INTRODUCTION
In the past century, medical care in the Western world has evolved tremendously. While in the early 1900s, healthcare was mostly a private affair, it has now become a major expense for all developed nations. Complex structures have emerged: modern-day healthcare professionals now evolve in highly diverse environments ranging from small private clinics to highly specialized teaching hospitals. With the rising costs of healthcare and the rapidly increasing demand for healthcare services, governments need to find new ways to render the delivery of healthcare services more cost-effective without compromising the quality of care or patient and healthcare worker satisfaction. The challenge is superb; obstacles are numerous and solutions are often complex.

In recent years, many commissions and reports have strived to explore these obstacles and solutions. In Canada, the Final Report on the State of the Healthcare System (1), published in 2004, is one of many “medicalization” reports that address the rigidity of healthcare structures and scope-of-practice rules—the rules defining which tasks different categories of healthcare professionals are permitted to perform—represents an ominous barrier to increasing productivity in healthcare. Another important Canadian report published in 2002, the Romanow Report (2), also highlights the need for change in the way healthcare services are delivered. By placing a special emphasis on “collaborative teams and networks of providers” the Romanow Report suggests that “traditional scopes of practice need to change [thereby suggesting] new roles for nurses, family physicians, pharmacists, case managers and a host of new and emerging health professions.” While a certain number of studies have shown that a growing number of physicians (especially primary care doctors) are very receptive to the idea of sharing part of their responsibilities with their fellow healthcare professionals (3, 4, 5), many others, often in fear of losing some of their autonomy, exclusivity and prestige are still reluctant to support initiatives aiming to restrict or redefine the scope of their practice (6).

In order to increase cost-efficiency in healthcare, the taboo surrounding physicians’ rigid scope-of-practice should be broken; this would promote a stronger and more integrated multidisciplinary approach to medicine. The evidence supporting this thesis is growing at a breathtaking pace and revolves around five main themes. First, alterations to scope-of-practice rules fall into the very promising realm of catalytic innovations. Second, the redefinition of roles for healthcare practitioners—with a special emphasis on doctors, nurses and pharmacists—allows for better patient and healthcare practitioner satisfaction and improved healthcare resource utilization. Third, a new generation of physician assistants can successfully help address the issue of rising healthcare costs. Fourth, smartly organized multidisciplinary teams can lead to better outcomes and resource utilization in healthcare. Finally, a certain number of compelling examples from the literature illustrate how multidisciplinary approaches have a high potential for encouraging better cost-effectiveness in healthcare.

Catalytic Innovations and Alteration of Scope-of-Practice Rules
Thanks to advances in technology, medical research is now able to target such complex issues as heart transplants, gene therapy and robotic microscopic surgery. Because of the impressive amounts of human and material resources involved in such “high-end, high-tech” innovative techniques, catalytic innovations tend to increase rather than decrease the costs of medical care (7). In an article published in the Harvard Business Review, Clayton M. Christensen, one of America’s most influential business thinkers and writers, describes such innovations as “sustaining innovation” (7). In his opinion, sustaining innovations are necessary to solve complex medical problems affecting small groups of patients in specialized medical clinics, but they do not lead to decreases in medical costs. Christensen also goes a step further in affirming that in most developed countries, the omnipresence of sustaining innovations has led to the maintenance of the status quo by way of an excessive amount of resources being allocated to organizations that are “wedded in their current solutions, delivery models and recipients” (8).

In an interview with Mark D. Smith (9), Christensen describes another category of innovations: disruptive innovations. Contrarily to sustaining innovations, disruptive technologies or services are available at much more affordable prices than existing alternatives. They “disrupt” the market by changing the approach to a problem and by bypassing more complex alternate solutions. They also allow the opening of a whole new market formed by purchasers who traditionally could not afford such products and innovations. In the same interview, Christensen depicts a third category of innovations—catalytic innovations—which he describes as being even more beneficial than disruptive innovations in the context of modern day healthcare. This third category of breakthroughs not only lowers the prices of products or services, but also focuses on bringing social change through scaling and replication (9). By making changes to rigid scope-of-practice rules, healthcare systems have the opportunity of creating a great number of catalytic innovations. For example, by allowing nurses or other healthcare practitioners to conduct a certain number of simple and highly reproducible medical acts that were traditionally completed by doctors, clinics can allow patients to be treated at lower costs while avoiding long waits. Yet, this perspective glosses over the possibility that patients might receive healthcare services of an inferior quality due to the fact that the healthcare professionals who are providing them do not have the same level of training as physicians. However, in a North American context of limited resources where no less than 25% of doctors willingly affirm that their scope-of-practice is too wide (5), such catalytic innovations should definitely be considered as a promising avenue for addressing some of the most complex issues in healthcare.

