COMMENTARY

Global Climate Change
The Interconnection with Medical Technology and Health Care

WILLIAM H. SAITO
KIYOSHI KUROKAWA

Throughout history, examples abound of technology that was developed with good intentions but led to unintended consequences. The development of subatomic particle theories, for instance, paved the way for nuclear weapons, thalidomide, X-rays, automobiles, the discovery and proliferation of fossil fuels, dynamite, and even the Internet. Of course, these discoveries and developments have been invaluable in aiding global progress; yet had the expected risks been forecast at the start, might some of these advances have been approached with more caution? The same dilemma can be seen in the advancement of medical technology and healthcare in recent centuries: it has created a mélange of beneficial results and unintended consequences.

Advances in medicine and other forms of technology have played a key role in reducing infant mortality and increasing longevity. But this has contributed to overpopulation, which in turn has resulted in excessive pollution and resource consumption. As the earth gradually heats up and the climate becomes increasingly volatile, there is a growing consensus amongst scientists that these changes are anthropogenic. Indeed, as Thomas Friedman has pointed out, we live in a new era that is "hot, flat and crowded." Climate change is now reaching a stage where it is creating its own health risks. These problems provide an impetus for medical technology to keep track of and solve the problems it helped create. With the spread of disease and the threat of famine, malnutrition and displacement become more acute.

The global community thus finds itself at a turning point in history: it is struggling to find ways for medicine to join the fight against climate change.

Efforts to mitigate climate change have been evident in recent years in the Kyoto Protocol, the Rio Earth Summit, the United Nations Framework Convention on Climate Change (UNFCCC), and most recently, in the disappointing outcome of the 15th Conference of the Parties (COP15). Despite dramatically differing views regarding Copenhagen, the summit's message was clear: climate change and the necessary interventions to slow it down remain one of the most fiercely contested topics facing the planet. While climate change is a global dilemma, different nations share varying degrees of responsibility for creating the problem and face different implications in the short- and medium-term.

Population Growth

After many centuries of nominal growth, the human population reached 500 million around the year 1500, and 1.6 billion a century ago. Now the figure lies at well over 6 billion. It is expected to stabilize at 9 billion by 2050 if we continue with business as usual. Revolutions in technology, including those in medicine, have played a pivotal role in this rapid population increase, which is currently measured at 200,000 people per day. Medicine now faces the challenge of keeping up with the attendant effects on the global population.

In Ancient Rome, the center of civilization two millennia ago, the average life expectancy at birth was only 25 years. Many children did not survive

William Saito, MD is a fellow of the National Graduate Institute for Policy Studies (GRIPS) and a distinguished expert in the areas of information communication technologies and information technology security.

Kiyoshi Kurokawa, MD is a fellow at the Graduate Institute for Policy Studies and Professor Emeritus of the University of Tokyo. He is also an Adjunct Senior Scientist at the Earth Institute, Columbia University.

beyond the age of five. (These figures are roughly equivalent to many areas of Africa today.) Nutrition and infectious diseases presented major problems. It would take almost 2000 years to achieve an additional 15 years of life expectancy. Around 100 years ago, in the U.S., the UK, and other developed countries, it reached 40 to 45 years. But now, just a century later, the life expectancy has reached 80 years, a truly staggering achievement. In the developed world, medical progress has contributed to a gradual stabilization of the population growth rate: by 2050, the population is likely to remain relatively unchanged from the current figure of 1.2 billion. Conversely, the developing world, which lacks all the recent medical technology available in the developed world, is still experiencing massive population growth, forecast to rise from 5.2 billion to around 7.8 billion by 2050.

Judging by such figures, it is not surprising that, if graphed from the 1700s to the present, population growth, CO_2 concentration, and average surface temperature all have similarly rising slopes. Today, we have developed countries that produce, on average, 20 tons per year of carbon per capita and developing countries that produce 0.1 tons per capita.

