinic Videocast: allowing observation of doctors, scientists and healthcare professionals advancing medicine.

The videos can also be recorded so that viewers can watch at their convenience on-demand or as a downloadable podcast.

3. Tensions of Medicine 2.0

Despite the numerous advantages that Web 2.0 has to offer for patients and health professionals, there are also drawbacks including: lack of a clear Medicine 2.0 definition; loss of control over information; information inaccuracy and ownership and privacy issues.

3.1. Lack of clear Medicine 2.0 definition

There is a lack of a clear Medicine 2.0 definition which results from the disagreement of researchers about what Web 2.0 is, and if it really exists. This is certainly an issue that concerns researchers but also has consequences for other parties [5]. Versel [25] claims that terms like Medicine 2.0 and Health 2.0 may be a fake “gold rush” because some studies have generated justification based on the number of participants and the number who recognized it as a concept. Giustini [26] argues that Web 3.0 applications will make some Web 2.0 applications such as social bookmarking redundant and irrelevant. However, it is expected that Medicine 2.0 tools will still be used by people, and the term Medicine 2.0 will be used in the future in an academic or international focus, while Health 2.0 is used for business and commercial audiences [4].

3.2 Loss of control over information

The second main issue with Medicine 2.0 concerns collaboration between doctors and patients. Doctors fear that their patients will be misled by the information they obtain via the Internet and they also predict that patients will change their behaviour through the use of Medicine 2.0, for example choosing not to consult a physician or consulting too late, or coming to wrong diagnosis even if the available information is correct. This results in a resistance of some doctors in their patients’ use of Medicine 2.0 and therefore a resistance of doctors to use these tools. This fear of loss of control is partly based on the lack of training in and awareness of Medicine 2.0 [4].

3.3 Information inaccuracy

Inaccurate information online and the potential risks associated are the third major tension in Medicine 2.0. Misinformation has always been seen as the biggest problem in eHealth [4]. However, the study by [27] argues that there is little support for this concern. A more recent study [28] determined that most information in an Internet-based cancer support group was accurate and that incorrect information was being corrected immediately. The concept of apomediation also contributes towards making increasingly better quality information available as apomediators act as filters and guide the consumer to the relevant information. Despite the results of these studies, there is ongoing resistance of practitioners and researchers and concerns regarding information inaccuracy in the Internet. The warning voiced within many Medicine 2.0 articles is that “consequences could be disastrous for any inexperienced trainee following the advice” and people should request clarification when authors suggest that Google could be used as a diagnostic tool [4].

3.4 Ownership and privacy issues

In addition to information accuracy, ethical, privacy, legal, and ownership issues arise due to the nature of health
information. Doctors that are using social networking sites for medical education and public debates are concerned with these issues too. Identity management and authorization schemes should therefore be researched as well [5]. Ferguson [29] believes that the patient groups that run specific sites should claim ownership of these data and use this information to influence research agendas.

4 Conclusions

The issues raised above are not peculiar to Medicine 2.0, but the need for solutions is greater due to the nature of the domain and the increased associated risks. Medicine 2.0 raises more issues than the controversial PHR because the focus goes beyond individual needs and rights to include the wider community, as seen in the PatientsLikeMe website aggregate community data and summaries of treatments and symptoms are provided. In a study of this site, Frost and Massagli [30] concluded, among expected concerns such as privacy, identity management, authorization and honesty, that design innovations are needed to promote data-centered patient conversation.

Medicine 2.0 as with Web 2.0 has changed the playing field. With Web 2.0 anyone, anywhere can author content and participate in a global learning community. From a 21st century classroom viewpoint it also means that the roles of teacher and student will be reversed and shared. Students may lead their teachers across the digital divide and teachers will lead their students to discern what information is relevant and trustworthy.

Medicine 2.0 offers medical students opportunities to explore and grapple with medical knowledge in a social, participatory, direct and open way with collaborators not previously accessible. Medical practitioners similarly are able to expand and disseminate their knowledge via interactions with their peers, access to powerful search engines and even through access to online patient data and discussion boards. More informally, patients can become purveyors of medical information and even best practices of treatment and even through access to online patient data and discussion boards. More informally, patients can become purveyors of medical information and even best practices of treatment and symptom management.

To ensure that Medicine 2.0 is used to its potential and not simply a passing fad, there is a need for medical research which goes beyond the laboratory and even beyond the clinic. While Web 2.0 phenomena such as FaceBook and Wikipedia have had major impacts, in general they have not raised life-threatening issues. When the same power is made available in the field of medicine, the need to address issues such as trust, authority, privacy, information accuracy and ownership become imperative. Understanding some of the applications already available and the impact they currently have and may have, as provided in this paper, is a first step in raising awareness of these issues.

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1 Note all URLS viewed viewed 16/12/2008