ReDefining the Roles of Healthcare Practitioners
In the past few decades, with the progressive lengthening of life expectancies and an on-going “medicalization” of society (10), healthcare practitioners—and especially doctors—have been brought to play wider and wider roles in the lives of individuals. As mentioned above, this has led to important discrepancies between what healthcare professionals think their scope-of-practice should comprise of and what their workload actually consists of. To illustrate this point, an article which was recently published in the American Journal of Health Affairs (3), maintains that American doctors, if asked the question: “what percentage of your time do you perform functions that require a medical degree?” would most likely provide a figure neighbouring 50%. Building on this example, let’s now further analyze how scope-of-practice issues specifically impact the work of four groups of key players of the healthcare workforce: physicians, nurses, pharmacists and other healthcare professionals.

Doctors
Acknowledging the fact that physicians are highly trained professionals, and that they are one of the most important healthcare expenses for most industrialized nations (11, 12), there is no doubt that their time should be used wisely and that their practice should focus on what they do best. There appears to be a consensus in the medical literature regarding the fact that where physician attention is the most essential is in the treatment, diagnosis and management of complex medical issues (7). Who other than highly trained specialists or experienced family physicians would be able to finally arrive to a diagnosis and effectively treat a rare congenital disorder bringing subtle changes in a long followed patient’s health?

However, this simplified view of what physicians should be responsible for fails to take into account that there are many levels of specialization inside the medical profession itself. While general practitioners and medical specialists might at first glance be assumed to work in collaboration—referring patients to one another when issues are either too broad or too specialized for their scope-of-prac-
As family, adult, paediatric, gerontologic, women’s education, nurse practitioners can be defined as a step in the management of a patient’s illness (5). Before moving on to redefine the scope-of-practice rules for nurses, pharmacists and other healthcare professionals, it is important to keep in mind that the medical profession itself has a highly varied array of members, each possessing different skills and levels of expertise. Thus, elaboration of a strong stepped-care approach, where the right patients are directed to the right physicians for optimal healthcare, accompanied by the installation of adequate financial incentives for doctors to follow this approach, might very well be the necessary first step to any healthcare reform aiming to address scope-of-practice redefinition (5).

NURSES

While the diagnosis of medical conditions has traditionally been thought of as the most important aspect of a doctor’s practice, there is a growing body of evidence showing that simpler illnesses presenting with an easily identifiable pattern and consistent clinical findings can be managed very efficiently by nurses without the need for doctors to intervene directly (13). In fact, healthcare teams in which registered nurses work independently, yet in tight collaboration with practising physicians, have not only been reported to provide adequate health-care services and diagnoses to patients; they have also been shown to be associated with equal or increased levels of patient satisfaction, with no significant differences in clinical outcomes. Most importantly, these teams also yield the promise of improved cost-efficiency allowing for more medical acts to be performed by lower paid professionals (4).

Whereas doctors are often thought of as the ones who treat patients, nurses are often considered as the ones responsible for caring for patients. This observation is usually correct, since doctors are often thought of as programs reforming nurses’ scope-of-practice rules and advanced nursing training programs for decreasing healthcare costs is all too often ignored. PHARMACISTS

Most North American pharmacists work in the private sector, often owning or co-owning their own pharmacy. For many patients, doctors, nurses and other healthcare practitioners, this has led to the idea that pharmacists are not necessarily considered integral members of multidisciplinary healthcare teams (6). However, a converging body of recent publications has shown that increasing the degree of involvement of pharmacists in patient care yields tremendous potential. Whether they act as individual outpatient physicians, managers or as part of multidisciplinary inpatient teams, pharmacists can most definitely represent a very valuable resource in an environment where pharmaceutical products are becoming increasingly diverse and more difficult to understand.

When working in tight collaboration with physicians, pharmacists can allow for a much more comprehensive and cost-effective way of prescribing pharmaceutical products. In fact, in settings where pharmacists have successfully been integrated in family healthcare teams, doctors report an improved availability of easy-to-interpret [...] drug information, an advantageous access to fresh perspectives regarding new and competing pharmaceutical products, more confidence about prescribing medications and more productive work relationships with pharmacists”(6). Furthermore, from the patient’s standpoint, this has allowed major improvements in patient education through ways of a facilitated access to high quality drug-related information.