The population growth rate in the developed countries is gradually decreasing, a promising indication that we have completed the demographic transition. This reflects a decline in the global total fertility rate (TFR), which now stands at 2.5 children, not far above the replacement fertility rate of 2.1 children. And yet, while this figure would suggest a promising decline in overall TFR, it is largely due to the high rates of infant mortality in the least developed countries, which are 17 times higher than for the more developed countries. High birth rates in the least developed countries will keep the population growing at an astounding rate, as the overall population is estimated to increase by 2.6 billion by mid-century. In many parts of Africa, TFR can still be as high as seven, with no prospect of decline if we continue along our current trajectory. Research has shown that when the TFR exceeds five, the population roughly doubles with each generation. Although the population growth rate of those countries that are consuming the most is gradually declining, the ones who will feel the effects most acutely are the developing countries that continue to grow at increasing rates. These countries will be a potentially destabilizing force in the global community.

Of course, not all developing countries have high TFR. Iran, Cuba, Thailand, and Mauritius, for instance, have all experienced dramatic drops in fertility as a result of improved access to family planning and contraceptives. But this is precisely the point: unless we invest more in the key areas of family planning and fund research into new ways for medical technology to respond to infant mortality and high TFR, the planet is heading for catastrophe. Much could be done to lower Africa's TFR simply by widening access to contraception: 25 percent of pregnancies are reported as being unwanted. Organizations such as the Bill and Melinda Gates Foundation work to popularize the idea advocated by the demographic transition theory that lowering infant mortality will, despite whispered fears that it would cause a population explosion, ultimately result in a population decline, as the developed world has demonstrated. As Melinda Gates stated in a recent *Newsweek* article: "Women will naturally have fewer children if they know their kids have a greater chance of survival." Saving children's lives is not only conducive to, but arguably essential for an accelerated reduction in TFR. Therefore, an approach that combines education on family planning with improved access to medical technologies will help reduce infant mortality and accelerate the demographic transition. This is the most expedient way for slowing down the population growth rate in the world's poorest regions.

But there is another side to the climate change problem. Each year, the richest seven percent of the world's population produces approximately 20 tons of carbon per capita. That constitutes a staggering 50 percent of CO_2 emissions. Meanwhile, the poorest 50 percent of the world population only produce seven percent of total emissions. The United States, with just five percent of the global population, is responsible for around a quarter of the world's emissions. We are clearly faced not only with an overpopulation problem, but also an over-consumption problem. The solution to this requires a combination of responses: a reevaluation of population trends; development of sustainable technologies; and a change in lifestyles.

This will become a more pressing issue as the

least developed third of the world's population, currently responsible for a miniscule 2.8 percent of total emissions, continues to grow at a rapid rate. To deny the same opportunities for growth to such countries as were given to the developed world would of course be impossible and horribly unjust. The global community has a responsibility to fund research into new and alternative technologies which will allow developing countries to move forward without the planet paying the price. This is particularly important when considering that few developing countries will be able to afford more energy-efficient technologies.

These issues are of central concern to Asian countries. The region is coming to play a central role in the world economy. At the same time, it is home to 57 percent of the world's population. Investing in new technologies and adopting alternative lifestyles in this region is becoming more crucial than ever.

The problem does not end there, however. Matters are made more complex by the fact that the effects of climate change, which are primarily caused by Western countries, are felt most acutely in the developing world. In the near future, temperatures are likely to rise most rapidly in the arid areas of northern Pakistan, India and western China, which would have catastrophic consequences for agriculture and livelihoods. This does not even consider the sociopolitical implications, as desperation potentially leads to a tipping of the balance in what is already a vulnerable region. Malnutrition, disease transmission, and a host of other medical and health related problems would also result.

Meanwhile, the rise in the global sea level, predicted to reach 16 cm by 2030 and 50 cm by 2070, will also have devastating effects. An estimated 75 million to 150 million people would be displaced in the Asia-Pacific region alone. Most at risk are the low-lying river deltas of Bangladesh, India, Vietnam, and China, as well as the small Pacific island states. Again, sociopolitical tensions will exacerbate the medical and health related problems caused by such a geological transition.

Advances in medical technology are partly responsible for our current problems, as overpopulation has led to overconsumption in conjunction with climate change. But the toll that this is taking on the planet will only increase the pressure on healthcare and medicine to develop new solutions before overpopulation outstrips its capacity for action.

The good news is that humanity has proven itself to be a large enough presence on the planet to exert an independent effect on the climate. As evolutionary biologist Edward O. Wilson has put it: "Humanity is the first species to become a geophysical force." Humanity may have created this mess, but that also means that it can, and must, resolve it.

