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The Picture of Health (Care): Healthcare Practitioner Education for People and Planet, Based on Comparative Analysis of Rural Medical Waste Management in Ecuador and Native American Reservations in Minnesota, USA

Blair Brown
Macalester College

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Title: The Picture of Health (Care): Healthcare Practitioner Education for People and Planet, Based on Comparative Analysis of Rural Medical Waste Management in Ecuador and Native American Reservations in Minnesota, U.S.A.

Author: Blair Brown

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The Picture of Health (Care):

Healthcare Practitioner Education for People and Planet, Based on Comparative Analysis of Rural Medical Waste Management in Ecuador and Native American Reservations in Minnesota, U.S.A.

Blair L. Brown
Honors Thesis
Department of International Studies
Macalester College
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Advisors:
David Chioni Moore (I.S.) and Michael Cepek (Anthropology)

Table of Contents

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Abstract

An evaluation of healthcare facilities in rural areas of Ecuador and Minnesota, USA shows that medical waste management decisions are often made by people unaware of environmental consequences. Since deteriorating ecosystems adversely affect human health, medical curriculum changes could combat the irony that the health care system contributes to environmental degradation. Thus all practitioners of allopathic medicine should be educated with curriculum that equally addresses environmental and human health. The recommendations in this thesis work to enable local practitioners to use existing resources ecologically and promote environmentally responsible healthcare.

INTRODUCTION

Maria tore off down one of the many dirt paths that crisscross San Isidro, Ecuador, shouldering her weekly burden. All lanky limbs and uncoordinated movement, she never let that get in the way of her speed. If they don't see you coming, she reasoned, they will be easier to catch. From at least a hundred yards away she narrowed in on a target: sleek and plump, with a glossy brown finish mottled by a smattering of cream feathers. Racing into the bustle of hens and chicks, she artfully scooped up Sunday night dinner under one arm, extending the other for balance as she dodged out of the flock angrily pecking away at her ankles. Giggling at her success, she was unprepared for the chicken's artless attempt at escape as it tumbled from Maria's arms before she could tie its feet and sling it over her shoulder for the walk home.

Startled and disoriented at his own success, the chicken took off towards the hill to its left with Maria at his heels. Playful and spirited all the way down to the rainbow band-aid on her left shoulder (a remnant from the decidedly less pleasant flu-vaccine two days earlier) she was not about to let up without a fight. The chicken had no reason to avoid running up and into the village landfill adjacent to the field that had moments before been its home, and given her generally mischievous 10-year-old ways, Maria had no reason not to follow him. Returning to the pack of chickens to fetch a less combative one smacked much less of fun and adventure than the task laid out before her with Sunday night dinner, so up and in she went. She recklessly waded through the heaps of trash from households and businesses. Dodging around uncapped gallon containers of needles from the previous week's immunization initiative she inadvertently stepped into the torn red plastic of a hazardous materials (hazmat) bag full of bloody bandages and the wrappers from countless rainbow band-aids. The bag had been ripped open by

indiscriminating stray dogs looking for their next meal. Maria's long arms were too quick for the now-distracted chicken and she swiftly caught his neck and pulled him into her arms from a pile of banana peels and mandarin seeds. She clamored back out from the garbage with the chicken firmly in her grasp and headed proudly home, trailing the contents of the red hazmat bag behind her, slowly reopening the gaping public health wound that the campaign which put the bag at her disposal and the band-aid on her arm was trying so desperately to close.

Six thousand miles away, the nurses of the IHS Hospital in Mahnomen, MN, USA are finishing up their evening rounds. With all the patients settled and accounted for, they collect the used IV bags and the soiled wound dressings and the full sharps containers (hermetically sealed for safety) and head down towards the back of the retrofitted education administration building to the hazmat holding room. Weary from long hours and consistently lacking funds, there is no money, time, or desire to consider the welfare of the environment when it comes to waste disposal. The cheapest legal option is the best one, as far as they are concerned, and no logic would ask them to reconsider their decision. The cheapest legal option, in this case, is to pay for a transport truck to pick up the waste and take it away.

To the west in Fargo, North Dakota, an incinerator steadily exhales smoke through the Sunday afternoon sky. Its black billowing clouds are fed by the staples of North American medicine: syringes, disposable plastic surgical instruments, IV bags, and blood soaked sponges. Brought in from the far reaches of the rural north woods, the waste is systematically plucked from hazmat dumpsters by workers with protective gloves and masks, collected by companies whose revenue comes solely from the

transport of this waste. With every belch of smog that sets forth into the crisp Fargo air and dissipates over days and months and years across the northern skies of the upper Midwest, the waste that this IHS Hospital paid to have taken away begins its long slow journey back to where it came from.

What goes around comes around. For every action there is an equal but opposite reaction. The Golden Rule. There are many ways to express the idea that there is no escaping the consequences of one's actions. It is possible to adjust the scale at which we focus our attention, but sweeping dirt under the rug will never be an effective way to clean the floor. Considering this, the system by which health care practitioners across the world are educated is inherently contradictory and fundamentally flawed in its aim.

Given the overwhelming body of scholarship that points to the inextricable link between natural environmental health and human health, it would seem logical that a profession concerned with maximizing human health would focus a significant portion of its energy on preserving environmental health as well. Interestingly enough, the international system of allopathic health care places such vehement importance on improving the quality of human health that it relegates a focus on environmental health to, at best, a second-rate priority. The result of such a system is an institution that is ultimately faced with working against its fundamental aims.

The project of this work is not to argue that broken thermometers constitute a greater health risk to rural communities than the mercury-laden sludge that lines lakes plagued by hydroelectric dams, nor is it to take on the position that the environmental lobby should replace dogged pursuit of the petroleum industry with a crusade against the hospitals of the world. The project of this paper is to problematize the counter intuitive

nature of the health care industry and show that it is in line with the goal of improving the quality of human health to do so in an environmentally responsible manner.

In a world whose human population is increasingly concerned with securing a permanent presence in the natural environment, it is imperative not only to address the most pressing threats to the extension of our global future, but also to identify and prevent the beginnings of foreseeable disaster from proliferating to the bounds of their ability. The conflict between allopathic health care and the environment fits most comfortably within the boundaries of the latter category. It represents a grouping of issues that is often overlooked in favor of causes rife with charismatic imagery to rally around. It is much more powerful, for example, to photographically document the effects of an oil spill than it is to wax hypothetical about what will 'most likely happen' in the future, no matter how powerful the consequences may be. While it is the institution of allopathic medicine that I take issue with in this work, I would like to begin by agreeing with the health care industry on at least one point: prevention is always preferable to cure.

One way to ensure the implementation of environmentally responsible practices is by educating those who physically carry out the waste-creation process, the allopathic health care practitioners and patients. By using education to instill an ethic of environmental responsibility and awareness in the practitioners and recipients of rural medicine, the standard of care becomes two-pronged. Allopathic healthcare then prioritizes both human and environmental health while working towards a 'sustainable' system of human healthcare that truly optimizes the preservation of human life.

This thesis uses fieldwork to examine the environmental impact of allopathic medicine in two rural locations, one in Ecuador and one in Northwestern Minnesota, USA. Considering my extensive racial and socio-economic privilege as a white, American woman student in Ecuador, I was granted a much greater depth of access to what would be considered privileged information in any Western medical facility. High-level Administrators and Nurses were willing to speak with me on a moment's notice and disclosed policy information without question. For these reasons, the quality of my information and access to information in rural Ecuador is much richer than that which I received in Northwestern Minnesota.

When conducting fieldwork in Northwestern Minnesota. My access to information was significantly more limited than in rural Ecuador. I was forced to comply with a great deal of bureaucratic protocol and was not allowed access to the official waste management policy of many healthcare facilities because it was considered 'privileged information' that no one was compelled to offer me. Overall, my privilege within the United States was considerably limited as a student with no healthcare credentials and information I was able to collect was correspondingly opaque. However, I did do fieldwork in communities where I did carry considerable racial and socioeconomic privilege as a white student at a private college.

Drawing from both fieldwork and existing literature, this thesis calls for the discipline of allopathic medicine to adopt patient and practitioner education practices that feature an environmentally responsible ethic. The majority of scholarship regarding the environmental impact of allopathic healthcare draws from a wide variety of disciplines. The most prominent of these are environmental health sciences (as well as other areas of

public health), conservation ecology (and other disciplines within biology), anthropology, and international studies as it relates to public and educational policy. Existing literature focuses on (re)structuring policy and increasing access to technology, where as virtually no work has been done addressing the role of education in the issue. This thesis seeks to insert itself in that vacancy and offer a unique perspective on both the problem of environmentally degrative healthcare and approaches to combat it with progressive change.

CHAPTER 1:
The Environmental Impact of Allopathic Medicine in Rural Areas

Healthcare comes in innumerable variations. Some of the most familiar categories are allopathic medicine, osteopathic medicine, traditional Chinese and Tibetan medicine, the Ayurvedic traditions of India and Sri Lanka, and scores of less well-known indigenous healing practices (Whorton). Each of these disciplines is united under the common goal of improving human health and each has its own manner of educating its practitioners. These processes exist in many variations such as formal medical/nursing/technician/pharmacy programs, apprenticeships, manuals, class instruction, informal self-education, etc. This paper engages specifically with the doctrine of what is colloquially referred to as 'western medicine' and scientifically referred to as allopathic medicine. Allopathic medicine is based on the thinking of Hippocrates and strives to diagnose and treat human disease and injury based on the basic principles of biological science. It is the most widely practiced form of medicine and the tradition that presently stands to have the greatest international impact on human health (OED online).

The driving principle behind all allopathic health care is the Hippocratic Oath, which all physicians take at the outset of their licensure. The Hippocratic Oath states that:

> I will respect the hard-won scientific gains of those physicians in whose steps I walk, and gladly share such knowledge as is mine with those who are to follow.
> I will apply, for the benefit of the sick, all measures [that] are required, avoiding those twin traps of over treatment and therapeutic nihilism.
> I will remember that there is art to medicine as well as science, and that warmth, sympathy, and understanding may outweigh the surgeon's knife or the chemist's

drug.

I will not be ashamed to say "I know not," nor will I fail to call in my colleagues when the skills of another are needed for a patient's recovery.

I will respect the privacy of my patients, for their problems are not disclosed to me that the world may know. Most especially must I tread with care in matters of life and death. If it is given me to save a life, all thanks. But it may also be within my power to take a life; this awesome responsibility must be faced with great humbleness and awareness of my own frailty. Above all, I must not play at God.

I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems, if I am to care adequately for the sick.

I will prevent disease whenever I can, for prevention is preferable to cure.

I will remember that I remain a member of society, with special obligations to all my fellow human beings, those sound of mind and body as well as the infirm.

If I do not violate this oath, may I enjoy life and art, respected while I live and remembered with affection thereafter. May I always act so as to preserve the finest traditions of my calling and may I long experience the joy of healing those who seek my help (Edlestein).

As one might expect, the oath proclaims the supreme importance of protecting human health. It does not provide a single explicit reference to protecting the health of the natural environment of the planet, and in this way is a mirror of the curriculum that

leads up to its utterance. In a personal review of the curriculum of eleven medical schools in the United States (6), England (3), Scotland (1), and Ecuador (1), not a single unit of academic material was spent discussing the effects of practicing allopathic medicine on the natural environment. However, eight of the schools offered course material acknowledging the relationship between natural environmental health and human heath, two entities that are increasingly shown to be inextricably linked (Commission for Environmental Cooperation). A similar review of nursing program curriculum revealed optional access to the concept of environmentally responsible medical waste disposal as well as mandatory course material that acknowledges the relationship between natural environmental health and human heath. A review of technician training curriculum yielded no mention of the natural environment. Regardless of their mention in any curriculum, there are countless examples that strongly correlate environmental degradation with diminished heath in corresponding human communities.

Linking Human and Environmental Health

In order to argue that the impact allopathic medicine has on the environment is detrimental to its goals of improving the quality of human health, it is essential to establish a connection between the health of natural environments and the health of humans living in them. This relationship is illustrated in a great deal of ecological scholarship and is a fundamental tenet of the public health approach to healthcare. While the science behind the relationship between human and environmental health is

uncontested in any academy, allopathic healthcare has yet to incorporate this idea into its practices.

One example that clearly illustrates the link between human and environmental health is a study of air pollution in China. China is undergoing rapid industrialization and subsequent escalating demand for energy, primarily from coal (Mumford). Air pollution due to this coal use occurs at many levels: indoor, local, regional, and global. Domestic use of coal for cooking and heating can generate high levels of particulate matter that have been documented to cause high rates of lung cancer among non-smoking women (World Resources Institute). Ambient air pollution in China's large cities arising from energy, industry, and motor vehicles includes high levels of sulfur dioxide and particulates. The result has been increasing rates of mortality and hospital admissions due to respiratory illness.

Regionally, acid rain affects about forty percent of China's agriculture, according to a survey by the National Environmental Protection Agency (World Bank). In southeastern China, the annual mean pH of rain is below 4.0 making it highly acidic. A study in the southwestern provinces of Sichuan and Guizhou found that approximately two-thirds of the agricultural land in the region is subject to acid precipitation; sixteen percent of the crop areas suffer significant damage and reduced crop yields as a result (World Resources Institute). While this may not appear to be a direct effect on human health, it contributes significantly to the ability of China to provide appropriate nutrition to its citizens. China also accounts for sixty-five percent of total emissions in Asia. Although most of this is deposited within China, thirty-five percent and thirty-nine

percent of the sulfur deposited in North Korea and Vietnam, respectively, originates from Chinese emissions (World Bank).

Another example of the human/environmental health link that more directly addresses the practitioners of allopathic medicine is the failure of the Global Malaria Eradication Program. When the insecticide DDT became available after World War II, the United States as well as other countries successfully interrupted the transmission of malaria by using DDT to kill adult biting mosquitoes that could transmit malaria. Their approach was *indoor residual spraying,* which is a program of spraying on the interior surfaces of human dwellings, leaving a residue of DDT that kills infected or infective mosquitoes when they rest, before or after biting. The eradication of malaria did not require the elimination of entire populations of mosquito vectors; mosquitoes that are capable of transmitting malaria may still be found in countries that eradicated malaria (Olliaro). That successful experience with eradication inspired the development of a global program based on the premise that an intensive schedule of indoor residual spraying over a limited period of five years could eradicate malaria, except in sub-Saharan Africa where transmission has been most intense.

However, it soon became clear that the original plans were too optimistic and that maintenance of intensive vector control operations for an indefinite period of time was not possible. The major problem was the very high efficiency required of spraying operations; spraying had to include an adequate dose of insecticide on all surfaces in all housing on a regular schedule (WHO, 1979). In addition, mosquito vectors frequently developed a resistance to DDT, certain vectors did not rest on walls inside houses, and many individuals refused to allow spraying in their homes. The collapse of the global

program led to a resurgence of malaria in many countries around the world and, in 1978, a change in strategy from eradication to control. Not only would a more sophisticated understanding of the natural environment have aided the development of this policy, it also would have prevented hundreds of thousands of people from exposure to a controversial chemical the human effects of which are unknown (Ascher).

Additional examples of this environment/human health relationship are abundant and internationally present. Documented cases range from extreme water scarcity in Goma, Zaire leading to Cholera outbreaks among refugees to the 'exploratory' phase of copper mining in Cotocachi county, Ecuador leading to severe skin irritation in local community members that bathed in a contaminated stream. The United States is not exempt from displaying such connections by any stretch of the imagination, exposing many of its marginalized people to environmental degradation a la Rachel Carson and Love Canal (Maugh). There is a very clear contradiction suggested by this information. Declining natural environmental health is closely linked to declining human health, thus the goal of securing human health should not come at the price of destroying natural environmental health.

This paper seeks to examine this contradiction in two very different yet strikingly similar places, a rural coastal province in Ecuador and Native American Reservations in Northwestern Minnesota, USA. These places represent marginalized rural communities, one in the Global South and one in the Global North. Such communities simultaneously shoulder the burden of being the most difficult to reach with quality health care, and also are the most notorious for haphazardly disposing of medical waste, which has been shown as the way allopathic healthcare most significantly contributes to environmental

degradation. By examining the role of practitioner and community education in the state of waste management in these areas, the goal is to identify the most promising avenues of educational change that might offer environmentally responsible medical waste management strategies to rural marginalized communities internationally. However, before examining what the state of medical waste management is in a place, it is important to understand why medical waste management is the source of allopathic healthcare's most significant environmental impact.

Waste Management as the Healthcare's Greatest Environmental Threat

Allopathic healthcare has a significant impact on the natural environment. Any given hospital combines the environmental impact of a full-service hotel and restaurant complex, a paper-intensive service industry, a warehouse and dispensary dealing in potent and toxic reagents, and a waste treatment facility dealing in particularly toxic precursor materials and infectious agents. Hospitals, clinics, and private practices contribute most substantially to international environmental degradation through their medical waste management practices, including the use and disposal of mercury containing devices and PVC plastics (Sattler).

Health-care activities lead to the production of waste, which based on its composition and volume, poses the risk of leading to adverse health effects. Most of this waste is not more dangerous than regular household waste. However, some types of health-care waste represent a higher risk to health. These include infectious waste (15% to 25% of total health-care waste) among which are sharps waste (1%), body part waste

(1%), chemical or pharmaceutical waste (3%), and radioactive and cytotoxic waste or broken thermometers (less than 1%) (HCWH 2002).

Sharps waste, although produced in small quantities, is highly infectious. It is also a type of medical waste often mismanaged in developing countries, especially those with access to mass-immunization initiatives such as Ecuador, Bolivia, and many African nations. Poorly managed sharps expose health-care workers, waste handlers, and the community to infections. Contaminated needles and syringes represent a particular threat and may be scavenged from waste areas and dumpsites for reuse. The WHO has estimated that, in 2000, injections with contaminated syringes caused 21 million hepatitis B virus (HBV) infections (32% of all new infections); two million hepatitis C virus (HCV) infections (40% of all new infections); and 260 000 HIV infections (5% of all new infections). Epidemiological studies indicate that a person who experiences one needle-stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively to become infected with HBV, HCV and HIV. In 2002, the results of a WHO assessment conducted in twenty-two developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64% (WHO 2004).

Even the management strategies of health-care waste may themselves lead to health risks and no perfect readily achievable solution to manage health-care waste exists. Health-care waste, whether generated at smaller rural clinics or larger facilities, can only be effectively managed where adequate well-operated infrastructures exist (Singh). However, the volumes of waste generated within large facilities and targeted public efforts (e.g., immunization campaigns) are more challenging, particularly in developing

countries where resources may be scarce. In these difficult situations for which waste disposal options are limited, small-scale incinerators have been used and are still used as an interim solution, often in less developed and 'transitional' countries. Unfortunately, small-scale incinerators often operate at temperatures below 800 degrees Celsius, a feature that can lead to the production of dioxins, furans or other toxic pollutants as emissions and/or in fly ash (Allsopp). Transport to centralized disposal facilities may also produce hazards to health-care handlers, if not safely managed.

As a sub-category of the larger medical waste management problem, the use of mercury containing devices poses its own significant environmental and human health risk. Mercury containing devices are used almost exclusively in developing nations, like Ecuador, often as 'donations' from countries in the Global North who have moved to non-mercury technology. Mercury is a naturally occurring heavy metal that ultimately accumulates in lake bottom sediments, where it is transformed into its more toxic organic form, methyl mercury, which is known to accumulate in fish tissue. Mercury, and especially methyl mercury, is highly toxic. It may be fatal if inhaled and harmful if absorbed through the skin (HCWH, no date). Approximately eighty percent of inhaled mercury vapor is absorbed into the blood through the lungs. It may cause harmful effects to every major organ system of the body as well as the immune systems. Adverse health effects from mercury exposure can be tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit and developmental delays during childhood. Recent studies suggest that mercury may have no threshold below which some adverse effects do not occur (HCWH, 2006).

Health-care facilities are one of the main sources of mercury release into the atmosphere in large part due to the emissions of medical waste incineration. Large-scale incineration is much more of a concern in the Global North, in Northwestern Minnesota for example, where it is a relatively cheap way to dispose of medical waste while still complying with strict government sanitation standards. In December of 2002, the Environment Minister of Ontario, Canada declared that emissions from incinerators were the fourth-largest source of mercury in the global environment (Emmanuel, 2005). In a 1997 report, the United States Environmental Protection Agency (US EPA) stated that medical waste incinerators may have been responsible for as much as 10% of all mercury air releases (Emmanuel, 2004). Health-care facilities are also responsible for mercury pollution taking place in water bodies due to the release of untreated wastewater. These facilities may also have contributed as much as 5% of all mercury releases in wastewater. Environment Canada estimates that more than one-third of the mercury load in sewage systems is due to dental practice (Emmanuel, 2005).

Waste incineration and crematoria are also listed as major sources of mercury emissions. Many countries such as Armenia, Cameroon, Ghana, Honduras, Pakistan, and Peru, recognize the contributions from hospital thermometers, dental amalgams (fillings, composed of 45-55% mercury), hospital waste and/or medical waste incinerators, but lack quantitative data to show their exact environmental impact. Despite this lack of data, there is good reason to believe that mercury releases from the allopathic health sector are substantial (CGH).

As the third major player involved in medical environmental contamination, PVC has proven especially hazardous to the animal kingdom of which humans are a part.

Polyvinyl chloride (PVC) is a plastic polymer that is used in a wide array of products. Unplasticized PVC is hard and brittle at room temperature and thus a plasticizer (softener) is typically added to increase the flexibility of the polymer. Di(2-ethylhexyl)phthalate (DEHP) is the plasticizer for most PVC medical devices (Center for Devices and Radiological Health). PVC use and disposal is also mainly a concern in the Global North as it is readily available there and used daily in a number of patient activities such as IV drips. PVC use is present many places in the Global South, however in much smaller quantities and rarely in rural areas.

In September of 2001, The United States Food and Drug Administration's Center for Devices and Radiological Health completed its safety assessment of DEHP released from PVC medical devices and issued a nation-wide public health notification advising health care facilities to limit the exposure of patients to DEHP. Everyone is exposed to small levels of DEHP in everyday life. However, some individuals can be exposed to high levels of DEHP through certain medical procedures. DEHP can leach out of plastic medical devices into solutions that come in contact with the plastic (Feigal). Exposure to DEHP has produced a range of adverse effects in laboratory animals, but of greatest concern are effects on the development of the male reproductive system and production of normal sperm in young animals (Center for Devices and Radiological Health). There are no current reports of these adverse events in humans, but there have been no studies to rule them out. However, in light of the available animal data, the FDA saw it prudent to issue its notification.

It might seem that large, urban hospitals in the 'developed world' would contribute the greatest share of health care's environmental footprint given their ready

and necessary access to large quantities of mercury and PVC coupled with each hospital's ability to generate more than two million tons of waste each year (HCWH, 2005). While that idea may quantitatively be true, the most concerning contributors to healthcare's environmental impact are hospitals in developing countries and the many healthcare facilities that serve rural populations in all countries of the world.