In two separate American studies observing the effects of integrating pharmacists in the care of patients with type 2 diabetes mellitus and chronic hypertension, pharmacists have been shown to lead the dramatic improvements in their patients’ medication regimen. As a result, the integration of pharmacotherapy, better self-management of illness, improved reinforcement of screening for medical complications and better patient follow-up (16, 17). Also, in cases where pharmacists were involved in patient care they have been proven to allow better glycemic control, more sustainable lifestyle modifications and greater decreases in systolic blood pressure than in cases where patients with chronic illnesses were cared for following a traditional physician-managed approach. Once again, as it was the case for nurses, all of these results have been obtained with a high potential for significant cost reductions and improved overall cost-effectiveness.

In light of these benefits, one might wonder why systematic reforms aiming to fully integrate pharmacists in healthcare teams haven’t yet been undertaken. Once again, as it was the case for nurses, resistance from physician associations, which hesitate to disrupt the existing status quo, and the lack of appropriate financial incentives seem to be the major obstacles (6). One of the most commonly mentioned arguments relates to the increased time required for physicians to interact with pharmacists on a regular basis. As one might readily predict, this argument loses much of its significance once a short period of adaptation has been completed.

OTHER HEALTHCARE PROFESSIONALS

The new generation of well-trained and efficient administrative staff in assuring the effective functioning of healthcare institutions, these new healthcare professionals, they contribute substantially to making their workplaces more effective. Taking into account the numerous changes brought about in the healthcare system, many tasks were received as very cumbersome tasks for other healthcare professionals (3), they should be more readily considered by their peers as essential members of a well-cited medical team. A NEW GENERATION OF PHYSICIAN ASSISTANTS

In the US and in an increasing number of OECD countries, a new generation of healthcare professionals has recently made its entrance on
the healthcare market and is being considered by many as a very appealing solution for addressing cost-efficiency issues in healthcare in the context of limited financial resources. These professionals, most commonly referred to as physician assistants, first entered the American medical system in the late 1960s.

Physician assistants, with their intermediate status, which places them somewhere in between doctors and nurses, have many advantages. Mainly, they allow palliating for an increased need for healthcare resources by taking over some of the tasks that were traditionally performed by sleep-eyed junior doctors, overwhelmed primary care physicians or overworked nurses (19). In the early 2000s, there were close to 50,000 fully trained physician assistants in the US. Thanks to favourable governmental incentives and to the emergence of more and more specialized education programs across the country, this number is rising consistent from year to year.

Most commonly, physician assistant degrees consist of 2 years of graduate university education training following a previous degree, most commonly in the area of biomedical sciences, physical therapy or occupational therapy. Students usually enter the program with a strong GPA, certain amounts of clinical work experience and strong interpersonal skills (20). In 2007, there were 136 state-recognized physician assistant programs in the US, 76% of them were at the master’s level and only 18% were considered a broad-based “condensed medical degree” while the remaining 24% of the programs offered doctoral or physician assistant training specializing in a certain medical domain.

In the US, physician assistants usually work under the close supervision of fully certified physicians. While many of their tasks can overlap with nurses’ job descriptions, they are usually not assigned to continuous patient care on hospital wards. Rather, their tasks are primarily directed towards providing specific medications, suturing, applying bandages, completing full physical examinations, making diagnoses, and doing rounds in nursing homes (20).

The results of physician assistant implementation in healthcare teams have been extremely promising throughout the world in all or most countries where they are present (19). In the UK, a small team of physician assistants has successfully provided a large number of patients with similar quality healthcare services as residents and doctors. When asked, patients reported that they were highly satisfied with the attention they had received and were impressed by the empathy with which their healthcare providers had treated them. In addition, the doctors working with the team of physician assistants reported excellent professional interrelations with the new staff members. This comes from the fact that teams comprising nurses, social workers and dietitians allow for patients to meet with healthcare professionals in a different setting than in a doctor’s office, where they are more likely to understand and initiate meaningful lifestyle changes essential to the management of their medical conditions. This will often allow them to manage their illness without needing to consult a doctor on a regular basis, thus avoiding considerable healthcare expenses (9).