So we are not necessarily doomed for a Malthusian disaster. But to avert it, we have to identify specific factors that have contributed to overpopulation. In regard to medical technology, it is possible to identify two key arguments: the first relates to the gradual reduction in infant mortality, and the second to the increase in life expectancy and general health.

The premise of the first argument is that lower infant mortality will result in more babies. Such an argument may appear to contradict the point made earlier about the correlation between lower infant mortality and *lower* TFR. In reality, when infant mortality declines, it takes time for TFR to follow suit. In the "baby-boom" period, which the developed world experienced in the 19th and early 20th centuries, technological progress led to rapid population growth. This was followed by a gradual slowdown in population growth between 1950 and 2005, when a mere 400 million people were added to the global population by developed countries. By comparison, 3.5 billion people were added by the developing world during that period. So while the population of the developed world is beginning to level out, the developing world is still waiting to follow a similar trajectory. The developed world has essentially come full circle, but the developing world is only halfway there. Therefore, the net effect of technological progress has been a surge in global population, from 900 million in 1800 to over 6 billion today. Sooner or later, the TFR of the developing world will catch up with the developed world: the infant mortality rate has already dropped from 105 (per 1,000 born) in 1990 to 88 in 2003. But given the state of our planet, this demographic transition must be accelerated. Part of the solution lies in medical technology.

Medical Advances

Medical technology – most notably hygiene, medical care, and disease treatment – has increased life expectancy and improved health. As a result, countries such as Japan that once struggled with high population growth and fertility rates are now confronted with an aging population. It took a mere 25 years for Japan to double the percentage of the population over 65, from just over 7 percent in 1970 to 14 percent by 1994. If this shift is compared with that of France, which took 115 years for the same process, the implications are striking. By 2007, a report by the UN Department of Economic and Social Affairs placed the percentage of elderly people in the Japanese population at 27.9 percent, which is the highest in the world. Japan's experience looks set to become a trend in other countries - the growth of the elderly population in South Korea is set to outpace Japan.

Some argue that the aging population is already exerting a negative impact on the well-being of Japan's elderly. This is partly evidenced by rising rates of divorces and suicides among this group. According to the Ministry of Health, the number of divorces per year among couples married for more than 30 years jumped more than eightfold between 1973 and 1997. The divorce rate is rising faster for older couples than for any other group. Part of the reason for this is the sacrifice of family values in favor of a militant work ethic; Japanese retirees suffer from what has been dubbed "husband-at-home-stress-syndrome". Partly as a result of this, the elderly population has contributed to making Japan home to the world's highest suicide rates: people over the age of 60 constitute 40 percent of all suicides.

Of course, "husband-at-home-stress-syndrome" is not solely to blame for the decline in the well-being of the elderly. There are increasing concerns regarding the financial implications of people living longer, such as rising healthcare and social welfare costs. These will only get worse over time. Also, there is the worry that in a society increasingly adopting Western values, the traditional Japanese custom of children taking care of aging parents will be rejected in favor of nursing homes and hospices. This may lead to rising costs in healthcare, both for the state and for the individual. A more fundamental reason is simply the lack of children: in the past, a larger number of children could at least "share the burden" of parental care.

At the same time, because people are staying healthy for longer, retirement ages are bound to rise. Related policy changes look set to be implemented soon, supported by the argument that such a movement would keep people active and healthy for longer – and paying more taxes. A society living longer with fewer younger people need not present a gloomy picture, so long as the appropriate measures are taken to ensure mental and physical well-being, including a serious reevaluation of family values.

Disease prevention has helped more people reach old age, as shown by advances in immunization, antibiotics, the elimination of diseases, and many programs of specific disease control. But such advances have created a host of new health risks. An example of this is diabetes. The discovery of insulin, statins, and stents has helped develop countermeasures for this health condition: insulin was commercialized by 1922, and biosynthetic insulin was first made commercially available in 1982. With 17.9 million people diagnosed with diabetes out of an estimated 23.6 million people in the U.S. (7.8 percent of the population) with the condition, the development of insulin has been crucial. But oddly enough, diabetes rates doubled between 1990 and 2005, leading the CDC to characterize it as an epidemic. Changes in lifestyle and rising levels of obesity have been identified as causes; yet the development of medical technologies such as insulin are in part to blame as well, because they have opened the possibility of making eating in overabundance a lifestyle choice. In short, technology has been a mixed blessing.