Rural Healthcare as an Important Locus of Environmental Impact

Many hospitals in developing countries, such as Ecuador, dump all waste streams together, from reception-area trash to operating-room waste, and burn them in incinerators, which are a leading source of highly toxic dioxin, mercury, lead and other air pollutants that threaten human health and the environment. Additionally, some urban and most rural hospitals and clinics in the developing world simply discard their medical waste with regular trash, which increases the risk of spreading disease, especially in poor communities that recycle materials from open dumpsites (Singh). Other health care facilities use open or makeshift incinerators to process their waste, but in doing so they expose their communities to toxic byproducts (such as those listed above) and create hazardous ash. As immunization and rural health care programs expand in developing countries, as is more and more the case vis a vis programs like the Gates Foundation's several billion dollar worldwide immunization initiative enacted by the WHO, the problem of medical waste treatment and disposal becomes increasingly critical considering that discarded needles and syringes may result in the spread of blood borne pathogens such as HIV and hepatitis (Emmanuel, 2004).

Even rural clinics in the Global North, where medical waste management is often highly regulated, are not scrutinized to the degree of larger urban hospitals. Hospitals and clinics like those in Northwestern Minnesota often cut corners or take shortcuts when disposing of waste due to financial constraints. These healthcare facilities are also much more likely to employ the least environmentally sound waste management strategies, such as incineration, because of their relatively low cost (HCWH, 2002).

The byproducts of medical waste incineration as listed above are categorized as persistent organic pollutants (POPs). These substances, such as dioxins and persistent toxic substances like mercury can travel long distances, accumulate in living organisms, and pose significant human and ecosystem health risks. Research in the last decade has shown significant links between exposure to incinerator emissions and lung, laryngeal, and other cancers (Allsopp). In addition, studies have shown increased risks of ischemic heart disease, and elevated levels of mutagens, various toxic compounds, and heavy metals in blood, urine, and/or hair. The Stockholm Convention on POPs, which took place in 2001, promotes the use of alternatives to incineration that avoid the generation of POPs. The Stockholm Convention was one of the first events to directly recognize the impact of allopathic healthcare on the environment as well as to make an effort to reduce said impact. Since the Stockholm Convention, several other programs, initiatives, and organizations have originated with the same goal and have narrowed their focus to address issues of medical waste treatment that specifically effect rural areas.

Attempts to Mitigate the Environmental Impact of Allopathic Medicine in Rural Areas

Eradicating incineration technology coupled with simultaneous replacement by comparable non-incineration alternatives has long been seen as the ideal solution to the pressing problem of rural access to medical waste management. Unfortunately, while many non-incineration alternatives such as large autoclaves, autoclaves with shredders, and microwave devices, are readily available in industrialized nations, poor and rural communities, especially in 'developing' nations, have limited or nonexistent access to these technologies. In light of this situation, two distinct attempts have been made to overcome the existing challenges that accompany international medical waste management in rural areas.

The first attempt took the form of an international competition sponsored by the leading organization on environmental responsibility in health care, Health Care Without Harm (HCWH). Led by engineer Dr. Jorge Emmanuel, the competition called for the development of non-burn waste treatment technologies that could be easily replicated in developing countries. Cash prizes were offered as incentive and word went out to universities, engineers and developers around the world. Applicants had to agree to transfer their intellectual property rights to Health Care Without Harm so the designs would be held in the public domain. Winning designs were to be able to be built using local materials, operated with little or no electricity, and were not to require highly skilled labor. From fifty-eight initial design ideas, judges selected thirty contestants from eighteen countries to submit complete descriptions of their concepts. On world health day (April 7) in 2003, three winners and five honorable mentions emerged at the top of the field for designs that best met technical criteria developed in consultation with the WHO.

First place, and $5,000, went to the Team of Rhys Hardwick-Jones of the University of Sydney, Australia, for a portable solar-powered autoclave system that can be used in any weather conditions (HCWH, May 2003).

Stemming from this effort, the German company Solar Alternatives installed a solar powered autoclave similar to the award-winning model described above at Holy Family Hospital in Mandar, India during the fall of 2004. The one hundred and fifty bed hospital is in a rural location where the high cost and difficulty of transporting conventional fuel coupled with the unreliability of the electric grid and excessive cost of photovoltaic technology make it difficult to employ any conventional technology to treat medical waste. The Solar Alternatives autoclave has operated without technical difficulties since its installation and is run up to four times a day in the dry season while the electric boiler of the autoclave is used during the rainy season. Following such a promising experience, Solar Alternatives is currently producing two additional solar autoclave systems for other rural hospitals in the region (www.solar-alternatives.com).

The second distinct initiative to end rural inaccess to sufficient medical waste treatment technologies also stems from the mission of HCWH. Together with the WHO and the United Nations Development Programme (UNDP), HCWH has developed a Global Environment Facility (GEF) funded project titled "Demonstrating and Promoting Best Techniques and Practices for Reducing Health Care Waste to Avoid Environmental Releases of Dioxins and Mercury." The program was developed primarily under the GEF mandate to assist developing countries in meeting the objectives of the Stockholm Convention on Persistent Organic Pollutants. The $8 million project is scheduled to be implemented later this year (2007) and plans to demonstrate dioxin and mercury-free

medicine within model health care facilities. It is currently in the final planning stages and is set to be implemented in the seven participating countries of Argentina, India, Latvia, Lebanon, the Philippines, Senegal and Vietnam. The overall objective of the program is to reduce environmental releases of dioxins and mercury by promoting best techniques and practices for reducing and managing health care waste (GEF Project Summary).

According to the program proposal and outline, it plans to meet this overall objective through a distinct set of components that each participating country will implement in collaboration with their national government, participating NGOs, professional associations, universities, hospitals and clinics (GEF Project Summary). The components include: developing model urban and rural hospitals that demonstrate approaches to eliminate dioxin and mercury; establishing national training and education programs on health care waste management to serve respective countries and the regions in which they sit; assuring that new management practices and systems piloted by the project are nationally documented, promoted, disseminated, replicated, and institutionalized; collaborating with Stockholm Convention National Implementation Plan preparation process; and disseminating and replicating project results regionally and globally. The final component of the project is a collaboration with the University of Dar es Salaam in Tanzania to build and test low-cost, small- to medium-size non-incineration technologies for use in developing countries. The technologies will be manufactured using local resources and a range of energy sources including solar energy. Ideally, the GEF project will promote and replicate these technologies in other countries (Draft of Additional Component, GEF Project Summary).

The long-term outcome of these initiatives remains to be seen, but what little work has been done in the area seems to have resulted in limited, yet successful progress. So far, all of the work aimed at alleviating the pressure allopathic medicine enacts on the environment has been directed through very specific and calculated goals. Projects target small areas and strive for bounded impact, they lack unification under a broader defined theme and while organized within themselves, they appear piecemeal in relation to each other. A focus on education as an avenue of change could provide such unification and offer a general framework that could be replicated in future initiatives.

Before adopting education as the best avenue for creating change, it is imperative to examine its current role in the communities in question. Here fieldwork becomes essential. The virtues of such work, while often romanticized, are most substantially practical. Being in close physical proximity to the situation one wishes to understand offers a chance to be a first hand observer of real-life, real-time scenarios. Comparisons can be made between reported realities and actual realities; conversations can be had with experts in the communities who are directly affected by/create the nexus of one's interest. Fieldwork is a very valuable tool for both understanding and manipulating situations, however it can also be a dangerous one. Fieldwork can create the temptation to feel all knowing and well versed in the 'true realities' of a situation that one has visited when only a very limited perspective can be gained. Cognizant of these limitations, it is time to shift the focus of this discussion to the role of education in the state of medical waste management in two specific rural communities. The coastal poverty of rural Manabi, Ecuador offers one perspective from the Global South while the bleak reservation life of

northwestern Minnesota, U.S.A. provides commentary from the perspective of a marginalized community in the Global North.

CHAPTER 2:
Medical Waste Management in Rural Manabi, Ecuador

Life in Rural Manabi

Dirt roads crisscross the lush vegetative hills of rural Manabi, Ecuador. They rise and fall along with the landscape and occasionally become stretches of roughly hewn pavement connecting the most highly trafficked towns. The capital of the peanut province, as its inhabitants affectionately refer to Manabi, is Porto Viejo, home to thousands of coastal Ecuadorians. It is a dusty town full of tropical heat, held together by concrete and split bamboo, painted all the faded colors of the rainbow. There are two shining anomalies to this description, both rising out of shiny black parking lots like brightly colored phoenixes from their ashes. Five blocks from the hustle and flow of the bus station, the 'Shopping' mall stands expansive and impeccably neat and clean, a bright shade of sunny yellow to match the fleet of taxis that encircle its premises. Inside, it boasts enough transnational culture to be absolutely indistinguishable from a mall in Miami, FL or Los Angeles, CA. On the far southern end of town, rises the second phoenix, the most impressive in all of Manabi. Surrounded by an oasis of freshly manicured vegetation and standing taller and more stately than any other building in the province, the SOLCA cancer hospital campus sprawls along a well-maintained and barren stretch of highway, a crisp white pillar of health against the clurean blue sky. Putting half of the hospitals in the United States to shame, it would seem as though this is where you would want to be sick. The more likely scenario, however, is that you would end up in the regional hospital run by the ministry of public health, which like all good public facilities, is worn down and under-resourced and overrun by the province's marginalized and neglected, indicated by the peeling paint and overflowing waiting rooms. The regional hospital is largely an open-air facility, with corridors and rooms

offering free exchange with the outside environment and each other. The accommodations are stark, with six or more patients occupying any given room, each with a cot and a hook for their IV bag on the wall. Medical students train here, and nurses are overworked, but perpetually cheerful.

Three hours southwest by bus lays the 'eco-city' of Bahia de Caraquez. It is a coastal city in the Manabi province of Ecuador that is home to approximately 13,000 people. It is situated on a peninsula where the estuary of the Chone River meets the Pacific Ocean (see appendix 1). While the coastal region of Ecuador generally struggles with a great deal of poverty, Bahia used to stand as a pillar of wealth. Unfortunately, it has fallen to a three-pronged attack in recent years and is struggling to reclaim its former economic prosperity. The city suffered from complete and prolonged flooding and landslides due to El Nino (1998), a devastating 7.2 earthquake (1998), and an epidemic of shrimp virus that entirely knocked out the booming shrimp industry which was the heart of the town (and regional) economy (1999), all within a fourteen month span of time (Mears). These events only added to ongoing deforestation and erosion problems propagated by the raging success of unsustainable shrimp farming practices that had previously devastated the area's local mangrove forests. As a result of the aftermath of these disasters, local residents with the support of foreign NGOs aimed their efforts towards a more sustainable re-development of the city. On February 23, 1999, Bahia was declared an Eco-city in which development activities are being carried out with careful attention to sustainable resource use and the conservation of local ecosystems. At the moment, Bahia remains a shadow of its former prosperous self, but is making steady progress towards regaining it all while retaining an ecologically responsible ethic

(Mears). Such a set of circumstances makes Bahia the ideal location to anchor at least part of a project of this nature, a project that both reinforces and benefits from the goals of the city. On the outskirts of Bahia lies a compact blue building overlooking the Chone River as it empties into the great Atlantic Ocean. The building houses the Bahia Hospital, which is modest and moderate in every way possible. It is clean and sparse, efficient and straightforward, and the nurses tend towards a curt and skeptical attitude when questioned about their practices.

These are the three hospitalization options in the province of Manabi. For those all over Ecuador who can afford to be not only diagnosed, but also treated for cancer, a pilgrimage to SOLCA is well worth the trip. The rest of the critically ill population of Manabi depends on the fifty beds of the Regional Hospital for its treatment. Considering the high volume of patients that each hospital moves through its doors on a weekly basis, the city of Porto Viejo is charged with the task of managing an equally high volume of medical waste. The hospital in Bahia acts as a significantly smaller hub for those who cannot afford the time and/or money that would take them all the way to Porto Viejo. In many cases, the Bahia hospital would be a preferable place for treatment because of its relatively light use (and thus less wear and tear and more resource availability) compared to the regional hospital. But even considering this 'light use', there remains a significant amount of the community waste that is created by the hospital.

Methods

In order to gather an accurate picture of medical waste management in rural Manabi, I completed a survey of the general waste management practices of the area

over a period of one month. The survey consisted of 19 health care facilities in 6 communities (Bahia de Caraquez [11], Canoa [1], Jama [2], Porto Viejo [2], San Isidro [1], and San Vincente [2]) in the coastal province of Manabi, Ecuador. I interviewed health care practitioners at each facility (doctors, nurses, etc) regarding a series of topics concerning the management of each type of their medical waste (see appendix 2). The results of these interviews were compiled and analyzed for common themes in education and practice as well as interesting anomalies. All information presented in this chapter is drawn from these interviews and personal experiences unless otherwise noted. It is also important to acknowledge my enormous privilege in this fieldwork situation. As a white, American student, I was granted what in my opinion is much more candid degree of access to information than an Ecuadorian student in my same situation.

Medical Waste Management Practices

Given the striking differences between the patrons of these three hospitals, it is remarkable how similarly they all address their waste. In Ecuadorian hospitals, it is the nurses who manage medical waste. The chief nurse enforces waste management policy, as handed down by the ministry of public health, and it is the job of the nursing staff to carry it out. SOLCA employs, almost exclusively, a United States imported policy of waste separation, right down to the containers and bags into which it is separated. At the regional MSP (Ecuadorian Ministry of Public Health) hospital, the nurses have devised a color-coded system of managing waste (which is largely a hold-over from when their incinerator was functioning) in which all receptacles that ever contain infectious waste are spray-painted red, and all the non-infectious waste receptacles are spray-painted blue,

while sharps are separately stored in the method described below. Each patient-occupied room is equipped with a small receptacle of each type, which are then consolidated daily *into* larger (think US neighborhood garbage bins) color-coded receptacles, before ultimately being rolled out to a bi-colored dumpster (red on the left side and blue on the right) and hauled off to the nearby landfill by the local all-purpose garbage men. In Bahia, a similar homemade system has been devised to separate waste. Garbage bins lined with US manufactured red plastic hazmat bags are the exclusive destination for infectious waste, and are collected in a separate room before being thrown into the large hospital dumpster with the various other non-infectious waste streams from the hospital.

An interesting trend to note in the waste management infrastructure of these hospitals is that it seems as though they have lulled into a regression. Both SOLCA and the Regional MSP Hospital in Porto Viejo had previously been in possession of entirely self-contained on-site infrastructure for managing *infectious* medical waste in a manner passable by the WHO. Granted, incineration is not the preferred method of medical waste management, as put forth in chapter 1, but it is preferable to the absence of any method. The Bahia Hospital is wholly opposed to the installation of an incinerator due to its contradiction with the core 'eco-conscious' values of the city, but also previously had a medical waste storage facility in the town, part of which currently remains intact and accessible.

Over the years since its construction, this infrastructure has been allowed to degrade to the point of non-functionality. On-site incinerators and building infrastructure to store infectious medical waste were visible on the premises of both SOLCA and the Regional MSP hospital, however in a dilapidated and neglected condition at the time of

my visits in 2006, and a landslide demolished much of the waste storage facility in Bahia in the late 1990s. Currently, none of the hospitals in Manabi have access to functional means by which to treat, manage, or store the bulk of their infectious medical waste. To credit the resourcefulness of these hospitals, all three do store all used sharps in sealable plastic containers (recycled milk and water jugs for the regional and Bahia hospitals and U.S. issued hazmat sharps containers in the case of SOLCA) and disinfect them in chlorine before disposal. They all also individually bag and treat placentas with a crystallized chemical disinfectant before adding them to the infectious waste stream.

The situation becomes much different after traveling radially outward from Porto Viejo. Aside from a few coastal cities that host ecotourism adventures and middle class beach vacationers, the vast majority of Manabi is inhabited by Ecuador's rural poor. There are small towns and villages scattered throughout the countryside, nestled in valleys or clustered near particularly fertile farmland. These places often have an intense and highly developed sense of community. Health care here is much less regimented and regulated than in the hospitals of the region. Each pueblo has its share of private clinics or practices, often run directly out of homes. Additionally, each relatively incorporated village has a 'centro de salud' which is a government healthcare facility provided by the national ministry of public health. These clinics offer standard services for the town such as immunizations, family planning services, and basic diagnostic tests. The community uses them in much the same way as college students utilize a campus health center. They serve as a first line of defense against health complications in the community. In very small towns and villages, a 'sub-centro de salud' will exist, which is an even more paired down and sparse version of the public health center. Rarely, the 'centro de salud' or

'sub-centro de salud' will be the only access to healthcare in a community, but it is more likely that there is at least one other private doctor who has taken up permanent residence in the community.

The waste output from any one of these private clinics or public health centers is quite minimal in comparison to the institutional quantities of a fully equipped hospital. However, in the most populous of these small towns, Bahia de Caraquez, it is not unusual to find upwards of fifteen private doctors announcing their specialties and services via hand painted signs or murals on the main streets of town. This solicitation in addition to the prominent face of the local public health center creates a significant total percentage of community waste that is medical in nature. Due to the large numbers of private practices in these small towns, there is no universal system of regulating waste management and it is largely the responsibility of each doctor to decide how to go about separating and/or disposing of their respective waste.

The MSP centros de salud are subject to the same regimented guidelines of waste separation as the regional hospital in Porto Viejo, and these facilities are often provided with government issued red plastic hazmat bags and various other containers for waste disposal along with their monthly rations of BD Systems single-use syringes and other basic health care supplies. The regional centros de salud to where these supplies are delivered further parcel out the supplies for truck-delivery to many smaller villages in the surrounding area. However, the province has no standardized method of garbage collection so after the guidelines have been handed down and the supplies distributed, there is no control over how the bags are filled or how the waste is disposed.

Nearly all the individual waste management strategies of private doctors mimic those of the large hospitals and centros de salud discussed earlier. Granted, they are less regimented. Interestingly, the private doctors themselves become the chief determinant and implementer of the waste management policies. Very few of the private clinics retain a staff, it is often a doctor, a secretary, and one or two nurse assistants. In slightly more prosperous practices (usually obstetrics), there is a small nursing team comprised of five or six nurses/aides.

The general method these doctors choose is to have two designated garbage cans one for infectious and one for non-infectious waste, usually labeled with tape or a paper sign. Additionally, they sequester sharps in five-liter water bottles and either dispose of the sealed containers without disinfecting them or employ the hospital method of a chlorine soak before discarding them. All 'centros de salud' abide by the chlorine bath method. There is some debate as to weather the chlorine soak weakens the plastic of the recycled containers such that they biodegrade more quickly upon disposal, adding exposed metal needles to landfills. Given that any interested human would have minimal difficulty unsealing one of these containers should they have the impulse, it is a point of contention weather these exposed, and eventually rusty, needles pose a greater health risk than the potentially infectious and accessible untreated needles.

Another interesting pattern within the most rural of these private facilities is that they retain no continuity of personnel. The 'sub-centro de saluds' often have doctors only present a few days of the week and the rest of the time the building is managed by one of several office clerks, or remains closed. In these instances of relatively low use, there is rarely any attempt to feign waste separation.

In general, each town has a local landfill where all its garbage is taken. This landfill is non-discriminatory as to what it can and cannot accommodate, and is thus a catchall for community waste. Most of the communities have running water in this area, so the landfill does not normally accommodate latrine waste/human excrement. These landfills are almost never in a reliably enclosed area, and frequently lack clear and visible signage, thus they function as promising scavenging sites for Ecuador's rampant population of stray dogs, prospective treasure mines for the poorest of the village poor, and mysterious adventure playgrounds for mischievous town youth. Being that none of these populations places a particularly high priority on avoiding contact with unsanitary material, it is unfortunate that they have such unmitigated access to these bacterial breeding grounds.

Aside from the infectious stream of medical waste, there is an equally hazardous chemical stream to consider. As to be expected in most developing nations, all of the blood pressure cuffs and thermometers used in Ecuador contain mercury. The blood pressure cuffs are usually donated from the cutting-edge 'first world' medical facilities who no longer have use for them, having switched over to non-mercury devices at the urging of the WHO and other international organizations that have recognized the immense danger of mercury exposure at any level. By default, these devices are increasingly prone to wear out, break, or become defective with time and without consistent maintenance. Considering this knowledge, it is striking, while perhaps not surprising, that not a single of the nineteen facilities surveyed had any means of cleaning-up, let alone disposing of mercury-containing devices. Mercury clean-up kits are relatively simple and extremely inexpensive to assemble and a DIY kit is equally

effective as a professionally assembled one (HCWH, no date). Temporary mercury storage facilities are also simple to construct with minimal access to resources. Instead, the universal response to questions about mercury waste was that it was just tossed into the infectious waste bins, or washed down the drain. There seemed to be little concern over the hazardous qualities of mercury, or the precautions that might surround its handling.

Still a third aspect of medical waste is the non-infectious stream, which is often ignored in discussions of this kind because it poses no direct threat to human health if managed incorrectly or recklessly. While many U.S. Hospitals employ general recycling companies to deal with the conventional recyclables like cardboard boxes and paper documents, there is virtually no 'recycling' infrastructure in place in Ecuador, least of all in rural communities. There are a few companies who specialize in recycled paper products, to which one could sell large quantities of used paper, but these companies only have a limited demand for this paper and are few and far between, both literally and figuratively. Because the majority of hospital waste is actually non-infectious, it begs the question as to what might be able to be reduced, reused, or recycled from such waste to diminish the quantities being sent to landfill where they artificially occupy space, and unnecessarily hasten the rate at which new landfills need to be created.

The larger pollution and over-consumption issues associated with non-infectious waste should command equal attention when addressing the paradoxical nature of the healthcare industry, given that they too hasten environmental degradation and may have even more broad and profound long term consequences regarding human health. The dioxins released from incinerating non-infectious waste such as PVC plastics (IV bags,

Nasal-Gastric tubes, etc) are more noxious and poisonous to human and animal health than many blood-borne pathogens. Instilling a consumption-conscious ethic in all health care professionals, not to mention the general public, could go a long way to curb this facet of the problem. Interestingly, much of the recycle, reduce, reuse rhetoric aimed at hospitals in the United States is already being practiced in Ecuador. Ironically, it is probably due to a lack of funding and resource availability that these practices have come to be implemented. The Hospitals in Porto Viejo and Bahia currently serve patients food on reusable dishes; launder and reuse bed linens, surgical gowns, and hospital gowns; and rarely use disposable surgical instruments.

This is an interesting place where what might be considered the 'overdeveloped' North American healthcare industry could learn from the practices of the Global South. When discussing the adverse human health effects of allopathic international health care via the adverse natural environmental effects of the practice, it is paramount not to overlook this non-infectious waste stream lest it be misinterpreted as benign.

To get at some of the root causes of these practices and management strategies, it was important to the project of this thesis to inquire as to the role of education in these iterations of medical waste management. Just as healthcare practitioners were systematically asked about the physical state of their waste management policies, they were also asked a series of adjoining questions about their attitudes and thoughts regarding said policies and how they were introduced to them. These questions were especially compelling because it is the impetus behind waste management practices, the reasoning used to implement them, that needs to change in order for any future access to resources or technology to be used in an environmentally responsible manner.