Finally, one of the most important aspects of multidisciplinary care comes from the fact that it allows the elaboration of more comprehensive and efficient case management plans for patients. By definition, case management represents a “collaborative process that assesses, plans, implements, coordinates, monitors, and evaluates the options and services required to meet an individual’s health needs, using communications and available resources to promote quality and cost-effective outcomes” (17). For instance, these “communications and available resources”, sometimes referred to as telehealth interventions, comprise such practices as telemedical check-ups, phone counseling, email exchanges and web-based healthcare services, all of which can be delivered effectively by more than one member of healthcare teams. The number of studies assessing the cost-efficiency of intensive case management is still very limited. Nevertheless, a fair number of trials have suggested that when patients are taken in charge by a multi-tiered team, they are much more likely to stay away from acute medical situations, thus saving the medical system considerable amounts of healthcare resources (4, 18).

POTENTIAL HURDLES

Multidisciplinary approaches to healthcare can also present certain drawbacks, a significant number of which have been reported on many occasions in the medical literature and the object of which is beyond the scope of this article. In fact, all of the above-mentioned advantages of team-based practice cannot be obtained without overcoming a significant number of hurdles. Most importantly, individual physician and physician association approval needs to be obtained before any major changes to healthcare systems and organizations can be made. When it comes to changes of this nature, doctors have traditionally adopted a very conservative mentality and usually request considerable amounts of “rock-hard” data before even envisioning undertaking major shifts in their practices (22). Furthermore, the risks of obtaining suboptimal results and thus eroding the potential of catalytic multidisciplinary healthcare reforms and innovations. In North America alone, many states and provinces have made clear moves to support the implementation of multidisciplinary approaches or have clearly underlined the need for a redefinition of scope-of-practice rules (1, 2). Many states and provinces have made clear moves to support the implementation of multidisciplinary approaches or have clearly underlined the need for a redefinition of scope-of-practice rules (1, 2). These teams, created by independent groups of healthcare practitioners since the beginning of the 2000s, have received numerous incentives and generous support from their provincial government initiatives, seeking to transform primary healthcare for its citizens, the Ministry of Health of Ontario has created a vision allowing physicians, nurse practitioners and other members of the team to practice in a productive working environment where cooperation and knowledge exchange are extremely important. Among other roles, Family
Health Teams are meant to promote disease management programs for chronic illnesses, self-care programs, health promotion, patient-centered care and facilitated navigation and care coordination for patients seeking services in multiple healthcare institutions.

Although the implementation of Family Health Teams in Ontario has been welcomed almost unanimously by citizens and healthcare practitioners, there still exists an important gap between the reality of practicing in a team-based setting and what is taught to medical and nursing students in Ontario medical and nursing schools (24). Hence, even though they are extremely promising, multidisciplinary approaches to medicine need not only be implemented on the field; they also need to be accompanied by pertinent reforms in healthcare education in order to ensure that the new generation of workers will be better equipped to deal with the new challenges of team-based practice.

MINUTE CLINICS

In the US, a very popular example of how scope-of-practice rules have been changed in order to provide patients with more affordable and convenient healthcare services is the advent of so-called “Minute Clinics” (21). These clinics are run entirely by nurse practitioners who use software-based protocols in order to offer vaccinations and basic medical attention for a limited set of health problems. If a patient presents with an illness that is beyond the nurse’s expertise, he or she is immediately referred to a doctor’s office or emergency room.

Many factors can explain the booming success of this catalytic innovation which has successfully reformed scope-of-practice rules for nurses in the US. First, Minute Clinics offer cheaper, quicker and more accessible healthcare for a great number of illnesses allowing patients to avoid more costly emergency room. She is immediately referred to a doctor’s office or emergency room.

KAYSER PERMANENTE

A recent article published in The Economist, entitled Another American Way, draws an extremely flattering picture of Kaiser Permanente, an integrated American healthcare firm which offers managed care packages to 8.6 million Americans via highly efficient primary healthcare teams (25). Each team follows a group-practice model composed of 3 to 5 clinicians (physicians, nurse practitioners or physicians assistants), 2 to 7 registered practical nurses or medical assistants that provide care to a sample of 8000 to 15 000 patients (22). One of Kayser Permanente’s biggest strengths is that it offers all of its employee’s a comprehensive training in team-oriented care prior to their first day of work. Also, teams have the freedom to adapt to the needs and conditions of their patient population. For instance, a team can decide to hire more or less physicians, more non-physician clinicians or more support staff depending on the patterns of care contracted by the population it serves. In addition, each primary healthcare team receives a thorough report of its activities every three months, outlining patient and staff satisfaction as well as clinical outcomes. Monetary incentives and feedback are then provided by Kayser Permanente’s headquarters with the effect of promoting constant progress and improvement among healthcare teams.