Obesity poses worrying problems for medicine. Back pain, arthritis, and shortness of breath are just the tip of the iceberg for what could potentially be a dramatic increase in cases of heart disease, stroke, diabetes, osteoarthritis, infertility, gallstones, and several types of cancer. Earlier this year, U.S. researchers found that obese people spend 40 percent more ($1,429 more per year) on healthcare costs than people of average weight. This accounts for 9.1 percent of medical spending, up from 6.5 percent in 1998.

By the same token, the environmental consequences of obesity are very worrying. Statistics released by Phil Edwards of the London School of Hygiene and

Tropical Medicine suggest that, with the increased availability of food and improved transport links, the percentage of the UK population that is obese is likely to have gone from 3.5 percent in the 1970s to a staggering 40 percent by 2010. Obese people are on average likely to consume 40 percent more in terms of calories than they would if they were thin. Judging by the fact that food production constitutes 20 percent of greenhouse gas emissions, this does not bode well for the environment. Moreover, more food consumption means more organic waste, resulting in more methane during the decomposition process. This rise in BMI generally correlates with an overall decline in fitness. As Edwards has stated: "The heavier our bodies become, the harder it is to move about in them and the more dependent we become on cars".

Climate Change

Climate change affects medicine in several profound ways. The first relates to natural disasters. Over the past two decades, seven out of every ten natural disasters were recorded as climate-related. The average "humanitarian toll" of climate-related disasters has also been increasing, from 1.8 billion in the 1990s to 2.2 billion in the period 1998-2007. There can be no doubt that the risks posed by climate change are growing markedly, and this has important implications for medical infrastructure.

Hurricane Katrina in August 2005 provided a poignant illustration of this. Although warnings were issued two days in advance, the storm resulted in 1,836 deaths and 705 missing persons. While many argue that Katrina was not solely caused by climate change, it undoubtedly served as an indicator of increasingly volatile weather for which we are still unprepared. Katrina showed how the flooding caused by a hurricane presents a much graver danger than wind. If climate change causes an increase in flooding, the global community must be prepared in terms of both infrastructure and medical technology. The challenge is complicated by the fact that major medical centers are generally built in larger cities - thirteen of the world's largest cities are built at sea level on the coast. Such cities will be the first to suffer from flooding as sea levels rise, rendering critical medical services unusable.

As natural disasters destroy livelihoods, large-scale migration becomes inevitable. As early as 1990, a report by the Intergovernmental Panel on Climate Change (IPCC) warned that "one of the gravest effects of climate change may be those on human migration." Hurricane Katrina alone was responsible for displacing around 1 million people. The estimated number of people who have thus far been displaced worldwide as a result of environmental changes is 25 million. Although it would be futile to predict the exact nature of future movements of people, it is safe to say that rising levels in temperature and sea levels will cause major increases in human migration in the coming years.

This will exert a major impact on medical facilities. Authorities will grapple with epidemics, malnutrition, and other health issues caused by refugees living in close contact in unhygienic conditions. The environmental and sociopolitical implications of such migration also need to be considered. Environmental refugees will place strains on the food, water, and energy supply of host regions. Areas such as Israel-Palestine, the African Sahel and Horn of Africa, the Middle East and Central Asia are already facing dire problems due to water shortage. The situation will be made all the more dangerous as desperate refugees crowd into these areas. Over-intensive farming to feed the increased number of people will lead to land degradation and depletion of agricultural capital. Environmental refugees also run the risk of destabilizing what are often highly vulnerable areas to begin with. This causes a vicious cycle that further threatens the security of the planet – both environmentally and politically.

Another more basic way in which medicine is impacted by climate change will be the change in temperature. Since 1995, we have experienced 11 of the 12 hottest years on record. Extreme temperatures have severe health complications, in some cases even leading to death. For example, during Europe's heat wave in 2003, 37,451 people (14,802 people in France alone) died from cardiovascular-related causes. As such occurrences become more commonplace, the elderly and the very young will be the first to suffer the consequences. Other exemplary effects of changing temperatures which are likely to have a tangible impact on medicine include increasing cases of food poisoning during the longer, warmer summers, as well as the heightened risk of skin cancer as global warming increases stratospheric ozone depletion.