Role of Education in Medical Waste Management Practices

In the three Manabi hospitals, the attitudes of most all nurses that I had the opportunity to speak with about medical waste management were either apologetic or defensive. The idea of mixing the waste streams seemed to make them uncomfortable, but it was not a discomfort they could pinpoint. There was no discussion of environmental degradation or health hazards; it just seemed to them a generally bad idea. Each nurse I spoke with had a sense that it was not the ideal procedure to combine all the waste at the end of the day, but had no other course of action to take. They were compliant with all the guidelines passed down by the MSP, to the last dotted i and crossed t. Every practitioner was extremely forthcoming and eager to describe the systems of waste management, but at the utterance of what was always the ultimate question, 'where does it all go in the end?', there was always a muted exasperation, a frustration at the idea that they were being judged for something they had no control over. It was a legitimate frustration that I never quite knew how to alleviate within the confines of my language ability.

Due to the long work days, and specific requirements of their jobs, there has never been much cause for these hospital nurses to deeply question or probe the environmental ramifications of discarding a bloody dressing into a red trash can or haphazardly mixing previously separated waste streams. The job as it is described to them is to attend to the health, well-being, and comfort of patients. The chance that ideas about environmental responsibility might even cross the minds of the nurses, or doctors, or patients, is made even less likely due to the removed nature of the waste. Once it is placed in the bi-

colored dumpster, or sequestered into the holding room, it is never seen again. Porto Viejo is a large enough city that it would be rare to live within walking distance of the local landfill, and possibly not even know where it is, making the direct connections between environmental degradation and human health so disconnected and opaque that they would be extremely unlikely to occur. Many doctors and nurses had actually no idea where the medical waste went after leaving the premises of the hospital. This information was of the last possible priority to these people, and often only one or two high-ranking nurses or administrators had any idea who was removing the waste and where it was destined to go. Being that there is no direct consequence for not knowing this information and that the system works more efficiently when it is not questioned, there seems to be little inherent value to questioning its methods.

. The Bahia nurses, perhaps because they were operating in a town that placed, at least rhetorically, so much emphasis on environmental stewardship, were very quick to cite environmental degradation and air pollution at the chief reasons for their lack of incinerator. They said they chose to deal with their waste in a non-burn way, discussing the placenta and sharps management strategies as evidence of their competence and effectiveness and non-need of an incinerator. To them, hospitals existed to help people return to their daily lives and to get the most out of each day that they lived, in essence, they were a vehicle towards greater human health, and really had no direct connection to the health of the environment. When asked about threats to their local environments, mining companies and the oil industry were most frequently cited.

Turning to the private clinic doctors, there is a distinctly different attitude towards medical waste management. Given absolutely no regulations, these doctors still find it of

value to incorporate some system of waste-stream separation into their practice. The reason for this is largely unknown. It might be a simple parrot of the MSP policy that they had come across in training or medical school education, or it could be a moral obligation to doing 'the right thing'. Whatever it may be, the private doctors were more frank and honest when asked about the medical waste management strategy they had instated. A significant fraction discussed the uselessness of the policy; saying that they did it mostly to keep up appearances, but many warned me not to believe anyone that told me medical waste was specially managed in any rural area of the country. It all goes to the same place, they said, and it is dangerous and unsanitary, but there is nothing else to do. Believe us, they told me; if there were a better option, we would be employing it. The doctors seemed generally concerned with the welfare of the environment just as they were with the welfare of their patients, but the resounding cry in regards to the health of either was that they can only work with what they have. They were very pragmatic in their comments and explained that their attitudes were drawn from common sense, but that they had no idea what the appropriate way to dispose of medical waste was.

This attitude suggests that there might be some portion of medical school education that instills elements of an environmental ethic in doctors before they practice, but there are also far too many variables to theorize a relationship between these two elements. Whatever it is, there is some compelling incentive that provokes private rural doctors to continue separating their waste streams even though there is not even a symbolic regulation to speak of that would encourage such actions.

Another attitude I encountered a great deal in talking with the health care professionals of rural Manabi was an openness to change. There was little resistance or

hesitance to the idea of changing the way things were done, given the stipulation that little adjustment was required financially. If there was a 'better' way to do things, they were very eager to hear about it. One idea that emerged as a way to speak to this mentality as well as address a lack of information surrounding it was to compile a resource manual directed solely at widening the range of information access available to these healthcare practitioners.

As an experimental project, I attempted to compile such a resource. Using information from the fieldwork in rural Manabi, I compiled a list of items that were described to me by the healthcare practitioners as being potentially useful in creating change and placed the greatest importance on issues posing the most severe threat to environmental and human safety. The most prominent of these common themes were: a lack of access to treatment for infectious waste, a lack of access to recycling programs or treatment for inorganic noninfectious waste, and an inability to manage toxic chemical waste (i.e.-mercury). This list of items was used to develop an outline for a guide to environmentally responsible medical waste management. The guide was designed to target the rural heath care practitioners in Manabi, Ecuador. Following the creation of a rough outline, extensive research was used to deepen the detail of the ideas and inform the booklet as a whole. Ultimately, data gathered during the fieldwork survey of local health care facilities was supplemented with research findings to create a final version of the 35-page guide to ecological medical waste management in rural Ecuadorian medical facilities (see appendix 4).

Interestingly, all of the health care facilities that were surveyed have significant infrastructure, education, and information about the importance of separating the different

factions of their medical waste. For these reasons, the guide devoted large sections to addressing on-site alternatives to managing infectious, inorganic noninfectious, and toxic waste, as well as promoting community organization/action to develop off-site management programs, and providing general background information on the types of medical waste and the importance of their proper management. A great deal of attention was focused on making the guide user-friendly and including suggestions that are both easy to understand and execute. From this effort came a set of illustrations that attempt to clarify many of the written suggestions in the text. The final product is a working draft and template for what will hopefully become a future published and distributed work.

A great deal has been done and written about the ways in which medical waste should be managed in rural areas (Gnau, Kermode, Singh, WHO), and a great deal of programs focus their efforts on swooping in and setting up waste management programs and campaigns in a select few locations in the most desperate need of such solutions. Unfortunately, there is little to no work being done to close the large and definitive gap between the scientific suggestions being made and the medical waste management practices taking place in the great number of medical facilities not receiving 'top-down' assistance from an outside source. There exist no tools, no paths leading towards self-education or community action in any of these matters. This leaves communities who desire change and are committed to creating it left in a frustrating position, waiting for outside recognition with their wings clipped, so to speak.

The guide was born with the intention of working to close this gap and work to give communities a more autonomous role in the state of their heath and the heath of their surrounding natural environment. Its aim is to provide simple and effective steps that can

be taken at all levels of health care to reduce its contribution to environmental degradation without compromising its benefit to the human population. The irony here is that community autonomy is born from individuality and the application of unique solutions to the specific needs of a specific place and a specific people and the guide is based wholly on targeting a broad and general audience. Granted, this irony was spotted far before the guide was created and every attempt to address it within the guide was seized (see appendix 3), it remains a worthwhile consideration to take when promoting the use of this and similar materials.

Another important consideration to make when assessing the usefulness of this guide is that is relies almost completely on community participation to achieve its goals. It provides a significant resource, but that is it; it does nothing to create excitement or action or interest within the communities to which it would be distributed. For any shift in medical waste management to occur, a heath care facility would need to be compelled to make the change. A reliance (such as the one created by this guide) on the free time and eagerness of community members, whose jobs and lives are very difficult and draining as they are, to embrace this cause with open arms and energized hearts might be extremely dangerous and short sighted. Such a criticism would suggest that additional planning needs to be done to flesh out other, supporting ways to achieve the goals of the guide and reduce the burden on communities to take on more than they may potentially be able to handle.

Fundraising and planning stages for implementing medical waste management infrastructure as well as printing of the guide herein are of the utmost importance. This goal must be preceded by circulating the guide enclosed here to all the clinics that were

surveyed in the process of its creation (if not many others) to get feedback and recommendations as to the feasibility of its suggestions and any other reaction to its content. This type of 'test-drive' will help guide future development of educational materials and community resources that would be of the greatest benefit to the rural Manabi area. Other future directions could include assisting community members interested in making waste management changes in garnering support, advocacy, and visibility within and outside of the community.

The current situation in rural Manabi seems to be representative of the many small rural communities that dot the countrysides of not only Latin America, but also the global south and developing nations worldwide. The literature (Basu, Lavy, Arriaga) suggests similar/parallel situations in eastern bloc nations such as gypsy villages in Bulgaria and Romania as well as India, Bolivia, South Africa, Ghana, and Togo. There is little resistance to change and a great deal of acknowledgement and/or understanding that there is a problem, or that the medical waste management practices are not ideal. Unfortunately, there is little in the way of resources, financial and otherwise, to facilitate developing an ideal situation.

The main concern in these places with regard to medical waste management as well as a great number of broader development themes is a lack of infrastructure and a lack of education about the problem. Waste management is dealt with, by and large, through unmonitored, unregulated delegation into smaller and smaller responsibilities without a great deal of focus from the big picture angle, as well as marked lack of communication between the levels of delegation. Also, usually it is only one faction of the health care workers that have any real contact or thought processes that involve

medical waste. In larger institutions, this responsibility falls to the nurses, while it is the primary physician's decision in smaller private establishments. Continuity might just bring about mobilization. However, a very separate issue becomes an increase in resource base from which to develop this infrastructure. Due to the time constraints and scope of this project, there was no time to discuss these ideas with administrators in these places. One can only speculate as to what type of reception I would have received from those who are actually in charge of logistics and resource allocation.

I would argue, however, that the infrastructure and resourcefulness to adapt it already exists in rural Manabi. It just needs a fresh application, a freshly educated perspective from which to develop ways to serve these new needs. For example, a truck already makes the journey from Bahia de Caraquez to all the surrounding Centro de Saluds on a regular basis to deliver supplies. Imagine for a moment if this truck served not only the purpose of dropping off supplies and returning to Bahia empty, but instead traded the supplies for hazmat waste, returning to Bahia, with large enough quantities of waste to warrant the installation of treatment technology. Building one solar autoclave (see appendix 5) in Bahia (approx. cost of materials $2000) could centralize all of the hazmat waste management in region to one location. Furthermore, building one solar autoclave in Porto Viejo, at the regional hospital, and adding a truck route from Porto Viejo to Bahia to transport the hazmat waste from Bahia could centralize the medical waste of the entire province. The solar autoclave design included in the appendices of this paper was specifically designed to be constructed without the need for specialized labor, and could thus serve as a source of temporary employment in the communities

where they are built, as well as permanent employment as technicians, managers, and servicers, once they are built.

A reduction in length of commodity chains for everything from lumber to food is an often-advocated remedy to the aforementioned problem of hurting another place as you help yourself. Resorting to small enclaves of regional magnitude is often seen as a realistic goal of many concerned primarily with conserving the natural environment. While the actualization of such a lifestyle might be ideal, again, we must work within the boundaries of reality. For better or worse, we have become wed to globalization, and the environment that medical waste management practices degrade in Ecuador is part of the same environment that exists in rural northwestern Minnesota, USA. While Ecuador struggles to implement nationally enforceable sanitation regulations, the healthcare facilities in Minnesota work to skirt the regulations in place there, adding to the urgency and immediacy of this issue.

CHAPTER 3:
Medical Waste Management in Rural Northwestern MN, USA

Reservation Life

The reality of the northwestern Minnesota Native American Reservation is at once a stark and solemn reminder of centuries of pain and anguish, but also a last refuge for deep cultural traditions and vibrant spirits that no amount of pain and anguish can wipe out. The Leech Lake, Red Lake, and White Earth Reservations are located in the northwestern corner of Minnesota, U.S.A (see appendix 3) and are home to three distinct bands of Chippewa people. On these reservations there are tremendous barriers to health care and information. The travel distance, limited roads, harsh climate, and unfamiliarity with urban areas and medical personnel results in many patients delaying or foregoing care (Meyer). It is important to fully investigate the causes of these barriers, because a number of the causes that underlie the marginalization of Native Americans also underlie their feelings about health care and their reasoning behind medical waste management decisions.

The Leech Lake Native American Reservation is located in the north-central Minnesota counties of Beltrami, Cass, Hubbard, and Itasca. As of the 2000 census, it had a population of 10,205, making it the largest Native American Reservation in the state by number of residents. Under the Indian Reorganization Act of 1943, the contemporary Leech Lake Native American Reservation was formed from the merger of Leech Lake, Cass Lake and Lake Winnibigoshish Reservations. The Chippewa National Forest now takes up most of the reservation land, and only a very small percentage is owned by tribal members (leechlakeojibwe.org).

The Red Lake Native American Reservation covers parts of nine counties in northern Minnesota, USA. It is divided into many pieces, although the largest section

is centered about Red Lake, in north-central Minnesota, the largest lake entirely within that state. It is home to the Red Lake Band of Chippewa, and is the most populous reservation in the state according to the 2000 census. The reservation's largest community is Red Lake, on the south shore of Red Lake. Per capita income is lower at Red Lake than on any other reservation in the state. It was estimated at US$ 8,372 in 1999 according to the Northwest Area Foundation. About 40% of residents live at or below the poverty line. Between 1990 and 2000, the population also grew by 40%. Many people have been returning to the reservation after having difficulty finding work elsewhere (often in the Twin Cities region to the south) (Wilkinson).

The White Earth Native American Reservation is the home to the White Earth Nation, located in northwestern Minnesota. It is the largest and historically poorest reservation in the state. Community members here often prefer to self-identify themselves as Anishinaabe instead of Ojibwe or Chippewa. The reservation held a population of 9,192 residents as of the 2000 census. The White Earth Native American Reservation is a member of the Minnesota Chippewa tribe. The reservation originally covered 1,300 square miles, but much of the community's land was improperly sold or seized to outside interests, including the U.S. federal government, in the late 19th century and early 20th century. In 1989, Winona LaDuke formed the White Earth Land Recovery Project, which has slowly been pushing for the recovery of more land. The project claims that only 10% of the reservation's land is owned by tribal members (Meyer).

On reservations like these, the unemployment rate hovers anywhere between 50 and 80 percent, and alcoholism, substance abuse, injuries, accidents, and violence are common. National statistics show persistent disparities in sociocconomic conditions

between the people who live on most Indian reservations and the U.S. population at large, with higher rates of unemployment, lower median incomes, lower educational levels, and higher rates of poverty (Wilkinson). For most Native Americans, relocation to rural reservations in the 1800s resulted in a loss of culture, traditions, and familiar ways of life and left them isolated in places that were far removed from the resources available in urban areas. Years of poor educational systems and lack of opportunity have resulted in seriously depressed socioeconomic conditions on most reservations.

The Red Lake Hospital in Red Lake, MN is located within the confines of a juvenile detention center and serves the entire reservation. The Mamowi Widokagaywin Clinic in Cass Lake, MN is located on the side of Highway 2 and serves the entire Leech Lake Reservation. The Mahnomen Health Center in Mahnomen, MN is a converted educational administration building that has been retrofitted for Hospital use. It has less than twenty beds and serves the entire White Earth Reservation. The Native Americans living in the area, but off of reservation land, as well as the non-native American Indian population of rural northwestern Minnesota looks to the Regional Hospital in Bemidji, MN for their emergency medical needs and long term critical care

The often outdated and understaffed hospitals in these communities frequently lack enough beds to serve all that would warrant them under ideal conditions, they have always-busy outpatient clinics, and small emergency rooms. Usually, additional clinical services are housed in trailers or make-shift buildings to the side of the main facility and signs are posted everywhere cautioning patients not to bring firearms onto the premises, a constant reminder of perennial violence and trauma. These types of hospitals and clinics typically treat adults and children with broken bones from unintentional injuries and car

accidents, attend to patients in various stages of alcohol or drug intoxication, and treat the unfortunate and often preventable complications of chronic disease.

Although the federal government has a trust responsibility to provide health care for American Indians and Alaska Natives, the Indian Health Service is substantially under funded and understaffed. This service was established in 1955 to provide primary care and public health services on or near Indian reservations. Although it can take credit for great improvements in health status, significant disparities in health and the quality of care persist 52 years later. Many factors contribute to these disparities, but the fact remains that Indian Health Service per capita health care expenditures are much lower than those of other health care systems in the United States (Kunitz).

Methods

In order to gather an accurate picture of medical waste management in rural Northwestern, MN, I completed a survey of the general waste management practices of the area over a period of four days. The survey consisted of 5 health care facilities in 4 communities (Bemidji [2], Mahnomen [1], Cass Lake [1], Red Lake [1]) that serve the rural, and mostly Native American, population of Northwestern, MN, USA. I interviewed health care practitioners and/or maintenance workers at each facility (doctors, nurses, janitors, etc) regarding a series of topics concerning the management of each type of their medical waste (see appendix 2). The results of these interviews were compiled and analyzed for common themes in education and practice as well as interesting anomalies. All information presented in this chapter is drawn from these interviews and personal experiences unless otherwise noted. It is also important to

acknowledge my position of privilege in conducting this fieldwork was not nearly comparable to my position of privilege in Ecuador. I retained much more limited access to information and forthcoming practitioners in Northwestern Minnesota than I did in Ecuador. However, I would still like to acknowledge that I carried socioeconomic and racial privilege with me into many of my fieldwork situations in Northwestern Minnesota.

Medical Waste Management Practices

In Northwestern Minnesota, similar to Ecuador, there are main hospitals that provide all emergency and critical care to the most serious ailments, diseases, and injuries. For most other medical needs, such as pregnancy consultations, immunizations, and check-ups, residents of very small communities prefer not to make the long, and occasionally expensive, journey to the larger towns. Much like the Centros de Salud and small private clinics in rural Manabi, there are weekday clinics scattered across extremely rural areas of the reservations and in Bemidji for less emergent health care needs such as refilling prescription drugs, etc. These clinics often have very limited hours of operation and can only address a small subset of medical needs and are most often run by private hospital brands such as Fairview. Rarely are these clinics state or federally subsidized.

Because of this relative shortage in resources, these hospitals and clinics are faced with similar concerns as Ecuador regarding the limitations of their ability to dispose of medical waste. The United States Government makes it more difficult to take the cheapest route of disposal, which would be simply throwing all hazmat waste in with non-infectious waste, as they ultimately do in Ecuador. There are regulations and laws

that are reliably enforced in the United States, as well as a registration process that allows officials to monitor the activities of any institution that offers health care. These regulations include guidelines for how medical waste is to be managed, and the penalty for being disobedient is steep enough to warrant compliance (HCWH, 2003). Given that legality factors in, it is the cheapest legal option of waste disposal that tempts these rural hospitals and clinics, not the allure of a system that aims to improve environmental health.

In the United States and similar nations with regulatory policy on medical waste, the most inexpensive manner of disposal is incineration. Fortunately for the environment, and unfortunately for many health care facilities with limited resources, there are a host of emissions standards and restrictions that keep most institutions from being able to justify the cost of installing and maintaining an on-site incinerator (Emmanuel, 2005). For these reasons, it becomes most cost-effective to ship waste to a large medical waste incinerator that is maintained to government standards. All of the facilities I visited had a virtually identical protocol for disposing of medical waste. Each had a holding room for hazmat waste attached to a loading dock or drive-up area and a separate set of dumpsters and recycling containers for non-infectious waste. Every clinic sent their waste, via various companies, to the same medical waste incinerator in Fargo, North Dakota. All hospitals used non-mercury technology in their institutions and at minimum employed a paper and cardboard recycling service to treat a large portion of their non-infectious waste stream. The Bemidji Regional Hospital also used a grease recycling company (MidWest Grease) based out of Minneapolis, MN to recycle their kitchen grease into livestock feed.

Once in Fargo, the medical waste is incinerated in a standard Medical Waste Incinerator (MWI) operated by the Health Care Environmental Services. The incinerator sits in an industrial park area off the side of a highway outside of town. It was built in the late 1980's, when medical waste treatment took the media spotlight after used syringes and other hazardous solid waste turned up on the beaches of New Jersey. In quick response, new regulations and requirements were developed for the handling and treatment of the medical waste stream (Thornton). Although these regulations calmed the public, medical facilities were left with trying to comply with new requirements. These new requirements focused on preventing contact between the public and infectious waste and, as a result, many facilities chose to put much, if not all, their waste into incinerators. This strategy was not only a quick and easy decision for them, it also significantly reduced their waste volume going to landfills, seemingly saving money. Thus, the waste was completely sterilized and the volume reduced, giving a double incentive for using incineration technology to manage waste.

To this day, most of the nation's 2400 medical waste incinerators, including the one in Fargo, employ little to no emission controls on dioxin release (Thornton). In addition, many facilities, including the Mahnomen Health Center, burn not only their infectious waste, but also their entire waste stream, creating even more unnecessary emissions. It almost seems as though because these hospitals have a systematic way of disposing of their waste and they have no personal connection to the ultimate fate of that waste, that they make no effort to curb waste creation or resource consumption as an institution. The total volume of waste output from comparable facilities in Ecuador relative to the Reservation hospitals and clinics is drastically different, and always significantly greater

for the United States facilities. Considering this, it could be argued that extremely large quantities of 'legally' managed waste do as much if not a great deal more harm to the natural environment than smaller un-managed or poorly managed quantities of medical waste.

Role of Education in Medical Waste Management Practices

When asked for their thoughts on medical waste management, the responses from healthcare practitioners and janitors in Northwestern Minnesota were strikingly similar to those of healthcare practitioners in rural Manabi. Instead of the decisions about medical waste management falling to doctors or nurses, they face falls to nurses and maintenance staff in rural Northwestern, MN. The doctors are seldom bothered by what one female nurse referred to as 'trivial matters like trash disposal'. True to her warning, the two doctors that I spoke with had no knowledge of the protocol for medical waste disposal in their respective hospitals beyond that infectious waste needed to be 'red bagged'. Every nurse I spoke with knew the protocol in at least some level of detail, mostly because the hospitals were small enough that many nurses had been assigned trash-duty several times. The nurses credited their knowledge about the waste management policy to training courses upon beginning the job (regarding in-hospital compliance such as what constitutes hazmat items). Maintenance workers had by far the most intimate knowledge of medical waste management policy, but even they only knew that the 'hazmat stuff goes to an incinerator in Fargo and I don't know what happens to it after that,' to paraphrase one gentleman. The only people I found able to give me detailed information about the company and manner in which hazardous materials were dealt with after they

left any respective clinic or hospital was from an administrative director of the 'environmental services' office at each facility.

Similar to the Ecuadorian response, the vast majority of healthcare practitioners and workers that I spoke with seemed too busy or hurried to think about any environmental impact they might be contributing to while at work. When pressed as to what effect they thought medical waste had on the environment, all of the administrators answered with some form of the same response, pointing out that relative to many global problems the environmental impact of medical waste was a relatively minute concern. Several nurses saw the environmental impact of allopathic medicine as a significant problem, but felt powerless to take any action against it, citing the corporate nature of policy in hospitals owned by private companies such as Fairview. The maintenance workers, again, had the strongest opinions and knowledge about the issue, and were very cynical in their responses. Many commented on the vast quantities of waste created by their respective healthcare facilities and all felt an attempt at change would be completely futile. They commented that all education they received before beginning to work had to do with governmental policy and compliance to regulations, no mention of the reasoning behind the regulations or any compelling logical explanation for the policies.