CONCLUSION

Considering the size of the challenge of controlling healthcare expenses in a context of growing healthcare needs and aging demographics, the application of new ways to improve the cost-effectiveness of healthcare systems is essential. One of the most promising avenues suggests that doctors should be encouraged to review the rules regulating the scope of their practice in order to promote a stronger multidisciplinary approach to healthcare. In order for this solution to yield the most effective results, healthcare institutions should follow the model of catalytic innovations, a model encouraging both simpler and more affordable solutions with a special emphasis on social change. In addition, scope-of-practice reform should be passed beyond its definition as a regulatory effort, they should extend to all healthcare practitioners. Also, the potential benefits of training a new generation of physician assistants should be acknowledged. All of these elements have the potential of giving rise to an efficient and visionary multidisciplinary approach to healthcare. Based on the large number of positive accounts taken from the medical literature, reforms that follow the idea of multidisciplinary approaches to healthcare should definitely be undertaken: the benefits of such enterprises seem to widely out-measure the potential obstacles and hurdles which might affect their implementation.

At this point on the road, one might wonder: Where to start? What should be the next big step? Who is responsible? A recent registered nurses’ survey showed that the healthcare systems to the realities of the 21st century, the answer to these questions might very well lie in the hands of those who are in the best position to implement change in the years to come: students. If medical and nursing students become aware of the potential benefits of redefining the scope of their practice and breaking the taboo which has traditionally surrounded the matter, they might just become the much needed vectors of change capable of increasing the cost-efficiency of 21st century healthcare.

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The Canadian Space Agency (CSA), via its Space Learning Program offers a bevy of opportunities that Canadian university students may wish to leverage.

Through the Space Learning Grants Program, the CSA provides funding to upwards of 200 students each year – the majority being undergraduate and graduate students – which supports their participation in space-focused learning initiatives. This grant program, designed to assist students with funds to help cover travel, registration and living expenses, is open to students from primary school right up to the doctorate level, so long as the student is either a Canadian citizen or permanent resident of Canada.

Over the past year, funding awarded through this program has allowed students to participate in a wide variety of initiatives covering an array of fascinating disciplines - from an annual Aerospace Medical Association Meeting, and international Lunabotics competitions to Solar-Terrestrial science conferences.

While individual requests for funding can be submitted and considered, budget-permitting, on an ad-hoc basis year-round, there are also two opportunities both earmarked and funded through this program on an annual basis.

The first is the International Astronautical Congress (IAC) – the largest annual international space conference. Each year in September, students are asked to submit abstracts to the CSA on relevant conference topics that will also allow them to highlight their research at the congress. Each abstract undergoes an internal evaluation by CSA scientists, engineers and medical professionals with those achieving the highest rankings forwarded to the International Astronautical Federation (IAF) – the organization responsible for the IAC - for final selection. In 2011, close to 60 abstracts were submitted for consideration to be included at the congress in Cape Town, South Africa, with 21 Canadian students ultimately being selected for funding by the Canadian Space Agency to share their work with the conference delegation of international space professionals and other students. For anyone interested in applying to the 2012 edition of IAC, to be held in Naples, Italy, information on the application process will be posted on the student (17+) section of the CSA web site in the late fall.

A second learning opportunity funded by the CSA is the NASA Academy summer program. NASA Academy provides students at the upper undergraduate or early graduate levels with an opportunity to spend 10 weeks paired with a researcher at one of the NASA centres. Students selected to participate are given the extraordinary opportunity to conduct space research with an experienced researcher in addition to developing their own group project with fellow students.

NASA Academy participants are treated to a wonderful introduction to the space field through a series of presentations, meetings and visits at the various NASA centres across the United States. In the past two years, two McGill students have been selected through this competitive process - Medical student Laura Drudi in 2010 and Atmospheric Science student Alexandra Anderson-Frey for the summer of 2011. Information for those interested in applying to the 2012 NASA Academy will also be available via the student section of the CSA web site in the fall.

Finally, the My Research section of the CSA website profiles the next generation of space leaders, providing a showcase for students involved in space-related research. The profiles

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