Such changes in temperature will also affect agriculture and environmental degradation. Once again, the effects will be manifest in medical and health-related problems. Malnutrition is one aspect of this: crop yields could drop by 17 percent with just a 1°C change in temperature as soil moisture evaporates. According to UNICEF, malnutrition already contributes to 53 percent of the 9.7 million deaths of children under the age of five in developing countries each year. With access to improved agricultural practices and technologies, the devastating effects of such a plummet could be mitigated; yet the necessary investments must largely come from the developed world.

As diminishing agricultural returns and environment-induced migration become more common, there will be a rise in food- and waterborne diseases. Research by the IPCC shows that diarrheal disease, already ravaging the world's poor, looks set to increase by up to five percent from current levels by as early as 2020. As flooding becomes more frequent, it will cause more bacterial and algae blooms in reservoirs, thus affecting the safety of drinking water and running the risk of spreading diseases such as typhoid. There is the risk that, as the planet gradually gets wetter, it will provide an ideal breeding ground for vector-borne diseases such as malaria, West Nile, dengue fever, and lyme disease. Such diseases could be transmitted to regions where they are currently nonexistent, as insects migrate to newly created breeding grounds. Malaria in particular poses a great concern, as it tops all diseases in terms of morbidity, mortality and lost productivity. Crucially, the wetter areas are likely to attract more migrants fleeing from drought. An increase in population density in such areas is likely to make the spread of the disease even easier. As the most common causes of infant mortality worldwide are attributed to dehydration from diarrhea, pneumonia, malnutrition and malaria, an increase in the number of children affected by these conditions would have devastating medical, environmental and socio-political effects.

Closer to home, medicine is being impacted as global warming is increasing the number of people suffering from asthma and pollen-related allergies. The rise in temperatures and elevated CO_2 is stimulating the growth of some types of mould and fungi, in conjunction with higher CO_2 levels causing plants to start producing pollen earlier in the year. This partially explains why sources show that childhood asthma in the United States, for example, rose by 160 percent between 1980 and 1994. Mould attaches itself to diesel particles, which deliver it more efficiently deep into the lungs. Thus, as fossil fuel combustion increases and pollen is produced earlier in the year, the already significant number of 40 million Americans suffering from allergic rhinitis (hay fever) and the 7.5 percent of the population suffering from asthma looks set to skyrocket. In other parts of the world, specific changes such as dust storms from the desertification of Mongolia and North Africa, as well as drought-driven bush fires, are likely to cause problems in the oeuvre of airborne disease, creating new challenges to which medical technology must respond.

And yet it is not all doom and gloom. Changing temperatures will have a positive impact on medicine in some areas, as more temperate climates see a decrease in winter deaths and an increase in food production. This is especially the case for high latitude regions. One key area that requires immediate attention and could have positive effects is that of deforestation, which lies at the heart of so many of today's climate-related problems. Rainforests once covered around 14 percent of the earth's surface - we have destroyed all but six percent. Experts predict that this remaining six percent could be consumed by 2050 if we continue with business as usual. As rainforests provide a home for 50 to 90 percent of all organisms, it is possible to see why E.O. Wilson described biodiversity conservation as tantamount to the protection of Creation itself. As he remarked on the subject of deforestation: "Destroying rainforest for economic gain is like burning a Renaissance painting to cook a meal."

By destroying the rainforest, we are undermining human food production and well-being. The most obvious explanation is that less trees means less carbon sink as the "lungs of our planet" become suffocated. But given that forests and biodiversity provide the source for 25 percent of Western pharmaceuticals, the medical implications of continual deforestation are great as well. This is not to mention the as yet undiscovered potentials of the rainforest: over 100 pharmaceutical companies and U.S. government funded projects are engaged in rainforest plant to find cures for diseases such as cancer and even AIDS. With AIDS ravaging the

planet as it is now, such research could provide crucial answers for a problem that is in places spiraling rapidly out of control.

The same goes for the world's oceans. One consequence of deforestation is that, as increasing CO_2 levels warm the ocean and raise its acidity levels, the algae living inside coral reefs are expelled and destroyed, as are carbonate structures. As marine life is increasingly placed under threat, it poses grave consequences for the future of medical technology and development; for although most of the drugs currently in use are derived from terrestrial sources, the rapid rate of expansion of marine biotechnology means that the potential gains within the medical oeuvre are huge.