The healthcare practitioners and workers in Northwestern, MN also seemed open to change as long as they were not required to instigate it. A more 'sustainable' healthcare appealed to the majority of them, however no one was receptive to the idea that it would be a feasible goal. If their job descriptions were changed, however, and they were given a new framework to operate within, one hundred percent of the practitioners and workers were not averse to adjusting their routine to accommodate it.

Overall, the responses from Northwestern, MN practitioners and workers suggested an apathy and cynicism towards change that I did not feel when conversing with Ecuadorian healthcare practitioners. While there was no hostility towards the idea of an environmentally responsible allopathic healthcare, it was laughable that anything might be able to begin to challenge the immovable structures of allopathic medicine as it has been practiced for hundreds of years.

Perhaps the solution here does not lie within the confines of allopathic medicine at all. The extreme socioeconomic depression that exists on these reservations begs the question of whether addressing the underlying social causes of many of the healthcare inadequacies for Native American populations might not do a great deal to decrease the amount of medical waste output that is created, along with providing a more informed outlook on the issue. Diverting resources towards these social causes and away from environmental solutions that could, in some light, be construed as 'band-aid' remedies, is one way to approach the problem. However, it will be a forever-contested question as to the causal (or non-causal) relationship between the two predicaments. Waiting for an entire societal turn-around to 'trickle down' into environmentally just manifestations may be too large of a price to pay in ascribing to such a strategy.

Another way to approach waste reduction rather than regulations or practitioner education is through the less formal lens of community education. Considering education in a more holistic sense, a focus on changing or shaping the way one sees the world, many more avenues open up as opportunities for addressing this issue in communities and non-practitioner populations. From here, there are a great number of places to draw inspiration.

Like healthcare, a healthy lifestyle will improve both the length and quality of one's lifespan. It will also lessen the frequency with which one visits the doctor, creating less medical waste simply from lack of necessary service. While this more abstract and 'big picture' take on the issue may not be the route towards a powerful impact, it seems to be the level at which the actual communities are addressing sustainable healthcare, and it is the beginning of a larger cultural shift. Thus, community education approaches should be honored and recognized as equally worthy avenues of change as practitioner curriculum alterations. Coincidently, one promising model for enacting this type of education comes from a community discussed above.

On the White Earth Reservation, a group of about a dozen women have come together to promote healthier living through education in traditional methods of farming, foraging, food preparation and preservation, nutrition, and renewable resources to name a few. Known as Minwamanji'o, this group of Native American women meets approximately once a week to share ideas and fellowship. The group also goes on foraging expeditions together, gathering seeds, berries and herbs to be used in cooking healthy, organic meals. These expeditions are a means of both good exercise and an education in botany. Often, they serve as seminars on plants usually regarded as weeds growing in the wild that actually have a medicinal or culinary application (Gashing).

In addition to growing gardens and foraging for food, seeds and herbs, the group has also formed a natural foods-buying club and built about five greenhouses for raising their own natural foods, herbs and flowers. They began planting flowers around the White Earth community about three years ago, as a beautification project. Some of the group's activities have included canning and basketry workshops, a maple sugar camp in

the spring, and herbal medicine workshops that teach how to identify, prepare and use various herbs for medicinal purposes. Given that most of the women are master gardeners, other gardening clubs in the region also invite the Minwamanji'o women to their meetings to share information about their projects and activities (Gashing).

Though most of the group's membership comes from the Chippewa community around White Earth, their goal is to share the benefits of a healthier lifestyle with the entire northern Minnesota community. A motto of the group is "We are keepers of the earth. We need to learn how to take care of the earth; it will always give something back" (Gashing). Community education that fosters this type of environmentally responsible ethic is an excellent way to build an environmentally responsible society whose concerns will rest with ideas like 'sustainable healthcare'.

It is this type of interdisciplinary support and cooperation that is needed for all initiatives addressing both human and environmental health. Grand mobilization is needed to apply legitimate pressure on the pillars of allopathic medicine and combat the cynicism of the healthcare workers of Northwestern, MN. Such a force might come from all types of organizations invested in different elements of the drive for an environmentally responsible healthcare realizing their connection to one another and pooling their resources to fight for the same ideas. Just as this thesis calls for humanity and the earth to be considered as a unit when determining how to establish an appropriate healthcare system, a cohesive unit of all parties affected by this issue is needed to enact any large and/or long-term solutions to this problem. However it is true that a push needs to come from somewhere, someone needs to get the ball rolling, so to speak. And if a revolution in sustainable living is going to be borne out of anywhere, it is only logical

that the health care industry should lead the way.

CHAPTER 4:
The Natural Environment in Healthcare Education and Implications for Curriculum Change

For the purposes of this discussion about education, the communities of rural Manabi, Ecuador and the Native American reservations of Northwestern, MN, USA will be used as representative examples of rural communities that presently contribute to environmental degradation through the waste management practices of their allopathic healthcare industries. As discussed in chapters two and three, the health care practitioners in these communities have received little to no education regarding the logic, purpose, or reasoning behind the medical waste management practices they enact. Many feel they should ideally be doing something different, but have no way of knowing what that thing is, and even more are open to learning a new routine if an improved system is implemented. The question then becomes, what would this system look like? How does education go about shaping and influencing practice?

The Natural Environment in Medical School Education

In October of 2006, over four hundred experts on ecology and human health from thirty countries convened in Madison, WI for the EcoHealth ONE conference. The theme of "Promoting Global Health—Sustaining Natural Resources" put it at an excellent position to discuss the place for environmental education in health care curriculum, and discuss it they did. The overwhelming message taken away from the conference was that health care must find a way to encompass a responsibility to ecosystem health in its fundamental tenets. The conference lasted three days and covered a range of material including topics like the effect of urban design on equity and health, the industrial livestock industry's cultivation of antibiotic resistance, and the ties between deforestation and malaria (www.ecohealth.net).

Rita Colwell, the banquet speaker and director of the US National Science Foundation from 1998 - 2004, made an especially compelling case for wedding ecology and health when she revealed surprising connections between climate and cholera. In 1983, Colwell discovered that *Vibrio cholerae*, the bacterium that causes cholera, attaches itself to zooplankton, and in particular to tiny relatives of shrimp called copepods. Until her discovery, the vibrios' hideout between cholera outbreaks was a mystery because the dormant bacteria are difficult to detect in the ocean. In the last few years, however, Colwell and her colleagues have used satellite remote sensing to show that the warmer sea surface temperatures conducive to plankton blooms are tightly correlated with past cholera outbreaks in Peru and Bangladesh (Colwell). The connection between climate and cholera exemplifies the glaring reasons why collaboration between all disciplines is necessary in an ever-globalizing world.

Unfortunately the essential collaboration that combines ecology with disease is missing from allopathic medicine, despite being long recognized as essential in understanding the biology of the world. Thankfully, growing fears of global plagues and bioterrorism are reviving disease ecology and citing SARS and avian influenza as two prime examples for its need (Smith). The newly launched journal EcoHealth (2004), which sponsored the conference, focuses on pushing towards the educational integration of environmental and allopathic disciplines, and used the conference to make the point that making professional connections between doctors and ecologists is as much of a challenge, and just as important, as making the scientific connections between disease and ecology (www.ecohealth.net).

The conference drew an interdisciplinary attendance including veterinarians, social scientists, public health workers, and organizations like NASA and Conservation International, but only a limited number of physicians. As a whole, the allopathic medical community is receptive to the concepts and mission of EcoHealth, but has yet to receive compelling incentives to become involved. Consider that none of the US National Institute for Health's $28 billion budget funds ecological studies (www.ecohealth.net).

Despite their small number, there are physicians and committees that do work tirelessly to integrate ecosystem and human health. As of 2004, the University of Hawaii's John A. Burns School of Medicine is undergoing an historical transition, which has involved the reorganization and creation of several new departments including the Division of Ecology and Health. In establishing this new unit, the US medical school leadership recognized the importance of addressing the cultural and ecological dimensions of health in research and education programs. The Division's establishment also was compelled by school's mission to serve the unique health needs of the people of Hawaii and the Pacific Islands, particularly those of indigenous populations with particularly high rates of chronic disease and significant community health issues. This especially depends on innovative, community-based, ecological approaches to research and practice, and integrating concepts at the interface of ecological and health sciences into the medical curriculum (www.hawaii.edu/ecohealth).

The Faculty of Medicine and Dentistry are developing the Ecosystem Health program at the University of Western Ontario, Canada in cooperation with a number of other faculties on campus. This program has the endorsement of the President of the University of Western Ontario, the Dean of the Faculty of Medicine and Dentistry, the

Dean of Science, and the CEO of the London Health Sciences Centre. The goal of the Ecosystem Health Program is to encourage students and faculty to "look outside the box" of traditional medical training and consider the bi-directional interactions between humans and the environment. Students are taught to consider not just the health of the patient, but also the health of the community, the population, the biosphere and the earth. In order to accomplish this, factors that affect health are considered to include medical, environmental, economic and socio-political aspects. The Program also works with those in other disciplines to promote an interdisciplinary approach, which addresses the linkages between ecosystems and human activity. Physician John Howard of the Ecosystem Health Program has been quoted as recognizing that "Big systems are going to be the problem for the 21st century" (Rapport).

The Faculty of Medicine at the University of Benin is also working to incorporate the Ecohealth approach into their curriculum in the fourth year of medical school as well as at the Masters and PhD levels. This model will be replicated in selected programs within other universities in the region. Additionally, the University of Benin will be further in charge of developing a set of basic courses on Ecohealth, which will be offered to students within the universities of Benin, Cote d'Ivoire, Cameroon, and Burkina Faso. This institutionalization of the approach will build a community of researchers in the region that will promote the use of Ecohealth methodologies in generating knowledge about the links between the environment and the human health (Yacoob).

The Natural Environment in Nursing School Education

While medical schools offer many promising moves towards incorporating an environmental ethic into their curriculum, it is nursing that has had the longest standing awareness and recognition of the connection between health care practitioners and environmental change. Since the time of Florence Nightingale, the environment has been considered a core phenomenon to successful models of nursing. Nightingale stressed the importance of developing sanitary codes for hospitals and identified five factors for nurses to consider in optimizing the physical environment of the ill person: (a) pure air, (b) pure water, (c) cleanliness, (d) light, and (e) efficient drainage. She has even been called an "environmental adaptation theorist" (Institute of Medicine).

Nightingale was also not the only nurse to emphasize the importance of the environment on health. At the beginning of the 20th century, Lillian Wald (1915), the founder of modern public health nursing, advocated for sewage and sanitation laws and established milk stations in New York City to provide safe milk for infants and children. Wald built playgrounds and started fresh air camps in the country to assist children in getting away from the environmental hazards of the city. Mary Breckenridge (1952), the founder of the Frontier Nursing Service, also used environmental principles in her work. In planning to build a hospital in rural Kentucky, she took into consideration that the building site should have a source of clean water, be at a safe distance from outdoor privies that could contaminate wells, be away from noise, and have adequate light. She enjoyed renowned success in reducing infant mortality by incorporating principles of environmental health into her nursing practice (Chinn).

In the early 20th century, many nurses worked predominately in the community setting in which they saw firsthand the key role the environment played in health and disease. However, as hospitals assumed a greater role in the care of ill people and as nurses were more frequently employed in institutional settings, less emphasis came to be placed on the importance of the environment on health (Institute of Medicine). However, recent resurgence of nursing's historical commitment to the environment can be seen in groups such as the Luminary Project, "a web-based effort to capture the illuminating stories of nurses' activities to improve human health by improving the health of the environment", Nurse's Environmental Health Watch, and Nurses for Environmental and Social Responsibility.

Part of this phenomenon might be that nurses are particularly well positioned to address environmental health hazards, both on an individual and community level, for a number of reasons. Nurses comprise the largest group of health care providers in the United States and as a general rule spend a significantly larger portion of their time in contact with patients and providing direct patient care. In addition, they are often the only health care providers who visit patients in their homes, workplaces, and local communities, thus gaining firsthand knowledge of the potential environmental hazards present in these settings (Chinn). The close interaction nurses have with their clients provides them with numerous opportunities to detect environmental health problems. Also, it is important to consider that nurses physically perform the majority of procedures and actions that contribute to a vast fraction of hospital waste. For these reasons, environmental issues have the potential to confront nurses in almost every aspect of their jobs.

While the above information is readily available for all who care to search it out, there are currently no standards of practice for environmentally responsible nursing. Both the International Council of Nurses (1986) and the American Holistic Nurses Association (1990) developed position statements on the nurses' role in safeguarding the environment. The National Institute for Nursing Research identified the need to incorporate environmental sciences in nursing research and occupational health nurses routinely utilize environmental health concepts in their practice, recently adding the word 'environmental' to the governing, policy, and general association documents of the American Association for Occupational Health Nurses (Chinn). Fortunately, nurses have again resumed their role as strong leaders in the fight to unite the pursuit of human and ecosystem health under the same profession.

The Natural Environment in Public Health

Within the field of Public Health, which has historically been overshadowed by the discipline of allopathic medicine, there is an entire sub-field dedicated to linking environmental and human health for the good of both. The field of Environmental Health Sciences is concerned with the adverse influence of the environment on human health and with controlling these influences. Traditionally, the field of environmental health sciences has focused on hazardous agents in the environment, including biological, chemical, and physical environmental agents (Baum).

The field of Environmental Health Sciences (EHS) is a well-respected and mainstream sub-discipline of Public Health. Virtually all graduate degree-granting institutions that have a School of Public Health or offer degrees in Public Health offer

curriculum and graduate degrees in Environmental Health Sciences. Those with EHS credentials are often involved in primary research aimed at specifically elucidating some facet of the environment/human connection. To a lesser, but still significant degree, EHS experts work the government, the industrial sector, clinical practice, and academia (Rapport).

The EHS discipline asserts that the environment permeates nearly every aspect of human disease and that various forms of environmental stress can be used to understand many of the unknown mysteries of human biology. EHS embraces the idea that solving these relationships requires the combined knowledge of a diverse array of scientific thinkers. Interdisciplinary collaboration is essential to the success of EHS, and as such it is rare that any EHS scholarship is done with experts of only one field (Thacker).

This type of interdisciplinary focus is ideal when grappling with issues of public health, environmental impact, and socioeconomic marginalization as the communities of rural Manabi and the reservations of Northwestern Minnesota do on a daily basis. Navigating the complex web of issues mentioned above while also working within the constraints of a longstanding and supremely respected institution such as allopathic medicine is an extremely difficult task to manage, but seems to be expertly suited to one dually educated in allopathic medicine and a discipline such as EHS.

Ecological Medicine

Perhaps the most promising educational initiative combining the interests of human and environmental health is the emerging field of Ecological Medicine. This field works to reconcile the care and health of ecosystems, populations, communities, and

individuals. It sees the health of ecosystems as the foundation of all health and views human impact in the form of population pressure, resource abuse, economic self-interest, and inappropriate technologies to be rapidly degrading the environment. Ecological Medicine then does what this thesis has been perpetually calling for and connects this human impact with new patterns of human and ecosystem poverty and disease. It does not specifically address the impacts of allopathic medicine as a cause of human impact, but the extrapolation to include such ideas seems in line with its basic tenets (Aguirre).

At present, Ecological Medicine represents a philosophy about health. There is no official degree-granting institution that can offer certification in Ecological Medicine. The system of thinking that underlies Ecological Medicine as well as the term 'Ecological Medicine' are the brainchildren of the Bioneers, a New Mexico based non-profit organization (also known as the Collective Heritage Institute) founded in 1990. According to the Utne Reader, a Bioneer is "a biological pioneer, an ecological inventor who's got an elegant and often simple set of solutions for environmental conundrums." As coined by filmmaker and activist Kenny Ausubel, the term describes individuals and groups working in diverse disciplines who have crafted creative solutions to various environmental and socio-cultural problems rooted in shared core values, including whole systems, anticipatory thinking, a view of all life as interdependent, and sustainable mutual aid. The Bioneers are most well known for their annual conference, held every October in San Rafael, California, and simultaneously broadcast via teleconference technology in many locations around the United States and Canada. The conference highlights the work of scientific and social innovators and helps support, nurture and propagate their ideas and models. Conference speakers come from a variety of

interdisciplinary fields (www.bionners.org).

The discipline of Ecological Medicine is centered on the claim that public health measures, education, and medical advances have significantly reduced death and disease in many parts of the world, but some advances come at considerable cost, and the benefits are not equally distributed. Public health systems charged with creating healthful conditions for all have suffered in competition with technologically intensive health care aimed at individual consumers. Health care systems struggle to keep up with the changing patterns of disease that result both from a rapidly changing and degraded earth and from the way people live. Due to increasing global interconnectedness, new and old diseases spread faster within and across national borders. Meanwhile, industrially based medicines and technologies that are designed to heal, also contribute to the growing number of persistent environmental toxins in plants and animals. Ecological Medicine calls for urgent and collective action in all aspects of environmental stewardship regarding medical practice, including but not limited to updating education curriculum. The discipline has a strict commitment to enhancing the quality of all life on this planet. It addresses the concerns of marginalized rural communities struggling to ecologically manage medical waste (Aguirre).

In rural Manabi, practitioners educated from an Ecological Medicine perspective would be attuned to using existing resources in an ecologically sound manner. These practitioners would also be aware of the reasoning behind medical waste practices and could apply the reasoning in creative and fresh ways when faced with challenging problems. Mobilizing the labor to build a solar autoclave could be one example of such innovation. On the Native American Reservations of Northwestern MN, practitioners

educated from an Ecological Medicine perspective would be hyper aware of strategies to reduce consumption and might decide to use the money saved by reducing waste to upgrade the infectious waste treatment technology away from incineration to an autoclave.

Implications for Curriculum Change

As Carlos Morel, the director of the special programme for research and training in tropical diseases of the UNDP/World Bank/WHO, said, "Because the theme—the interface between ecosystem change and public health—is so extraordinarily complex, relevant literature and information sources are spread throughout a multitude of different disciplines, from biology, chemistry, and physics all the way to the social, economic, and behavioral sciences. As a consequence, students, faculty, and researchers interested in this area have lacked a primary source of inspiration and reference for their work" (Aron). This source of inspiration still remains elusive, but I propose that it take the form of education reform for all allopathic healthcare practitioners.

In chapters two and three, the state of medical waste management and resulting environmental impact of allopathic medicine was laid out for two rural marginalized communities. Allopathic healthcare practitioners and workers in both communities felt their current system of medical waste management was inadequate, but had no means to change it and no access to understanding what would make it more optimum. One way to address this lack of access to information is a change in practitioner education curriculum that addresses the concerns of ecological as well as human health.

It has been demonstrated above that a trend towards environmentally conscious allopathic healthcare instruction is on the horizon. In order for marginalized rural communities to avoid environmentally degrative behavior, it is imperative that this trend be fully embraced by the institution of allopathic medicine. I suggest that the best way for allopathic medicine to fully embrace the values of ecological health is by incorporating the fields of Environmental Health Sciences and Ecological Medicine fully into its entire practitioner curriculum. Such an action would create a unified, interdisciplinary system of healthcare that addresses all the causes affecting human health, not just the biological symptoms. In addition to incorporating the tenets of allopathic medicine, Ecological Medicine, and Environmental Health Sciences, new healthcare practitioner curriculum should be united by an adherence to several universal values: interdependence, diversity, and cooperation.

Ultimately, humanity is dependent on the health of the earth's ecosystems and vice versa. An appreciation of this interdependence is essential to making informed decisions about healthcare practices. Additionally, healthcare comes in a number of diverse varieties and is informed by many traditional healing systems, local adaptations, and indigenous science around the world. In order to gain knowledge and improve practices, patients should be in equal partnerships with practitioners, and medical practitioners should cooperate with ecologists and other experts on the natural world. Relative to cooperation, healthcare organizations should be managed with the active participation of the communities they serve while communities must learn to coexist respectfully with their local ecosystems.

This comprehensive approach to healthcare would ensure that allopathic medicine no longer endangers human health by degrading ecosystem health with environmentally reckless medical waste disposal. The benefits of this education system would be especially beneficial to the residents of rural marginalized communities such and rural Manabi, Ecuador and the Native American Reservations of Northwestern, MN, USA because they have the least access to resources and technology that help to mitigate the effects of ecologically irresponsible practices.

Final Conclusions

When addressing the needs of a wide variety of unique communities all dealing with degrees of the same problem, it is difficult to prescribe a single antidote that will be equally effective everywhere it is used. In the case of using education to alleviate environmental degradation due to allopathic medicine in rural marginalized communities, the same sentiment holds true. This work shows the variation between two communities grappling with the same issue, as well as a great degree of similarity. However, reforming healthcare practitioner education will certainly affect the two communities differently. Because such sweeping initiatives would most likely begin in the Global North, their effect would be felt much more immediately by communities in the Global North, no matter how marginalized. Here is where the benefits of community education and organization could help to offset the waiting period for the effects of education to 'trickle down' to the Global South. For this reason, any curriculum reform should place excruciating pressure on existing as a truly global and international solution, providing all communities equal access to the curriculum.

As with all things international, an interdisciplinary response seems to be the best. A call for reformed allopathic healthcare practitioner education is really just one facet of a larger project that aims to provide a structured means for those concerned with the issues of human and ecosystem health to engage with each other. Never has this function been more important or necessary. Communication is essential to maintaining global health and a universal healthcare curriculum could be the first step in facilitating and promoting interdisciplinary interactions in both traditional and innovative ways. One of the greatest benefits of an educational reform is its ability to reach into the future and shape upcoming generations of healthcare practitioners. Now is an especially crucial period for the healthcare industry. In the United States, the baby boom generation is beginning to move into old age and in developing countries people are living increasingly longer lives. Educational reform now could help to develop, promote, and provide innovative perspectives on healthcare that do not exist today.

Although a number of burgeoning education reforms exist with the goal of creating a more 'sustainable' healthcare system, no one system of curriculum provides a specifically focused source of support for the goal of alleviating the burden of environmental degradation due to allopathic healthcare in marginalized rural communities. Such an initiative would be extremely beneficial to the healthcare industry as a whole because it would empower a whole group of previously marginalized people to assess and devise solutions for the medical waste management problems of their own communities. This autonomy would allow for unique situations to be addressed accordingly using a standardized toolbox of information as well as effectively merging the interests of ecological and human health. The allopathic healthcare industry needs to

commit to eliminating the present concept of an anthropocentric healthcare that pits the health of the natural environment against the health of the people that reside in it. Only once the idea of healthcare is understood as the truly global concept that it is and enacted as such, will humanity be able to pursue its goal of improving human health without contradiction.