Finding Solutions

Upon evaluating the ways in which medicine and other technologies have contributed to climate change, it is necessary to explore the question of how they can rise to the challenge of helping to solve the problem. As a growing population demands more energy, food and water, space to live and land to cultivate, can Planet Earth accommodate all of these demands? There have been a few valiant attempts to come up with suggestions for how technology can respond to the call. The Rio Earth Summit, the Convention on Biological Diversity (CBD), and the United Nations Convention to Combat Desertification (UNCCD) all served as concrete evidence of the commitment of the world's governments to combat climate change. In parallel, the 1994 International Conference on Population and Development (ICPD) in Cairo brought 179 of the world's governments together to tackle the problem of reducing infant mortality and fertility rates. The resultant Plan of Action stated the necessity of "ensuring universal access by 2015 to reproductive health care, including family planning, assisted childbirth and prevention of sexually transmitted infections including HIV/AIDS." Cairo saw the need for an integrated approach combining education, widened access to family planning, and medical advances in tackling the problem of overpopulation. The World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, and most recently the COP15 in 2009, almost two decades after the Rio Summit, both serve more as symbolic demonstrations that we can continue to talk about the problem, but time is running out.

How can medicine contribute to this? As mentioned earlier, the first thing it can do is to speed up the demographic transition process and lower TFR. The WHO promotes three main medical interventions to accelerate the decline of infant mortality in the developing world: integrated management of childhood illness, expanded programs of immunization,; and safer infant and young child feeding. If such interventions are successful, the demographic transition model suggests that a decline in TFR will follow. This has already happened in the majority of the developed world as the role of medical technology in lowering infant mortality has worked in conjunction with the diffusion of contraceptives. Having more babies in fact creates a vicious cycle, as, on a global average, each birth reduces by a fifth the likelihood that a woman would have a job, thus lowering household income and pushing some families into poverty. Girls born into large families in the developing world are much less likely to receive an education and escape the poverty trap. Therefore, they become more susceptible to having a similarly large number of babies.

As a result, medicine must target areas such as this and, crucially, educate women; the empowerment of women is key. Educated women are more likely to go out and get a job, more likely to demand contraception, and less likely to want large families. Iran is a shining example of what a targeted focus on educating women can do in an incredibly short period of time. When the clerical regime took over in 1979, it placed enormous emphasis on the education of women: the literacy amongst rural women between the ages of 20 and 24 shot up from 10 percent in 1976 to an astounding 91 percent today. This increase can be seen to correlate with a simultaneous plummet in TFR from seven in 1984 to 1.9 in 2006, well below the replacement rate of 2.1.

Education of women must work alongside widened access to affordable contraception. With contraception wanted by over 200 million women in the developing world that currently lack access to it, the calculus is simple: preventing unwanted pregnancies in such places would translate into a reduced demand for ever depleting and energy-intensive global resources. Thomas Wire, a doctoral student at the London School of Economics, has calculated that if every woman around the world

was granted access to contraception that needed it, we could potentially save 34 gigatons of CO_2 between 2010 and 2050. What is more, promoting family planning is a cheap way for the developed world to reduce carbon emissions. Reducing carbon emissions by one ton would cost just $7 spent on family planning, as opposed to at least $32 spent on green technologies. This cost-effective measure presents a win-win situation, and yet the contribution of the developed world towards this worthy cause has been erratic to say the least. Notwithstanding a few ups and downs, the U.S.'s population assistance spending is at a similar level today as it was in 1970. It reached a remarkable peak in 1995, with $723 million committed, but has since suffered drastic cutbacks, and the latest estimate stands at around $338 million.

Figures such as Bill Gates and Jeff Sachs are constantly reminding us of their belief that overpopulation is one of the greatest threats facing humanity. Yet if medical technology and population policy do not work together to widen access to contraception, lower infant mortality and educate women, the population is doomed to continue growing. In the meantime, as we struggle to accommodate a growing proportion of elderly people alongside a diminishing number of young people, education will be more important than ever. Fewer younger brains will have to be increasingly creative and innovative to support an elderly population. This rings as true in the developed world, where the number of young people is decreasing, as it does in the developing world, in which there are conversely too many young people, thus creating a "youth bulge". Demographer Henrik Urdal surmises that when youth make up more than 35 percent of the population, as they are close to doing or are exceeding in countries such as Afghanistan (37 percent) and Somalia (34 percent), there is a 150 percent higher chance of conflict arising. By engaging youth in a positive manner, education can foster social entrepreneurship and innovation.