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Appendices

I. Map of Ecuador

II. Template of the form used to gather information during fieldwork in Ecuador and Minnesota (Spanish Version)

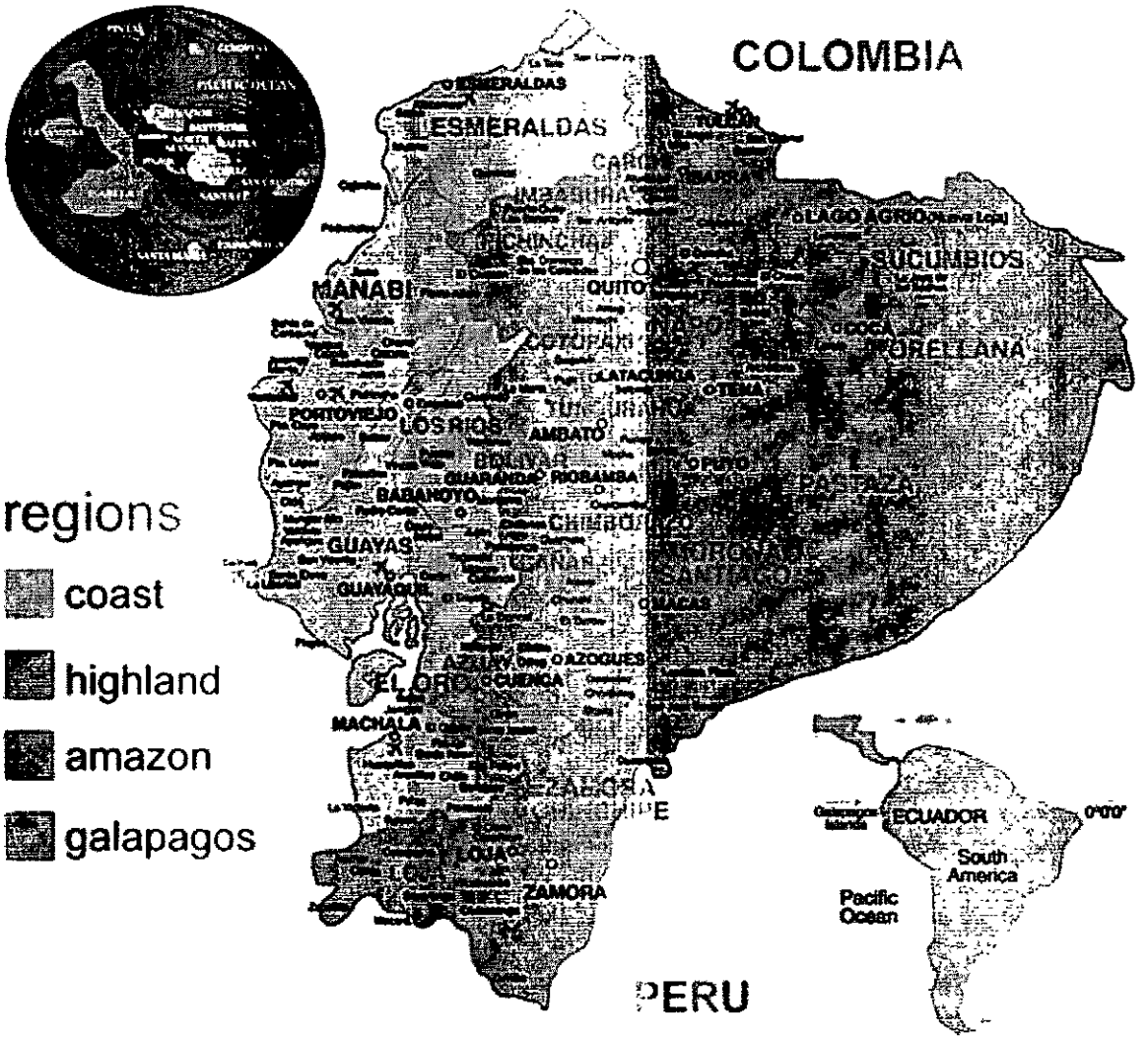
III. Map of Native American Reservations in Northwestern Minnesota, USA

IV. *Asistencia Sanitaria Para un Mundo Sano: una guía para el manejo de los desechos médicos en lugares rurales de una manera ecológica*; the medical waste management guide mentioned in chapter 2 of this paper; any imperfections are a result of photocopying the sole original copy, which exists only in printed form.

V. Instructions for Building a Solar Powered Autoclave; winning entry of HCWH rural healthcare technology competition

Appendix I.

Map Of Ecuador, sourced from:
http://exploringecuador.com/images/mapas/gr_map_ecuador.jpg



Appendix II.

Template of the form used to gather information during fieldwork in Ecuador and Minnesota (Spanish Version)

FORMULARIO de INFORMACION

FECHA:

NOMBRE DE LA FACILIDAD:

QUE PARECE ESTE LUGAR:

AFUERA→

ADENTRO→

CON QUIEN HABLE:

NOMBRE (y apellido si es possible)	TITULO (si es possible)
1)	
2)	
3)	
4)	

NOTAS SOBRE:

DESECHOS→

separación…

tratamientos…

adonde van…

afilados, agujos, etc…

sistema de reciclando…

MERCURIO→

mecanismos…

destrucción…

ADMINISTRACION→

educación previo…

NOTAS ADICIONALES→

ANALISIS:

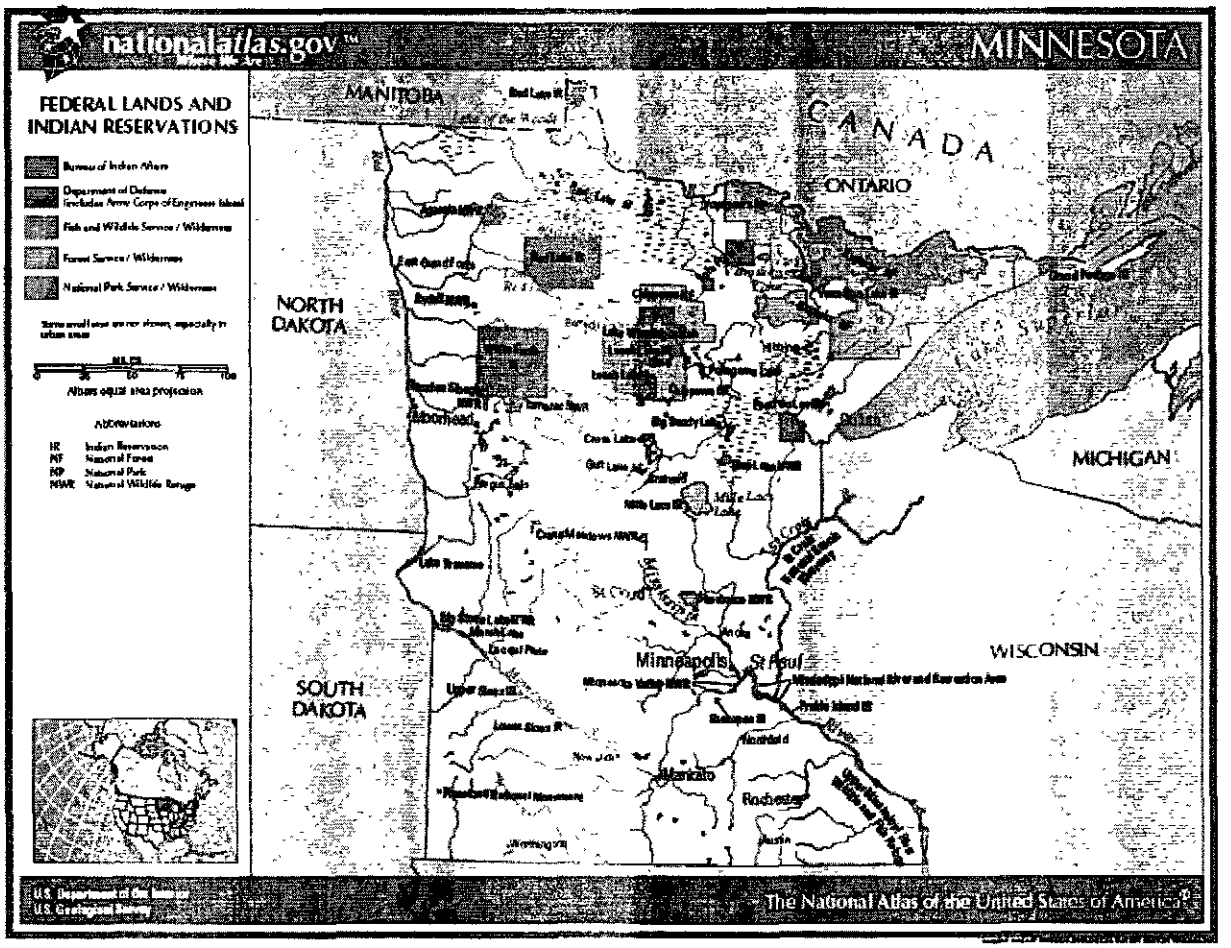
TEMAS→

COSAS INTERESANTES→

IDEAS NUEVAS→

Appendix III.

Map of Minnesota Government Lands, sourced from:
http://nationalatlas.gov/printable/images/pdf/fedlands/mn.pdf



Appendix IV.

Asistencia Sanitaria Para un Mundo Sano: una guía para el manejo de los desechos médicos en lugares rurales de una manera ecológica; the medical waste management guide mentioned in chapter 2 of this paper; any imperfections are a result of photocopying the sole original, which exists only in print form.

NOTE: *I wrote and submitted this guide in partial fulfillment of the requirements for the Fall 2006 term of the SIT Study Abroad program entitled Ecuador: Comparative Ecology and Conservation. The guide was a portion of my Independent Study Project, the goal of which is for the study abroad student to engage with an Ecuadorian community such that the study abroad student commits to leaving a contribution of scholarship, research, labor, etc. with the community in return for the invaluable learning experiences the student received on their behalf. As such, this guide was created using the same fieldwork described in Chapter 2 of this thesis and remains with community members in Bahia de Caraquez as a draft awaiting further development.*

ASISTENCIA SANITARIA PARA UN MUNDO SANO

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una guía para el manejo de los desechos médicos en lugares rurales de una manera ecológica

BLAIR L. BROWN

December 6, 2006

INDICE

INTRODUCCION

****

¿Qué son desechos médicos?

Desechos médicos generalmente son el total de los desechos de cualquier lugar que proporciona asistencia sanitaria. Algunos lugares que prestan estas facilidades son oficinas de dentistas, hospitales públicos y privados, centros de salud, clínicas privadas, y todos los lugares que ofrecen asistencia sanitaria. Se pueden dividir los desechos médicos en dos categorías definidas: Desechos Infecciosos y no Infecciosos. Desechos Infecciosos los que incluyen todos los desechos con sangre o líquidos que tienen bacterias o virus y que transmiten enfermedades; y Desechos no Infecciosos, los que no producen ninguna enfermedad. Además los desechos infecciosos incluyen productos de sangre, vendas con sangre, carne de humanos o animals, y objetos filudos como agujas y bisturis. Desechos no-infecciosos son los envases de comida, y todos otros desechos que no tienen la capacidad de transmitir enfermedades (Cortese).

¿Por qué es importante manejar este tipo de desechos de una manera ecológica?

Nuestras vidas y nuestra salud dependen de todo del mundo. Si no trabajamos duro, de todas las maneras para mejorar y asegurar la salud de nuestro hogar y del mundo, la salud de los humanos se deteriorará hasta que no haya nada que preservar con asistencia sanitaria. La asistencia sanitaria trabaja para mejorar la salud de los humanos, pero debe poner mas fuerza en el trabajo que realice para mejorar la salud del mundo en general de manera que facilite el bienestar para nuestras vidas. Los desechos médicos son la manera más fácil conque la asistencia sanitaria contamina el medioambiente (McCally).

El mayor problema de la asistencia sanitaria es manejar los desechos médicos, el tratamiento de estos desperdicios, la destrucción de los desechos infecciosos y la destruccion de mecanismos con murcurio. Estos temas son como guia que se apunta a las facilidades de la asistencia sanitaria en regiones o lugares rurales por dos razones: la asistencia sanitaria no tienen el menor acceso a las nuevas tecnologias, ni existe la minima cantidad que regule el control y el proceso en el manejo de los desechos médicos. De esta manera las facilidades de asistencia sanitaria en lugares rurales son una gran amenaza a la salud del medioambiente, pero en gran parte esta amenaza tiene soluciones faciles o simplemente evitarlas. Para esta situación existen muchas soluciones, pero necesita mucha atención y que se haga un compromiso formal de acción, asi como el que tienen los empleados de asistencia sanitaria para mejorar la salud de sus pacientes (Morris).

¿Cómo usar esta guia?

La meta de esta guia es para dar medidas simples y efectivas a todos los niveles de asistencia sanitaria, para de esta manera reducir su contribucción a la contaminacion del medioambiente. Todas las facilidades de asistencia sanitaria son diferentes tanto en su estructura como en su función; las sugerecias de esta guia estan marcadas con colores que dividen los tipos de facilidades que son apropriadas para cada idea.

Las sugerencias para los hospitales estan marcadas con texto morado, para centros de salud y clinicas privadas estan marcadas con texto anaranjado, y para las facilidades de asistencia sanitaria estan marcadas con texto azul. Las sugerencias estan organizadas por categorias y sub-catergorias en el indice y también estan en remision en el texto

Es importante mencionar que cada facilidad de asistencia sanitaria tiene una colección de diferentes situaciones sobre sus desechos médicos, depende de muchos factores como su lugar, población, tamano, etc. Por estas razones, esta guía quiere ser esto, solo una guia. Sus sugerencias no son rigidas ni exactas, solo quiere ser un punto de origen de asistencia sanitaria de los humanos y el medioambiente, pero tambien las sugerencias tienen como meta encender una chispa de creatividad, innovacción e ingenio en las personas que las lean, esperando que las acciones e ideas de estas personas supere las ideas escritas en estas páginas. Los habitantes de un lugar son los mejores jueces de las cosas que el lugar necesita. Entonces, por favor adapten y hagan especificas las ideas de esta guia para que quede bien y las adapten a sus facilidades.

Se dice que no hay duda que un grupo pequeño de individuos se dediquen y puedan cambiar el mundo aunque sea una sola cosa que hagan. Esta guia nació con la confianza y la fe que las personas que la lean lograrán gran éxito, cambiando y majorando el mundo, pero también con muchos sentimientos en sus corazones, estas personas haran una verdadera revolución que hara mejoar el mundo.

Muchisima suerte en sus metas y trabajos.

DIRECCION Y REDUCCION DE LOS DESECHOS MEDICOS

****

VIAS PARA NO HACER DESECHOS

Mientras la importancia de dar soluciones para manejar desechos medicos es lo maximo, tambien es necesario dar un cantidad igual de atencion a las vias para reducir la cantidad de basura que produce. Los mejores procesos de reciclaje todavia usan alguna cantidad de energia y recursos. Darle solucion a la cantidad de basura o eliminar basura ANTES de su produccióonn son las solucciones absolutamente mejores para el medioambeinte, y tambien por que estas soluciones usan menos cantidades de recursos, son los solucciones mas baratos de las facilidades de asistencia sanitaria (CGH). Estas soluciones son mejores en muchas niveles.

****

LIMPIEZA/MANTENAMIENTO:

En todas de las areas de asistencia sanitaria que requieren limpieza (fabrica sucia, higenico personal, disinfeccion, etc), hay muchas cosas que se puede hacer para reducir la cantidad total de la basura del hospital.

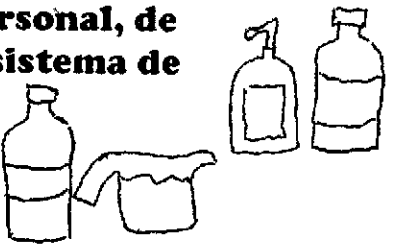
FABRICA SUCIA-

IDEA 1. Espera que haya suficiente ropa para limpiar asi como textiles para reducur la cantidad de agua que se usará.

IDEA 2. Use jabón biodegradable (puede comprar en almacenes en Quito) cuando hay ropa sucia evite la contaminacion del sistema de agua.

COSAS GENERALES-

IDEA 1. Use jabón biodegradable (puede comprar en almacenes en Quito) en los baños para limpiar las manos y en todos los lugares de higiene personal, de hospitales para evitar contaminación del sistema de agua.

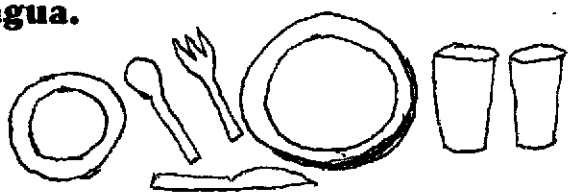


COCINA:

En hospitaes que dan comida a pacientes y/o trabajadores, hay muchas cosas que se puede hacer para reducir el volúmen de basura.

PLATOS-

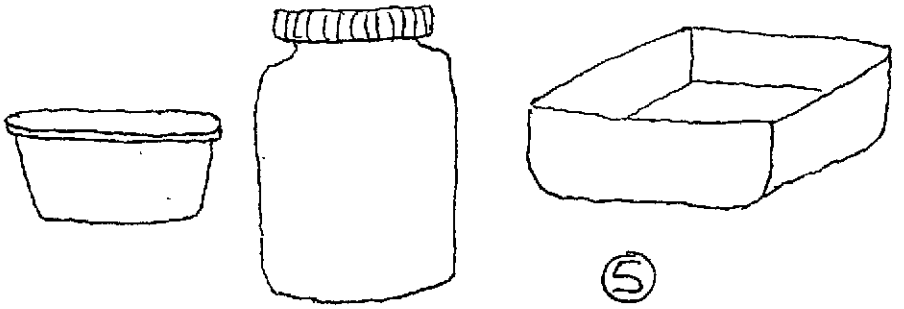
IDEA 1. Limpie los platos con jabon biodegradable (puede comprar en almacenes en Quito) para evitar contaminacion del sistema de agua.



PREPARACION DE LA COMIDA-

IDEA 1. Cocine con vegetales (del jardin de la facilidad asistencia sanitaria, quizas...ve pagina 10), carne, y granos locales. Esta acción apoya la economía local y deja a un lado eso de transportar y envasar comidas a distancias largas. Cada vez que sea posible, compre cosas con lo minimo de envase o en grandes cantidades.

IDEA 2. Guarde y limpie los recipientes de comida de vidrio y plastico con tapas para almacenaje cuando quede comida extra e ingredientes extras, y busque productos con estos tipos de recipientes cuando compre comida para cocinar.



FOOD SERVICE-

IDEA 1. Sirva y prepare todas las comidas con platos, vasos, la vajilla de plata, o porcelana, etc que puede limpiar cada vez que use.

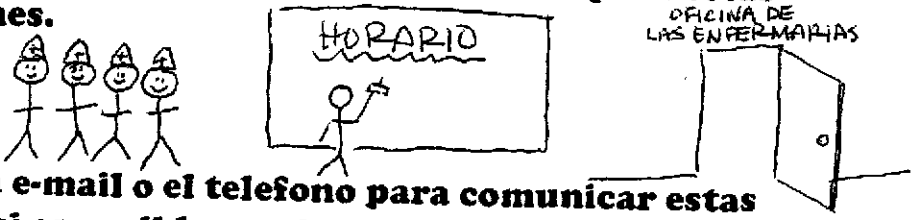
LA OFICINA/ADMINISTRACION/INFORMACION DE LOS PACIENTES:

Con la gran cantidad de formas, información de los pacientes, y horarios diarios usados en asistencia sanitaria, es como tener una mina de oro para las soluciones de reducir la basura de papel antes de que sea basura.

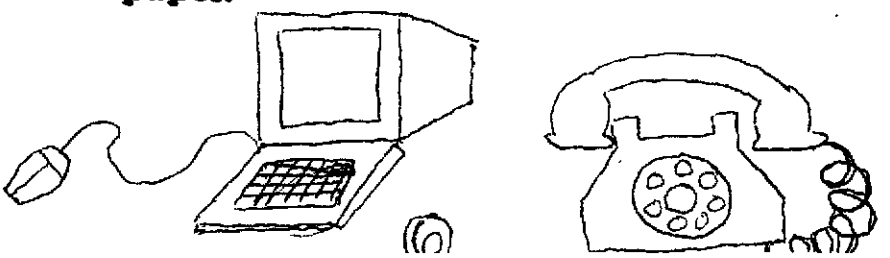
REDUCCION DEL PAPEL-

IDEA 1. Hacer carteles (ve pagina 12) con el diseno en la parte posterior y poner cerca de todas las máquinas copiadoras donde llega mucha gente y cerca de cada recipiente de basura, para que sea un recordatorio a usar los dos lados de una hoja antes de botarla.

IDEA 2. En oficinas y salas de trabajadores (como estaciones y oficinas de enfermerias), se puede colocar una pizarra de acrilico (puede comprar en almacenes en Quito) y usar tiza para poner informacion permanente como las que etan diariamente en noticias, horarios, listas de pacientes del dia, etc. Esta informacion es muy fácil para cambiar cuando necesite y elimina asi el uso de papel completamente para estas informaciones.



IDEA 3. Usa e-mail o el telefono para comunicar estas situaciones si es posible, y asi elimina en gran cantidad el uso del papel.



DESECHOS NO-INFECCIOSOS

Desechos no-infecciosos incluyen envases, desperdicios de comida, y todos los desechos que no tienen la capacidad de transmitir enfermedades. Estos desechos son en gran parte los desechos médicos, pero son lo más facil de reducir, usarlos de otra manera o reciclarlos usando las facilidades de asistencia sanitaria rurales aunque no haya infraestructura y tecnologia nueva (HCWH 2005). Lo primero que se puede hacer para manejar los desechos no-infecciosos es reduccion y separacion de los mismos. El momento de botar estos desechos no-infecciosos se pueden dividir en dos categorias y realizarles un tratamiento diferente para cada categoria y se obtendra mejor resultado con este tipo de desperdicios (HCWH April 2006). Las suugerencias de la división por categorias estan mas abajo.

DESECHOS ORGANICOS:

Los desechos orgánicos tambien se llaman desechos biodegradables y estan hechos de material que pueden descomponerse en cualquier parte del mundo sin ayuda de nadie. Usualmente estos desechos son restos de plantas, animales, y otros organismos bióticos. Ejemplos de desechos orgánicos son basura de comida, estiércol, aguas residuales, basura de plantas, basura de papel (sin tinta), y plasticos que tienen compuestos biodegradables (Kulick). Algunas tipos de desechos infecciosos son productos orgánicos pero no son desechos orgánicos porque puedan contaminar a los seres humanos y el medioambiente con enfermedades. Pero, despues de realizar algún tratamiento varios tipos de desechos infecciosos se convierten tambien en desechos organicos.