Another measure that must be taken is to reduce over-consumption and obesity. Given that heavier people place greater pressure on the environment, especially in the area of food production, medicine must play a role in responding with appropriate measures. One choice that can be made at an individual household level, especially in developed countries, is to reduce meat intake, as meat production is said to account for 20 percent of global anthropogenic greenhouse emissions. This figure is only bound to rise as further deforestation is carried out to create pastures for grazing and crop-production to cater for an increased demand for livestock. The fossil fuels that will be used on such farms, the enteric methane emitted from the animals themselves, the nitrous oxide deriving from soil management and the increase in fertilizer use will all contribute to rising emission levels as a result of our meat eating. Rajendra Pachauri, chairman of the IPCC, has suggested that meat eaters should try for one meat-free day a week. From a medical point of view, this would be conducive to positive results as there have been many links made between reduced meat intake and reduced risk of colorectal, breast and other cancers, ischemic heart disease and a possible reduced risk of other diseases such as arthritis, as well as increasing longevity.

From an environmental point of view, the lower carbon intensity of vegetable and fruit production would make a shift away from meat comparable to the difference between driving an ordinary fuel-powered car and a highly efficient hybrid. If such a shift were realized, the reduction in livestock production emissions would allow for a more efficient use of farmland, and reduce air and water pollution – all of which will have positive returns for medicine and healthcare.

As well as evaluating dietary trends, changes in the way we cook can have a positive contribution. Indeed, innovations in such areas are already underway; for example, the Envirofit Smokeless Stove created by Nathan Lorenz and Tim Bauer of Colorado State University. Toxic emissions such as benzene, carbon monoxide, and formaldehyde produced by traditional cooking methods in developing countries have had and continue to have severely detrimental effects both on health and on the environment. This is responsible for killing a reported 1.6 million people every year, 85 percent of whom are women and children. Lorenz and Bauer's Envirofit invention is designed to burn the poisonous emissions before they are released into the air, thus reducing toxic emissions by 80 percent and fuel consumption by 60 percent. Likewise, the innovative D.Light light source has brought a light revolution to the developing world; with kerosene lamps held accountable for over 1 million

deaths, 62 percent of them under the age of 14, and at least 100 million tons of CO_2 emissions every year, the affordable and solar powered D.Light presents a hugely welcomed alternative. As well as its positive impact on health and the environment, UNDP research states that as engagement in after-dark activities has been made possible, incomes have risen by as much as 30 percent in some cases. These are shining examples (no pun intended) of how research and investment in innovative new technologies can create a more hopeful future for the interlinked issues of health and the environment.

As the clock ticks and environmental consciousness becomes more widespread, there will be an ever-greater sense of competitiveness as nations seek to provide the most cutting-edge in sustainable technologies. China, Japan and South Korea have been dubbed the "clean technology tigers" as they have already surpassed the U.S. in practically all areas of clean energy technologies. These three countries plan to spend $509 billion between 2008 and 2013, compared with a mere $172 billion by the U.S. Japan and Korea have traditionally had a monopoly on electronics and automobile production, yet China's concerted efforts at competition have them poised to equal if not surpass the efforts of their rivals. All three countries are forecast to produce 1.6 billion hybrid vehicles by 2012, dwarfing the proposed U.S. effort of 267,000 vehicles. Thus, Asia looks set to lead the way in terms of clean technology. Although nationalist skeptics in the West often voice fears about an Asian economic takeover, the rest of the world must wake up and follow their promising lead, and fast.

Conclusion

Medicine interacts with other social, economic, and cultural factors to act as both a cause and solution to climate change. The longer we wait before taking decisive countermeasures, the higher the risks and costs of inaction will be. Medical and other technologies must face the challenges lying ahead. It must be prepared for the pandemic of health problems likely to result from an increased number of environmental refugees. It should also seek to mitigate the negative impact of such mass migrations in advance. It must also tackle head-on the challenges of an overpopulated planet, making critical changes at all levels, from lifestyle changes in individual households to more decisive measures at the policy making level. Only then do we stand a chance of averting disaster. In sum, a healthier planet requires us to become healthier ourselves.