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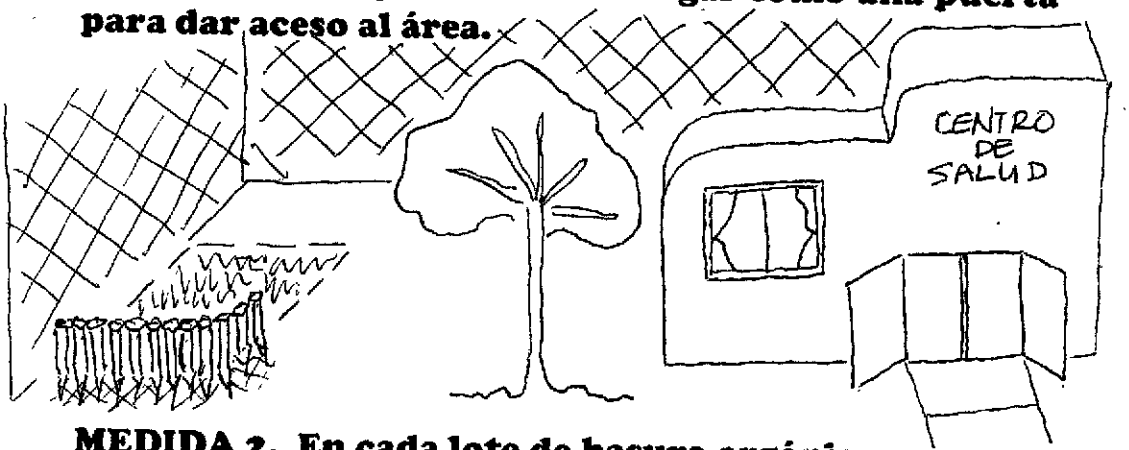
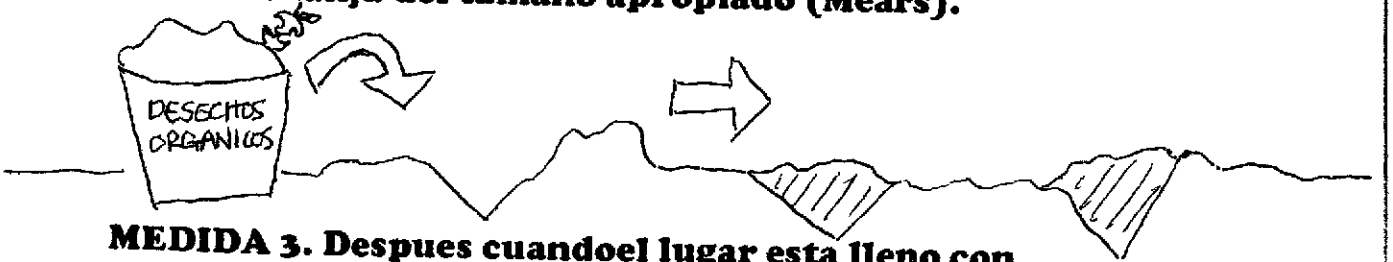
ABONO- Lo más fácil y la mejor manera para manejar los desechos organicos es convertirlos en abono. Esta palabra simplemente significa devolución de la basura al mundo. El mundo usa la basura para tener un suelo con bastantes

nutrientes, es excelente para la agricultura y el cultivo de plantas y flores. Existen tres medidas de este proceso para poder manejar este tipo de basura en cualquier area de una propeidad gracias a la facilidad de asistencia sanitaria.

MEDIDA 1. Elegir un lugar privado en la propiedad de la facilidad de asistencia sanitaria y hacer un valla a una altura de aproximadamente 1 metro. El área puede ser de cualquier tamano pero debe ser un tamano proporcional a la cantidad de basura que se tenga, y se deja un espacio para entrar al lugar como una puerta para dar aceso al área.



MEDIDA 2. En cada lote de basura orgánica se cava una zanja y se la cerca, alli se botan los desechos orgánicos y después se cubre la zanja con la tierra que se saco donde se hiso la zanja. Para cada lote de basura orgánica se cava una zanja del tamano apropiado (Mears).

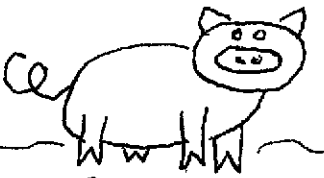


MEDIDA 3. Despues cuandoel lugar esta lleno con zanjas, se empieza el proceso una y otra vez pero en direccion opuesta, asi se continúa con este mismo proceso por largo tiempo. Posteriorme el suelo que sufrio este proceso sera muy rico en nutrientes, hablo de aproximadamente un año, dependiendo además de la cantidad de basura que recibió.

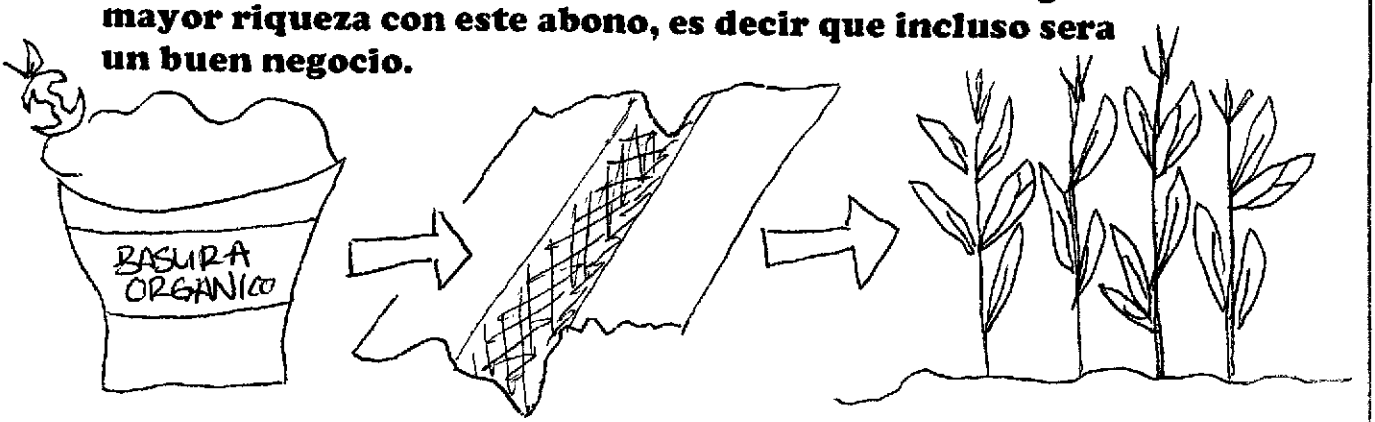
Posteriormente el compost que produjo el suelo, tiene gran valor existiendo varias formas para usarlo.

IDEA 1. Si hubiera un programa de como manejar los desechos orgánicos en su pueblo o ciudad, estos se usarian adecuadamente. Si no lo hubiera se podria buscar un granjero de chanchos y preguntarle a el/ella si desean la basura orgánico de su facilidad de asistencia sanitaria (mucha basura orgánica puede ser comida de chanchos).

Si esto sucediera al haber un hospital , se podria pedir al granjero que done un chancho cada dos meses para la cocina del hospital

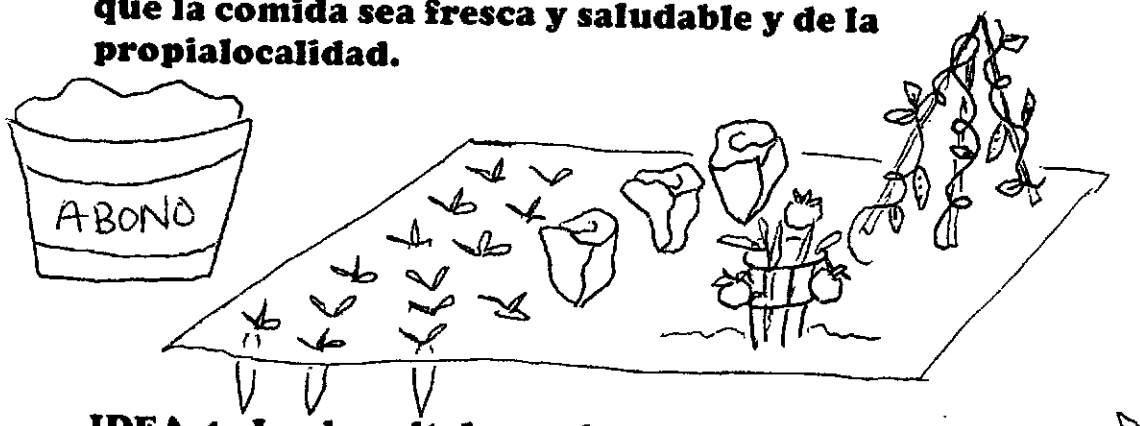


IDEA 2. La communidad puede proporcionar un lugar para poner sus desechos orgánicos. Con más basura, habrá en tiempo más corto el abono. Y cuando tengan grandes cantidades de suelo enriquecido podran vender a las granjas locales para que sus suelos tengan mayor riqueza con este abono, es decir que incluso sera un buen negocio.

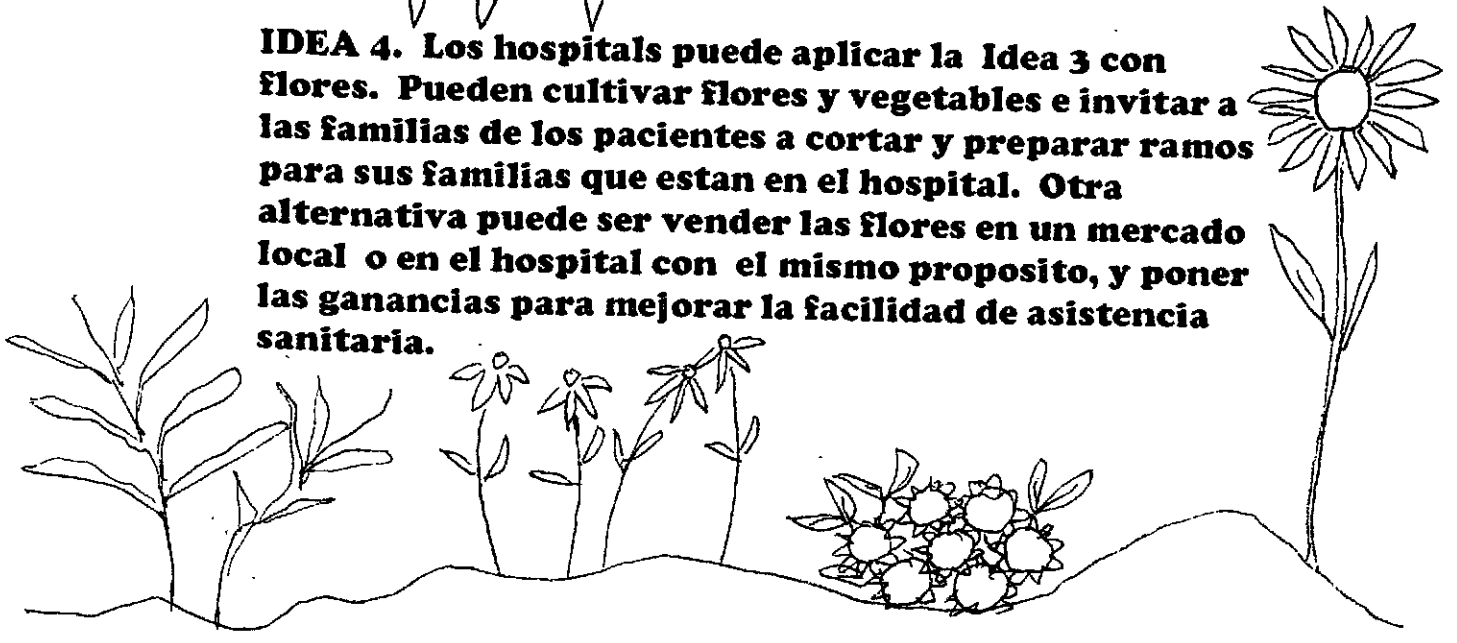


Si estuviera en un hospital donde sirven comida a pacientes y quisiera usar esta idea, solicitaria a los granjeros que entreguen productos que hayan sido cultivados con este abono para que sean usados en la elaboración de sus comidas; tendrian en sus manos comida fresca y saludable y lo que comprarian en otros lugares seria en pocas cantidades.

IDEA 3. Lo mismo se puede hacer en otro lugar (como el lugar de compost) como en la propiedad de la facilidad de asistencia sanitaria y fortalecer el suelo alli con el compost. Se pueden usar esto en los lugares para jardines o convinarlos con vegetales, se les puede proporcionar una cantidad pequeña de estos vegetales a las peronas que llegan de visita, a la vez se les puede entregar un folleto sobre la importancia de una buena nutricion y comida saludable. Este folleto podra incluir informacion sobre por que el cuerpo necesita vitaminas y nutrientes, qué nutrientes tiene cada tipo de vegetales, recetas de vegetables, e instrucciones para empezar un compost y un jardin de vegetables en sus hogares. (ve las paginas ultimas de esta guia para mas recursos sobre donde debe buscar este informacion). Otra alternativa seria que pueden vender los vegetables en un mercado local y poner las ganancias para mejorar la facilidad de asistencia sanitaria, o tambien los hospitales pueden usar los vegetables en la cocina para que la comida sea fresca y saludable y de la propialocalidad.



IDEA 4. Los hospitals puede aplicar la Idea 3 con flores. Pueden cultivar flores y vegetables e invitar a las familias de los pacientes a cortar y preparar ramos para sus familias que estan en el hospital. Otra alternativa puede ser vender las flores en un mercado local o en el hospital con el mismo proposito, y poner las ganancias para mejorar la facilidad de asistencia sanitaria.



DESECHOS INORGANICOS:

Desechos inorgánicos son todo los desechos no-infecciosos, que no tiene la capacidad de dañar la salud de los humanos, pero tambein el mundo no puede degradar sin ayuda. Estos desechos usualmente son separados en seis catagorias (HCWH 2005). Las catagorias ayudan en los procesos de desarrollo de cantidades grandes de materiales similares que tienen tratamientos diferentes para re-usar y reciclar. Este proceso es mejor y se gasta menos energia que en un procesa que trata manejar cantidades de basura mesclada. La separacion de la basura en las seis catagorias que se explican a continuaión es mas efectiva cuando se lo hace al momento de botarlos desperdicios (Chivian).

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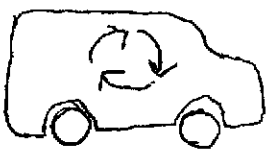
PAPEL- son todos los productos de papel, hasta el carton más grueso, inclusive periódicos, cuadros de pacientes, horarios diarios, etc.

IDEA 1. Separe papel de la oficina que tiene usado solo un lado y venda o entregue este *papel a un compania de* reciclar. Corte las hojas que ha arrancado en cuatro pedaos y haga paquetes (50 1/4 hojas con un goma o hilo) de papel para notas o mensajes del teléfono. Ponga estos libretines o paquetes en cada escritorio y cerca de cada teléfono, *le será muy útil.*

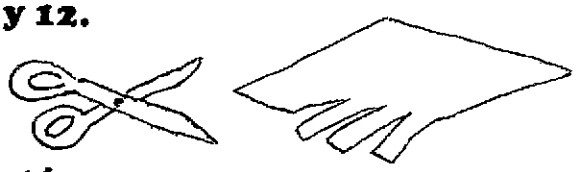
IDEA 2. Hay muchas compañias que reciclan papel y hacen muchas cosas con este papel, como otras hojas de papel, cajas, tarjetas, etc.Se puede dar o vender su basura de papel a ellos. Si se venderia la basura, se pondria las ganancias a mejorar la facilidad de asistencia sanitaria. Contactos de varias compañías de papel reciclado estan en las paginas ultimas de esta guia.



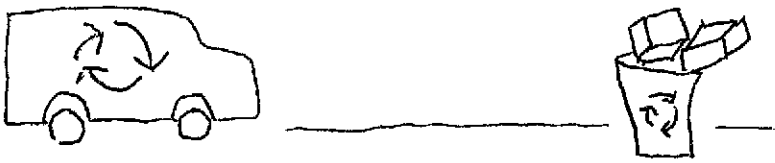
CARTON- De todo espesor y tipos, ondulado y no-undulado

IDEA 1. Use todas las cajas de todo tamano y forma para organizar los materiales de oficinas, compartimientos de almacenaje, y compartimientos para separar todo lo que es basura inorgánica.

IDEA 2. Use carton de otras cosas para hacer franjas de carton para los equipo de limpiar mercurio y para hacer carteles en páginas 19 y 12.

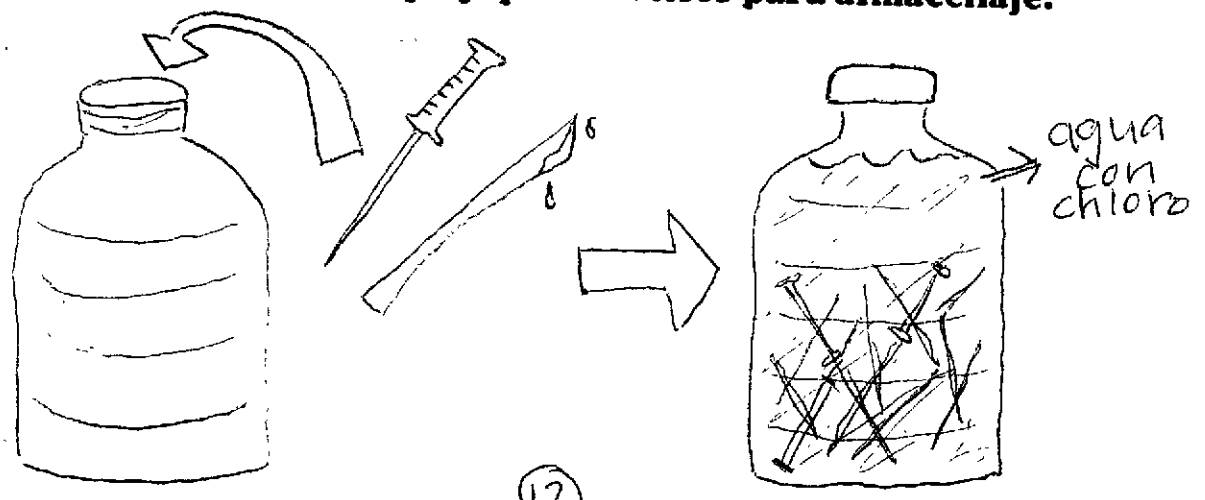


IDEA 3. Entregue todo el cartón que no puede usar con estas ideas a un compañia de reciclar.

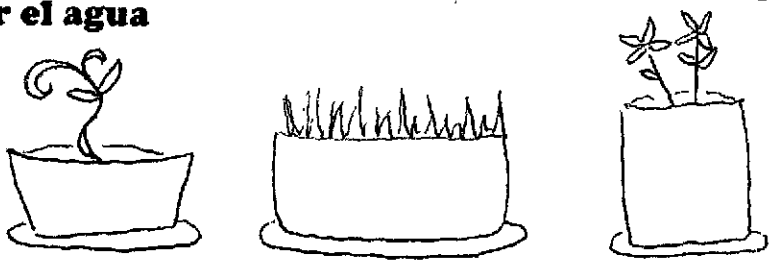


PLASTICO- Todo tipo de botellas, contenedores, y envases hecho con plástico.

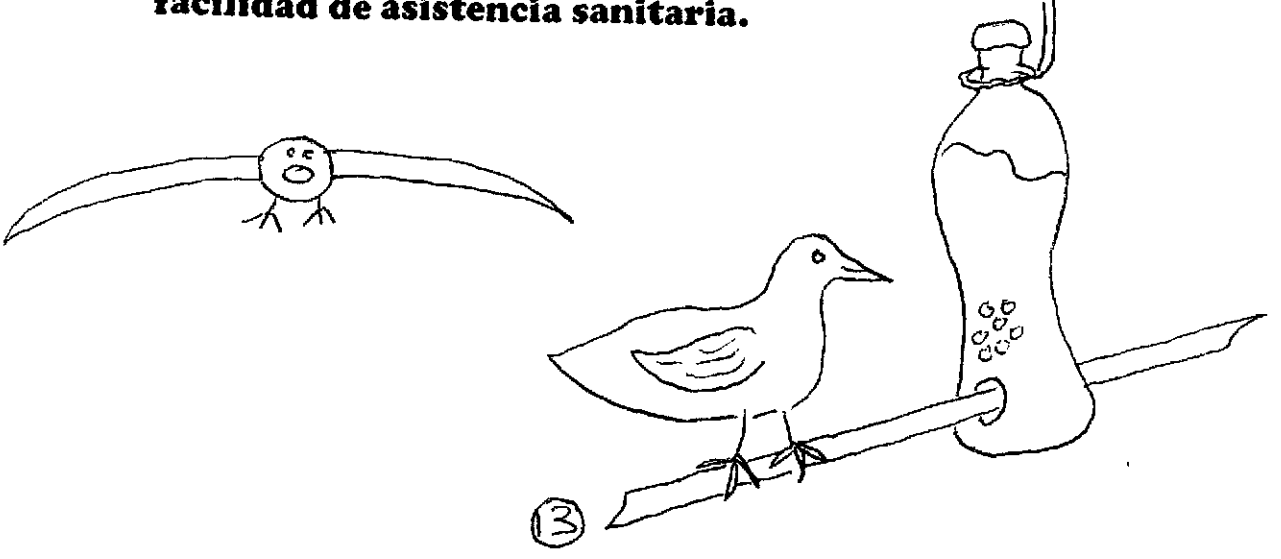
IDEA 1. Colecte y limpie todos los recipientes que tienen tapas y que tienen un volumen igual o más que un galón, para usar con basura de afilados. Llene los recipiestes con 3/4 de su volumen y cierrelo con sus tapas. Para disinfectarlo, llena con agua de chloro y espere 30 minutos. Después tape el contenedor y cierrelo con su tapa y quedara listo para almacenaje.



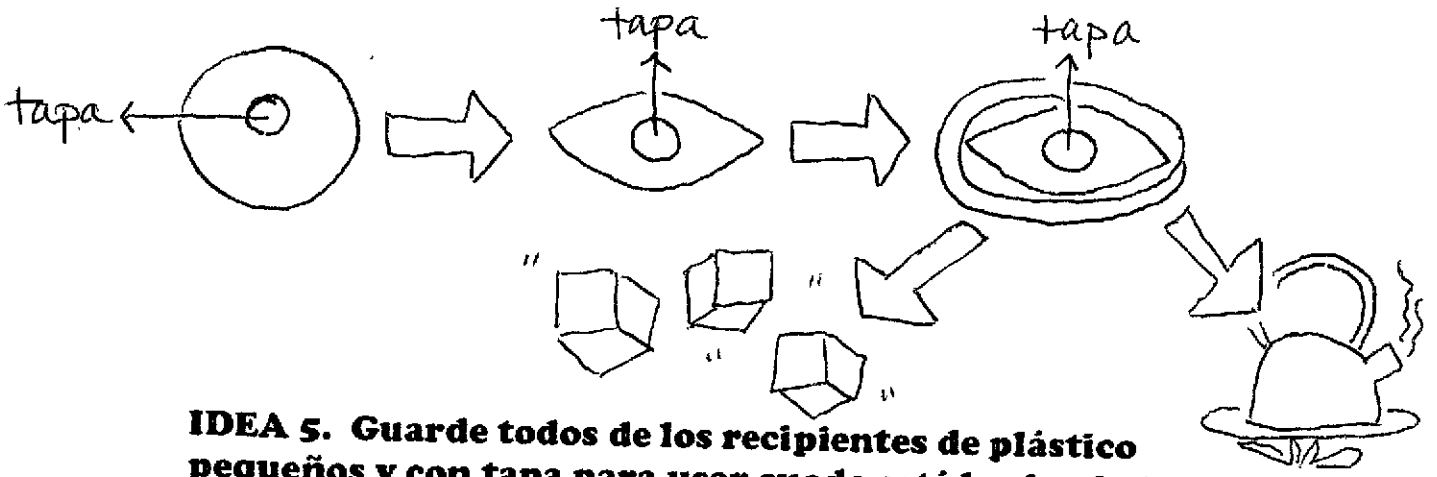
IDEA 2. Todos los recipientes que no son botellas son perfectos para cultivar plantas pequeñas o semillas, para decorar habitaciones de pacientes o escritorios de secretarias/enfermerias o en lugares públicos como salas de espera, etc. Limpie el recipiente y haga huecos pequenos en el fondo para desaguadero del agua. Llene el recipiente con tierra (del compost, quizas), ver página 8) 3/4 de su volumen. Y siembre cualquier tipo de semillas o plantas pequeñas. Riegue las plantas o semilla con mucha agua y ponga encima de su tapa para recoger el agua



IDEA 3. Las botellas de plástico más pequeñas son buenas para llenar con alimentos para aves, son perfectas para que las aves coman y puedan convivir en la propiedad de la facilidad de asistencia sanitaria ademas las aven seran como una distracción tanto para los pacientes como para los familiares que le visitan en los hospiotales. Para hacer de estas botellas un lugar donde las aves comen se debe hacer lo siguiente: limpie una botella y haga huecos pequeñas en los lados de la botella cerca del fondo y un hueco mas grande en cada lado de la botella para poner un baston para que descansan las aves. Llene la botella con semillas de los aves (de una flor de sol en el jardin, quizas, ve pagina 11) y cierre con su tapa. Cuelgue (con una cuerda o algo parecido) afuera, cerca de las ventanas de los pacientes o en cualquier lugar en la propiedad de la facilidad de asistencia sanitaria.

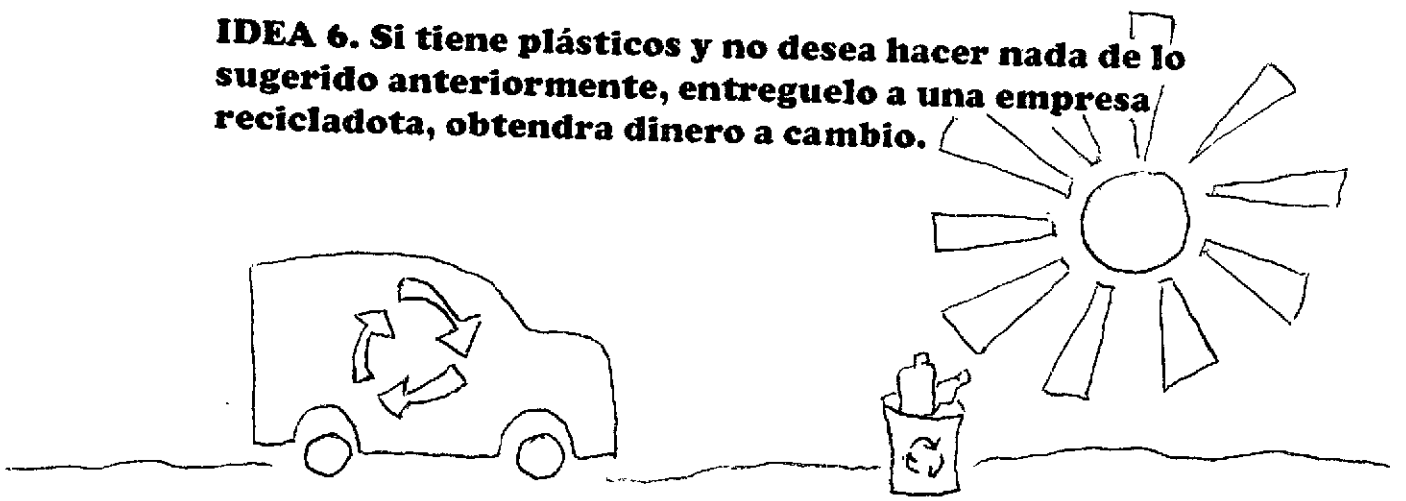


IDEA 4. Las botellas de plástico más pequenas tambien son perfectas para llenar de agua caliente o hielo para los pacientes cuando les duele sus musculos, tienen hinchazon, les duele la cabeza, y/o tienen fiebre fuerte o persistente. Para esto se debe limpiar las botellas, quitar la tapa, y aplastarla suavemente de manera que tome la forma ovalada . Luego se envuelve la botella que se ha llenado con agua caliente en una toalla y se le aplica al paciente en el lugar del dolor o hinchazón. (ve pagina 15). Para obtener botellas con hielo se las llena con agua, se las tapa y se las pone en el congelador, cuando ya esten congeladas de la misma manera se la envuelve con una toalla y se4 la aplica al paciente en el lugar deseado. Lal toalla o chal da protección a la piel del paciente para que no se queme en el caso de la botella con agua caliente y guarda la condensación del hielo en el caso de la botella con hielo.



IDEA 5. Guarde todos de los recipientes de plástico pequeños y con tapa para usar cuado esté haciendo los equipos de limpia con mercurio (ve pagina 19)

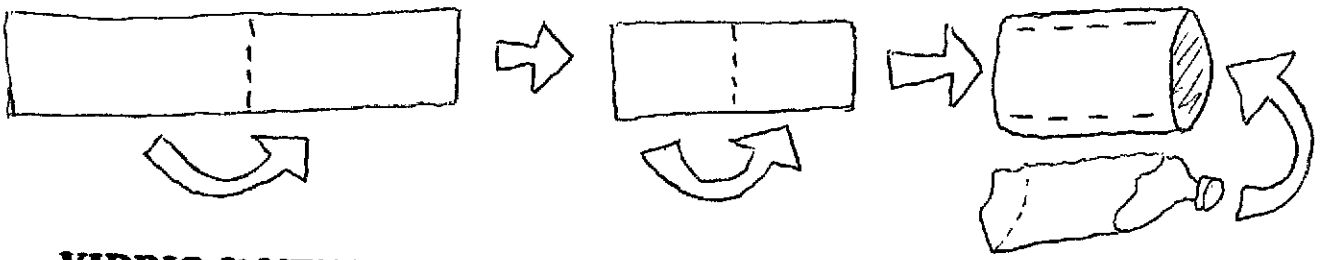
IDEA 6. Si tiene plásticos y no desea hacer nada de lo sugerido anteriormente, entreguelo a una empresa recicladota, obtendra dinero a cambio.



TEXTILES- Son todos los restos de tela paño u otro viejos, con manchas, y que no puede usar.

IDEA 1. Las telas que tienen manchas o no son bonitas sirven para limpiar,cortelos en trapos para los equipos de limpiar el murcurio y tambien para limpieza en general.

IDEA 2. Las toallas y mantas que no puede usar y que estan limpias sirven para hacer mangas para las botellas de agua caliente y hielo (ve pagina 14). puede cortar la tela del tamaño adecuado y le hace un pliegue en el centro de tal tal manera que quede como un bolsillo para las botellas, lo puede hacer doble para mayor protección con el paciente, puede cocerlas y quedarán mejor confeccionadas.



VIDRIO & METAL- De todos los tipos, separe en dos cajas o recipientes medianos.

IDEA 1. La basura de vidrio y metal son muy dificil para manejarlos sin tecnologias adecuadas, por lo tanto la mejor opción para manejar estos desechos es entregar a un artesano que trabaje con estos materiales para que le de un buen uso con su creatividad. (como escultura o soldadura, etc). A cambio solicite al artesano que le proporciones una de sus artesanias que elaboró con las botellas que se le entregó para adornar los lugares de asistencia sanitaria.

DESECHOS TOXICOS Y CON QUIMICOS:

Desechos tóxicos y con quimicos son todos los desechos no-infecciosos que hay y son una amenaza para la salud de los seres humanos (tambien animales y plantas). Estos desechos no trasmiten enfermedades, pero pueden contaminar las aguas que se encuentran dentro del suelo, el aire, y nuestro cadena alimenticia. Son complejas pues pueden hacer daño a todos los sistemas del cuerpo cuando estan dentro de los animals y de los seres humanos tambien (WHO). Ejemplos de estos desechos son mercurio, bioxidos, y otros quimicos duros que usa en productos de limpieza. Estos desechos necisitan ser manejandos con mucho control y seguridad (Singh).

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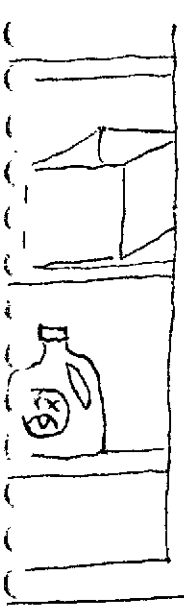
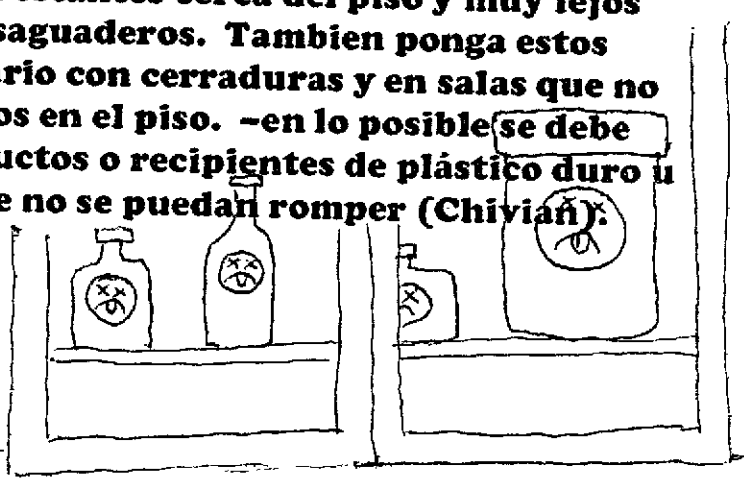
ALMACENAJE Y SEGURIDAD DE QUIMICOS- Todos los quimicos (chloro puro, etc) y los productos que tienen quimicos (productos de limpieza, productos disinfecctantes, etc) son un amenaza a la salud de seres humanos y animales si entrarían en el cuerpo cuerpos y pueden ademas contaminar el medioambiente si permanecen en el suelo o en el sistema de agua (la via del desaguadero). Guardar y no tocar con las manos son cosas importantes cuando se maneja quimicos y cuando se lo hace en un manera corecta se puede eliminar muchas de los peligros de ocasionados por quimicos (LeBlanc).

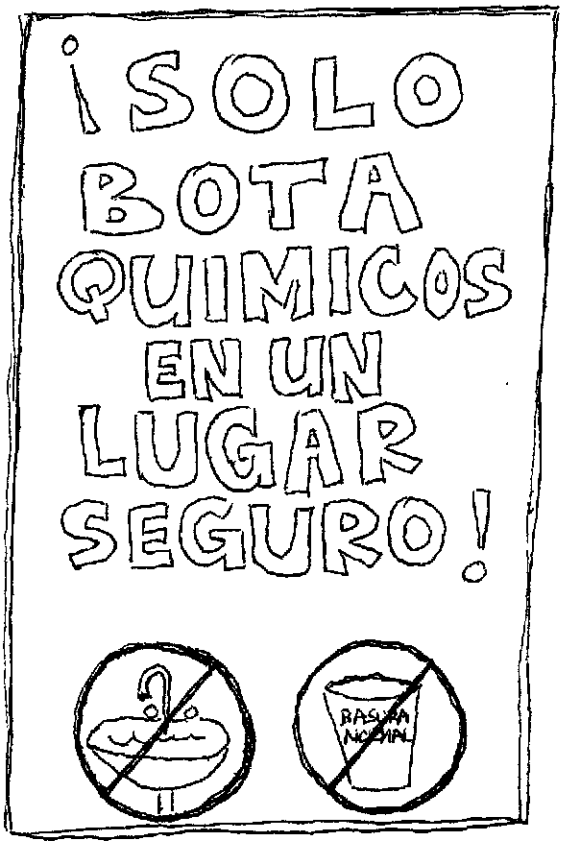


IDEA 1. Guarda todos de los quimicos y productos que tienen quimicos en estantes cerca del piso y muy lejos de fregaderos y desaguaderos. Tambien ponga estos productos en armario con cerraduras y en salas que no tienen desaguaderos en el piso. -en lo posible se debe trabajar con productos o recipientes de plástico duro u otros materials que no se puedan romper (Chivian).

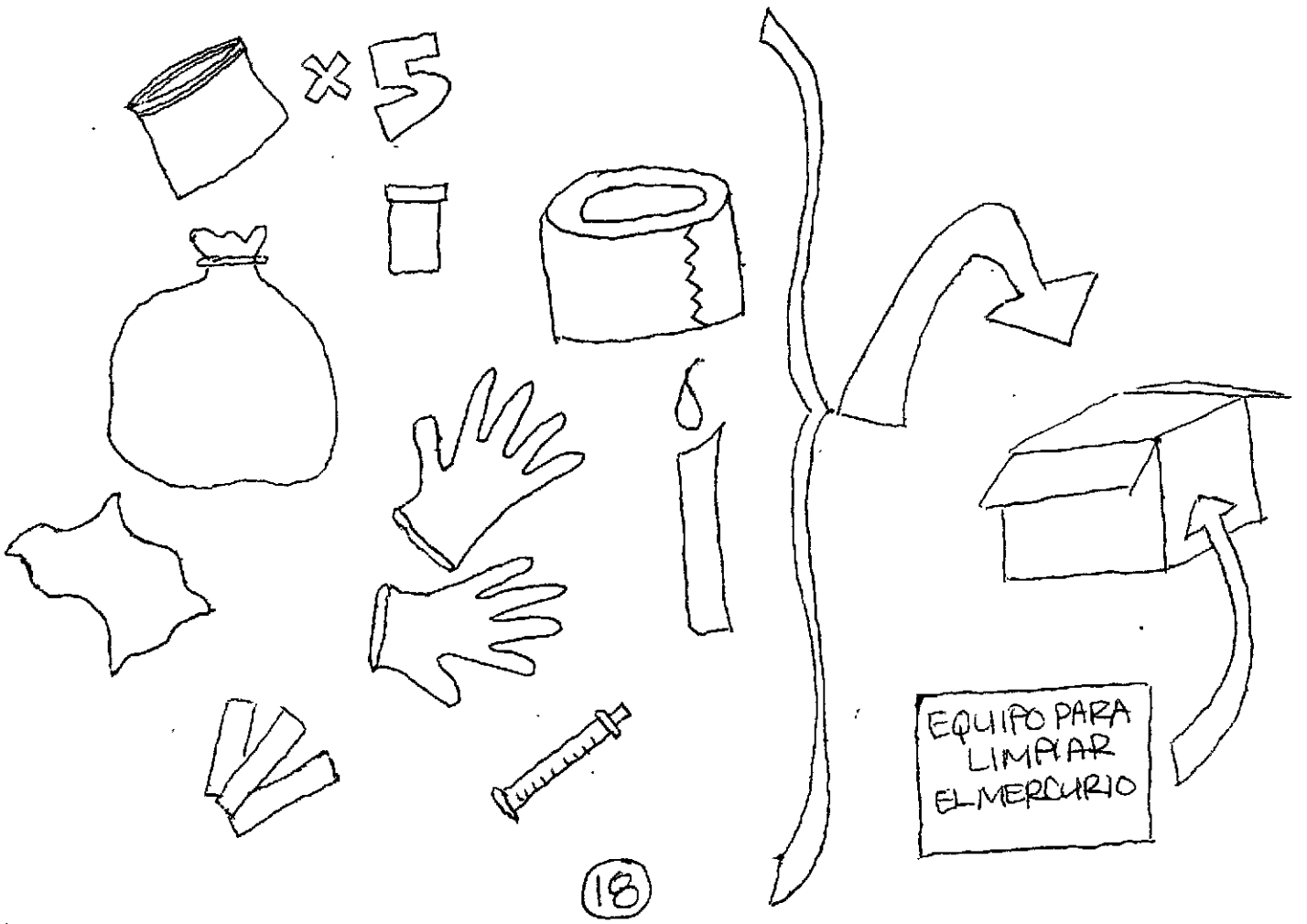


IDEA 2. Poga cionta adhesiva de seguridad (como el bosquejo que esta abajo) en cada qumico y producto que tiene quimicos inmediament que llege a la facilidad de asistencia sanitaria. Para hacer los adhesives, compre cinta adhesiva en cualquier papeleria y usted mismo escriba la informacion y/o bosquejo para cada recipiente para de esta manera evitar equivocación o accidentes

IDEA 3. Hacer carteles como el ejemplo que esta en la parte inferior y ubiquelo cerca de cada fregadero o tacho de basura para que sea un aviso guia sobre la manera correcta para botar desechos toxicos y con quimicos.



MERCURIO- El mercurio es un metal que esta en la naturaleza y se lo usa en dos cosas médicos muy comunes: termómetros y para medir la presion de la sangre. Cuando está en temperaturas normales, el mercurio es un liquido que tiene el color como blanco y plata y puede vaporizarse en el aire, asi puede permanecer hasta un ano. Cuando está en el aire el mercurio puede viajar y contaminar todo el mundo (HCWH sin fecha). El mercurio es bastante tóxico, especialmente cuando es metabolizado a methyl-mercurio. Puede causar muerte si estaria dentro de el cuerpo y muy peligroso si se absorbe con la piel. Cuando respira el vapor de mercurio en el aire, la sangre lo absorbe hacia los pulmones. El mercurio puede perjudicar a todos los sistemas del cuerpo inclusive hay investigacion que indican que el mercurio es perjucicial en gran cantidad (Sattler). Cuando se bota el mercurio en la basura normal o en el desaguadero, está contaminando el mundo y dañando la salud publica de su comunidad y también perjudicando el estado de nuestras aguas y suelos y la cadena de alimentos de las personas. Estos resultados no son aceptables, especialmente en la profesión de salud publica (WHO).



IDEA 1. Haga un equipo de limpieza del mercurio en cada lugar cuando use mercurio y ponga en un lugar visible un cartel de instrucciones exactas.

<u>Como hacer un Equipo para Limpiar el Mercurio (HCWH 2006):</u>
4-5 fundas plásticas que puede cerrar
Funda regular/de basura de uso normal
Recipiente pequeno hecho de plástico y que se pueda cerrar definitivamente
Guantes de latex
Toallas de papel o un trapo o paño (ve pagina 15)
2-3 tiras de cartón (ve pagina 12)
Jeringa sin aguja
20 cm de cinta fuerte
Linterna o vela encendida
*****poner todas estas cosas en un funda plástica grande o una caja mediana y marcar con cinta adhesiva en palabras grandes. Guardar en un lugar muy accesible o a la vista en cada sala cuando use mercurio*****

<u>Instrucciones para usar el Equipo para Limpiar el Mercurio (HCWH 2006):</u>
*****Haga unos carteles de estas instrucciones (ver página 12) y los pone en un lugar muy visible cerca de cada equipo para limpiar el mercurio*****

ANTES DE EMPEZAR: Quite de sus manos y brazos todas sus joyas por que el mercurio puede combinarse con otros metales (como joyas) y siempre esta alli, y es muy peligroso cuando el mercurio esta cerca de su cuerpo (como sus joyas). También debe tener en cuenta que su ropa y zapatos no queden contaminados durante este proceso.

1) **Tenga seguridad que no haya personas en la áreas de contaminacion, cierre todas las puertas del area, cuide toda la vetilacion que entra o salga del área**

2) Póngase los guantes de latex

3) Si el roce occuriria en un piso duro (como madera, mosaico, etc), tome las siguientes medidas. Si el roce occruriria en un alfombra o un material similar que pueda absorber, corte el rededor de la area

4) contaminada y pongalo en una funda plastica y luego en un recipiente donde este seguro. (ve pagina 21).

5) Ponga el vidrio roto y/o cosas agudas en una toalla de papel o trapo. Doble la toalla de papel o trapo en la mitad y ponga en una de las fundas plásticas, lo cierra y lo pone al lado del área de contaminación.

6) Use las tiras de carton para 'barrer" y los residuos de mercurio visibles juntos. Apague las luces y tenga la vela o linterna encendida cerca del piso a un angulo superficial para buscar los residuos de mercurio. El mercurio puede moverse a grandes distancias en pisos duros y planos, entonces es importante investigar en toda la sala de contaminacion.

7) Usa una jeringa para recoger todos los residuos de mercurio y ponerlos estos en el contenedor pequeno de plastico. Cierre el recipiente y lo bota con la jeringa en una otra funda de plastico y lo pone al lado del área de contaminación.

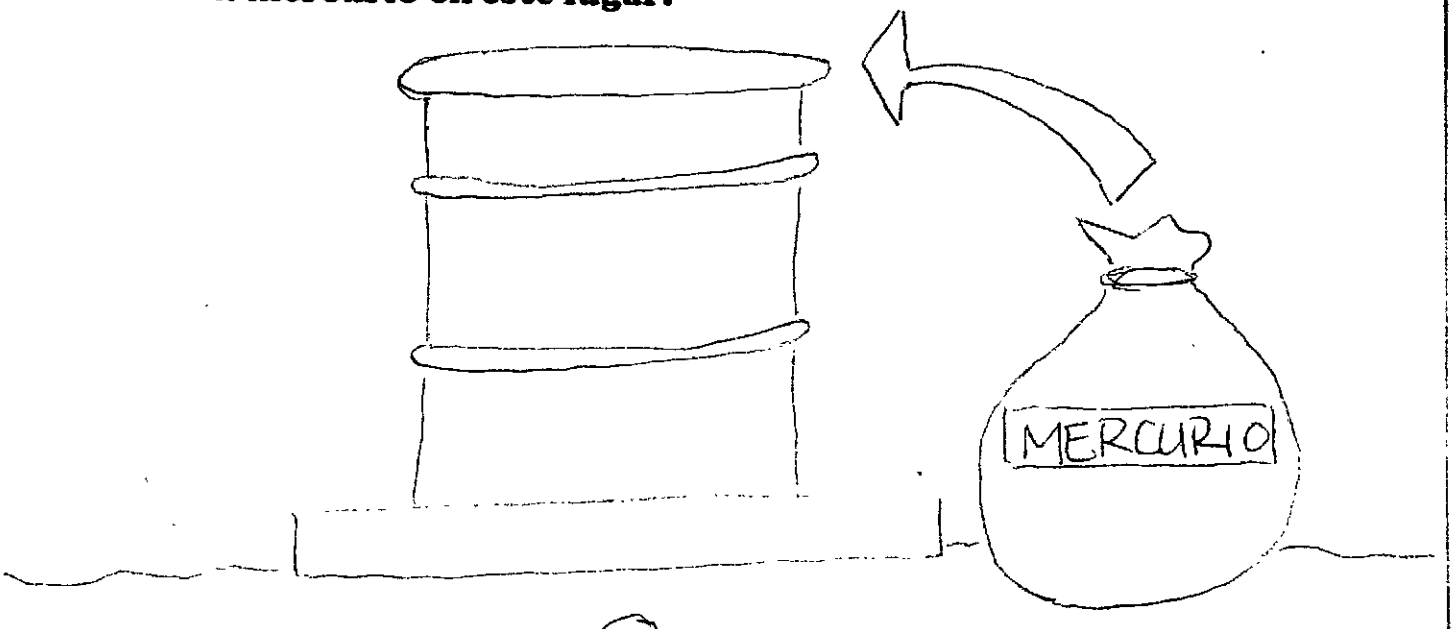
8) Revise el área con el lado adhesivo de la cinta para recoger los residuos más de mercurio que no se pueden ver. Ponga la cinta en otra funda plástica, la cierra, y la pone al lado del área de contaminación.

9) Poga todas las cosas que usa en el proceso de limpieza (incluyen los guantes de latex) en la funda grande (de basura) y lo ata con mucha seguridad y marque con cinta adhesiva de tal manera que diga que el mercurio esta dentro de la funda. Ponga la funda en una lugar seguro para desechos quimicos (ve pagina 21).

10) Abra todas de las ventanas de la sala decontaminacin y usae ventiladores para que circule el aire por 24 horas o más despues del roce.

IDEA 2. Si es possible, trabaje o reemplace todos de los termómetros con mercurio por termómetros digitales (cuestan aproximadamente 3 dólares en farmacias en Quito—ver pagina 29-32 o sugiero preguntar a lugares que hacen donaciones.)

IDEA 3. Busque un lugar seguro para almacenar todos los desechos de mercurio hasta que existe una solución permanente. Puede constuir este lugar con un tambor de 50 galones para aciete (lo encuentra donde cualquier mecánico). Pone una funda grande de basura dentro del tambor y pone todo en un piso plano de cemento (puede hacer en cualquier lugar en la propiedad de la facilidad de asistencia sanitaria que este protegido de la lluvia). Tambien el tambor necesita una tapa que se pueda cerrar con seguridad. Debe poner todas las cosas con mercurio en este lugar.



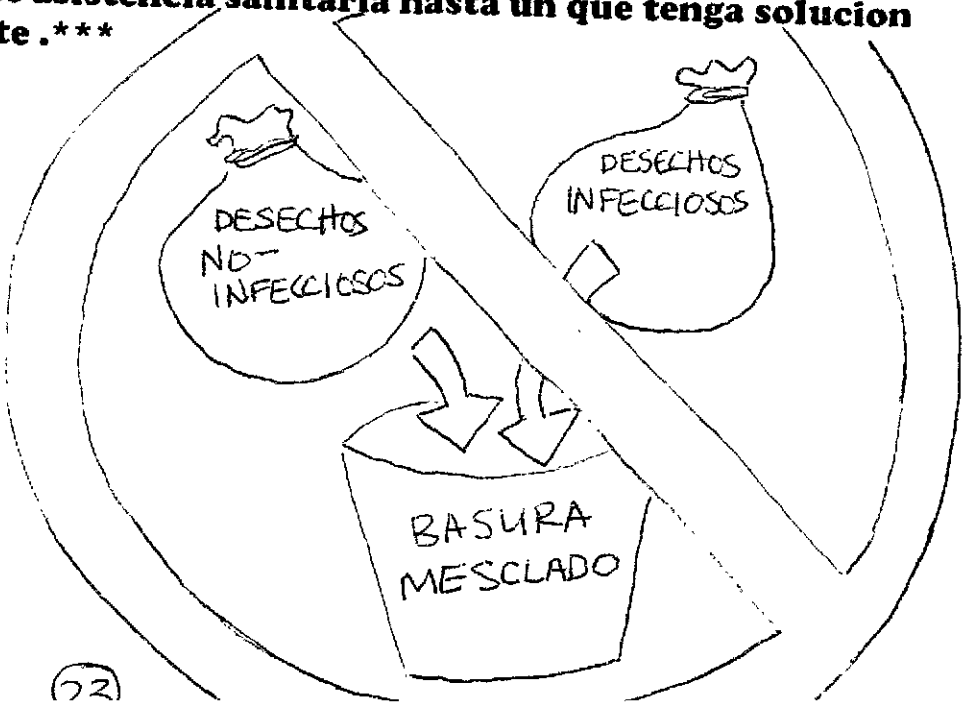
DESECHOS INFECCIOSOS

Desechos infecciosos son todos los desechos que pueden tener bacterias y/o virus que puedan transmitar enfermedades. Estos desechos incluyen productos de sangre, vendas con sangre, carne de humanos o animales, y herramientas filudas como agujas y bisturis. Desechos no-infecciosos incluyen envases, basura de comida, y otros desechos que no tienen la capacidad de transmitir enfermedades (HCWH 2003). Para botar estos desechos sin contaminacion, se necesita de dos procesos, tratamiento y almacenamiento, antes de esto,los desechos no son consideradan seguro. Hay varios tratamientos de desechos infecciosos, los más communes son por incineración (cuando se quema con temperaturas muy altas) y autoclavado (desinfección con vapor). En los dos procesos, el resultodo es excelente hasta el punto que quedan desinfectados y ya puede echar los desechos orgánico o no-contamianante. Desafortunadamente la incineración produce mucha contaminación del medioambeinte y se debe evitar esta manera de tratamiento si es possible. El almacenamiento de los desechos infecciosos occure cuando pone los desechos en un lugar seguro en donde no hay la posibilidad de merma, contaminacion, y en donde no pueden contactar personas o el medioambiente. Este lugar es generalmente un hueco grande hecho o sala de cemento, hecho solamente para almacenaje de desechos infecciosos. Como hay buen acceso a las tecnología de tratamiento de desechos infecciosos en muchas lugares rurales, se usa las salas o huecos de almacenamiento que es la manera más común para manejar los desechos infecciosos en lugares rurales (CGH).

De estos métodos, el autoclave y otras tecnologías que no nesecita quemar los desechos son las mejores para manejar los desechos infecciosos por que son la que tienen menor 'huella ecolósgico' en el mundo (se usa lo minimo de los recursos en total). Pero tambien, estas tecnologías son muy difíciles de encontrarlas en lugares rurales. Una solución a este problema para reunir todos los desechos en contenedores seguros es usar una camioneta para recoger los

desperdidios en un intervalo regular (usualmente cuando los suministros son distribuido s) de todos facilidades de asistencia sanitaria en una región, y transportar estos desechos con más facilidad (usualmente un hospital) que puedan manejar los desechos efectivamente. Este es un sistema muy efectivo y fácil para manejar los desechos infecciosos (Cortese). Desafortunadamente muchas veces es muy dificil convencer a instituciones gubernamentales y públicas la implementacin de este sistema que es muy importante. Una de las sugerencias es trabajar con alguno de estos métodos mientras existe una solución efectiva a este problema, esto implica un trabajo fuerte y responsable pero lo más importante son los resultados. Los desechos que no son bien manejados son MUY peligrosos, por la irresponsabilidad y pueden causar grandes daños. En conclusión son un gran riesgo a la salud de todo de la comunidad es decir el punto opuesto de las metas de asistencia sanitaria (WHO).

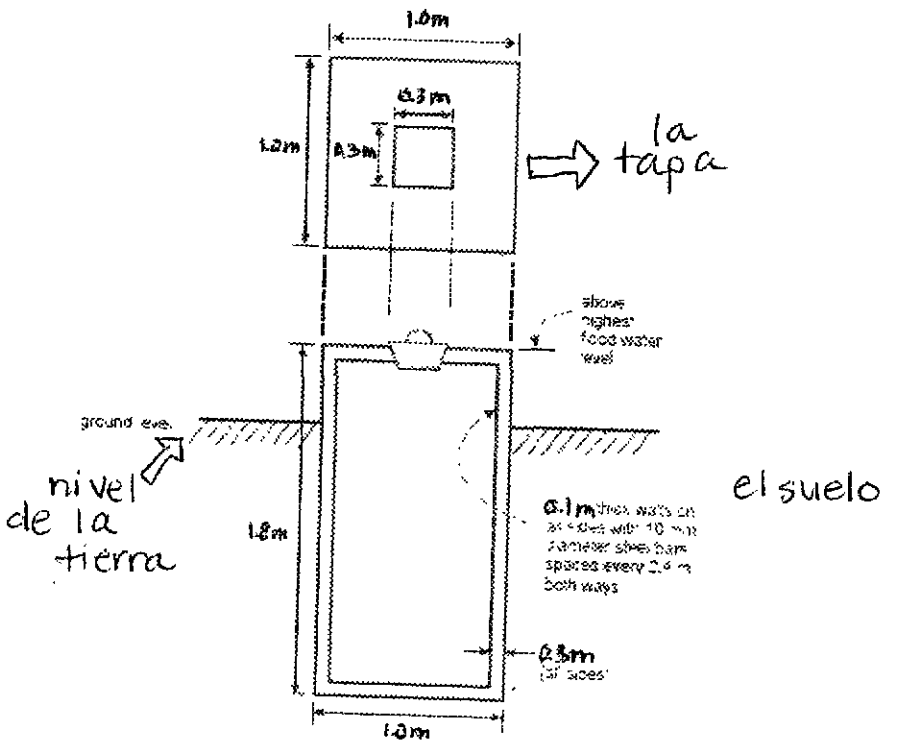
NOTA IMPORTANTE: Los desechos infecciosos sin tratamiento son BASTANTE peligrosos para todas las personas que estan en contacto ellos. Todas las facilidades de asistencia sanitaria que se usa en un sistema local para manejar sus desechos nesecitan estar ABSOLUTAMENTE SEGUROS, que la empresa separe los desechos infecciosos y su manejo sea de una manera correcta. Si no esta ABSOLUTAMENTE SEGURO que estos métodos sean los eficientes, busque otro plan para almacenar INMEDIATAMENTE los desechos en la propiedad de la facilidad de asistencia sanitarja hasta un que tenga solucion permanente .



ALMANCENAJE:

En la parte posterior de esta la información hay instrucciones sobre las maneras para almacenar desechos infecciosos 'en-sitio' con seguridad.

HOYOS DE CEMENTO- Los hoyos de cemento son la manera más segura y más fácil de almancenaje de los desechos infecciosos. El cemento es un material que no puede degradarse y puede resistir a mucha fuerza, porque estos hoyos de cemento permaneceráns muy duro despues de mucho tiempo. El diseño básico de estos hoyos estan en el dibujo e instrucciones que constan debajo de esta página y se puede construir con un mínimo de materiales de cada lugar rural. El diseño necesita acceso a trabajadores, palas, cemento, y astas de rebar. Debe construir los hoyos en un lugar privado en la propiedad de la facilidad de asistencia sanitaria, rodeado con una cerca, y cerrar con cemento cuando esten llenos (Emmanuel).



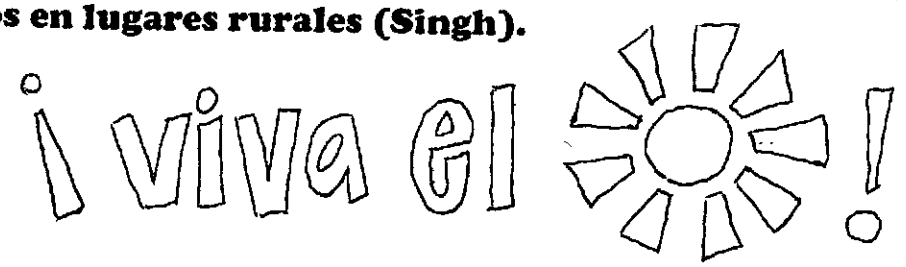
TRATAMIENTOS:

Abajo de esta información estan los tratamientos mas comunes para manejar los desechos infecciosos y sus ventajas y disventajas.

INCINERACION- Incineración es simplemente el proceso de quemado de materiales infecciosos con temperaturas muy altas para matar todos de los focos infecciosos y reducir el material a un volumen demasiado menor que el original. Puede manejarse los restos de incineración con otros desechos no-infecciosos. Mientras que por un lado la incineración es muy efectiva por otro ladoes una amenaza como desechos infecciosos, es últimamente el origen de los problemas del medioambiente que se debe resolver. Puede producir aire toxico y cenizas tóxicas (Allsopp). Las emisiones del aire contaminan el medioambiente local pero tambien estan libre con los vientos para contaminar otros lugares en el mundo. En suma la incineración puede crear compuestos toxicos nuevos, se llaman bioxinos, si hay cosas de plastico como PVC y otros tipos en los desechos incinerados (HCWH 2003).

AUTOCLAVES- Autoclaves son máquinas comunes en muchas hospitales y han estado funcionando por muchos años para esterilizar instrumentos medicos reutilizable y cosas de vidrio de los laboratorios. Hace viente anos mas o menos se ha usado para tratar desechos medicos. Una autoclave consiste en una cámara de metal sellada con un puerta pesada y rodeada con una champa de vapor. Vapor fuera de la cámara (en la champa) y dentro de la cámara donde los desechos son expuesto a temperaturas muy altas por un tiempo especifico. Los restos no son infecciosos y pueden botarlos con los otros desechos no-infecciosos (Emmanuel). Hay autoclaves en muchos tamaños que van desde máquinas pequeñas que puede mover cosas pequeñas,

hasta máquinas muy grandes que pueden cargar máss de una tonelada de los desechos cada hora. Son muy caros, pero hay modelos que son refabricado y son mas barrato cuando la meta es para trata desechos medicos. Recientemente se ha creado planes sobre autoclaves solares que no necesitan electricidad. En lugares rurales en India, estas autoclaves solares ha funcionado con muchisimo éxito y han resultado un buen ejemplo de solucion para el problema de desechos medicos en lugares rurales (Singh).



ACCIONES DE LA COMUNIDAD:

Esta seccion contiene una serie de plantillas de cartas a varias oficiales del gobierno, ONGS, y compañias sin-ganacia. Las cartas deben explicar la situacion presente en lugares rurales en Manabi sobre los desechos médicos y destaca la importancia de aplicar un sistema organizado para la transportación y administracion de los desechos infecciosos en todo de la provincia. Tambien las cartas deben proponer un resumen y plan basico para un sistema e incluyen costos estimados. Una carta pide a financiacion y/o ayuda en insta el gobierno a apoyar este plan, otra carta pide directamente al gobierno su apoyo, y la última carta pide una promesa de colaboracion en hacienda al plan si esta aprobado. Los nombres de personas a quien puede enviar las cartas y su informacion de contacto estan en frente de cada carta con una descripción breve sobre sus organizaciones o posiciones. Hay un lista adicional de contactos y recursos del internet dividida por temas en las últimas páginas de este guia. Estas cartas son simplemente plantillas, y por favor cambiarlas para referirse a situaciones parecidas a su facilidad de asistencia sanitaria. Las acciones de las comunidades son una de los mejores vias que pueden cambiar el mundo, y la colaboración entre las comunidades con metas y situaciones similares casi seguro que resulte como un gran éxito.

UNA CARTA QUE PIDE DIRECTAMENTE AL GOBIERNO SU APOYA

Algunos recipientes de esta carta deben ser...

Ministro de Salud Publica—la autoridad más alta del gobierno en asuntos de sanitaria

Nombre: Guillermo Wagner
Numero del teléfono: 5 932 297 2900 ext. 2841
Email: despacho@msp.gov.ec

Ministro del Medioambiente—la autoridad más alta del gobierno en asuntos del medioambiente

Numero del teléfono: 5 932 2563429
Dirección: Avenida Eloy Alfaro y Amazonas. Quito.
Email: mma@ambiente.gov.ec

A quien concerna:

Párrafo 1:

>Introduzca su trabajo, su organización, y su situación en el mundo
>Indique brevemente el propósito de su carta (en este caso, pide a financiación y/o ayuda en insta el gobierno a apoyar un plan)
>Proporcione el fondo información acerca del problema que usted desea resolver (Por ejemplo: no hay opciones para tratar los desechos médicos infecciosos) y por qué obliga y digno de mención (¿En que tiempo ha sido un problema? ¿Por qué es un problema? Lista las tentativas previas resolverlo y la situación actual ahora)
**** mucha de la información que usted necesita para esta sección se puede encontrar en esta guía, pero ve ´más información´ para el acceso a recursos ****

Párrafo 2:

>Discuta su solución propuesta al problema, incluye los costos aproximados. ¿Cómo específicamente lo aplicaría usted en su conjunto exacto de circunstancias? (mucha de la información que usted necesita para esta sección se puede encontrar en esta guía, pero ve ´más información´ para el acceso a recursos)
>Explique que el problema es imposible resolver sin apoyo gubernamental repleto debido al carácter nacional de una solución apropiada.
>Diga que la gente de una nación son sólo tan sanas como su ambiente circundante los permite ser y esta salud da a luz su potencial para el crecimiento.
>Diga que para estas razones, usted debe hacer este problema una prioridad; para descuidar que sólo aflojaría la habilidad de este país para ser un jefe de estado en el desarrollo sostenible y moderno.

Párrafo 3:

>Vuelva a exponer los puntos más compulsivos de su argumento
>Dé gracias pródigamente al recipiente para su tiempo y la atención
>Ofrezca su información del contacto en caso de que el recipiente tenga más preguntas o desee información adicional

Sinceramente,
Firme aquí y proporcione una lista completa de su información del contacto (el número de teléfono, la dirección, y la dirección email)

UNA CARTA QUE PIDE A FINANCIACION Y/O AYUDA EN INSTA EL GOBIERNO A APOYAR UN PLAN

Algunos recipientes de esta carta deben ser...

Salud sin Daño (Health Care Without Harm)– Salud sin Daño es una coalición internacional de más de 443 organizaciones en 52 paises que trabajan para transformar el sector del cuidado de la salud, para que deje de ser una fuente de daño para las personas y el ambiente. Pida una carta de apoyo que habla directamente con el gobierno y/o cualquier trabajo del cabildeo/apoyo que ellos quizás sean implicados en y/o información sobre recursos apropiados de su tema.

Nombre: Verónica Odriozola
Numero del teléfono: 54 114 701 8872
Dirección: 3 de Febrero 3062, 1429 Capital Federal, Argentina
Email: info@saludsindano.org

***H2E– Una organización de hospitales en los estados unidos que trabaja a mejorar el medioambiente. Pida una carta de apoyo que habla directamente con el gobierno y/o cualquier trabajo del cabildeo/apoyo que ellos quizás sean implicados en y/o información sobre recursos apropiados de su tema.**

Nombre: Laura Brannen
Numero del teléfono: 1 603 795 9966
Direction: Hospitals for a Healthy Environment, P.O. Box 376, One Lyme Common, Lyme, NH 03768

***NOVATION– Una compañía médica grande del suministro en los estados unidos que tiene una historia del trabajo con metas a mejorar el ambiente. Pida peticionar las compañías médicas que suministran su facilidad para reducir la cantidad del envase ellos utilizan. Pida también los donativos de termómetros de no-mercurio.**

Nombre: Nataaka Singleton
Numero del teléfono: 1 972 581 5529
Dirección: P.O. Box 140909, Irving, TX 75014-0909
Email: nsingleton@novationco.com

*** necesita escribir estas cartas en inglés porque las compañias no entenderán español, pero si pueda escribirlas en español, puede contactar brown.blair@gmail.com sobre traducción gratis**

A quien concerna:

Párrafo 1:

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>indique brevemente el propósito de su carta (en este caso, pide a financiación y/o ayuda en insta el gobierno a apoyar un plan)
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Párrafo 2:

>Discuta su solución propuesta al problema, incluye los costos aproximados. ¿Cómo específicamente lo aplicaría usted en su conjunto exacto de circunstancias? (mucha de la información que usted necesita para esta sección se puede encontrar en esta guía, pero ve ´más información´ para el acceso a recursos)
>Explique que el problema es imposible resolver sin apoyo gubernamental repleto debido al carácter nacional de una solución apropiada.
>Diga que es el carácter desgraciado de gobiernos a menudo dejar pasar las peticiones y los pedidos de poblaciones marginados, pero éstos son las poblaciones que pueden beneficiar la mayoría del de la implementación de la política.
>Pida el apoyo abierto de la organización o institución (en cualquier manera que ellos quieren darlo) en las esperanzas que ellos quizás ayuden a convencer el gobierno de la importancia arrolladucho de este problema.

Párrafo 3:

>Vuelva a exponer los puntos más compulsivos de su argumento
>Dé gracias pródigamente al recipiente para su tiempo y la atención
>Ofrezca su información del contacto en caso de que el recipiente tenga más preguntas o desee información adicional

Sinceramente,
Firme aquí y proporcione una lista completa de su información del contacto (el número de teléfono, la dirección, y la dirección email)

UNA CARTA QUE PIDE UNA PROMESA DE COLABORACION EN HACIENDA AL PLAN SI ESTA APROBADO

Algunos recipientes de esta carta deben ser...

***7ma Generación-- Una compañía en los estados unidos que fabrica los productos biodegradables. Pida los donativos de jabones de mano, los jabones de ropa sucia, los jabones de platos, y cualquier otros artículos apropiados ellos quizás estén dispuestos a dar.**

Nombre: Seventh Generation, Inc.
Numero del teléfono: 1 802 658 3773
Dirección: 60 Lake Street, Burlington, VT, 05401-5218
Email: Usa su pagina de la red @
www.seventhgeneration.com/contact_us/index.php

Proyecto Quito-- Una organización de la facultad de medicina en la universidad de michigan que trabaja a mejorar asistencia médica en Quito. Porque estudiantes y profesores siempre viajan de aquí para allá entre Ecuador y los Estados Unidos, piden una promesa para transportar artículos donado y comprado de los estados unidos a Quito y los puso en un autobús al Porto Viejo para evitar pagar los costos de envío exorbitante.

Nombre: Darren Morris
Email: darren.morris@thequitoproject.org

***Sustainable Village-- Una organización en los estados unidos que es un banco de los recursos que ayudan le a vivir en una manera ambientalmente responsable. Pida una promesa para encontrar y contratar una compañía para construir una autoclave solar en el hospital regional en Porto Viejo. Pida también cualquier otros servicios ellos estarían dispuestos a proporcionar.**

Numero del teléfono: 1 303 998 1323
Dirección: 717 Poplar Ave, Boulder, CO 80304
Email: info@sustainablevillage.com

*** necesita escribir estas cartas en inglés porque las compañías no entenderán español, pero si pueda escribirlas en espanol, puede contactar brown.blair@gmail.com sobre traducción gratis**

A quien concerna:

Párrafo 1:

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Párrafo 2:

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>Explique que el problema es imposible resolver sin apoyo gubernamental repleto debido al carácter nacional de una solución apropiada.
>Diga que es el carácter desgraciado de gobiernos a menudo dejar pasar las peticiones y los pedidos de poblaciones marginados, pero éstos son las poblaciones que pueden beneficiar la mayoría del de la implementación de la política.
>Pida la organización o institución para prometer sus servicios, los productos, los fondos, el apoyo, etc. si el plan propuesto es adoptado.
>Explique que estas promesas ayudarán a convencer el gobierno de la viabilidad y la necesidad de este plan y ayudar a asegurar su aprobación.

Párrafo 3:

>Vuelva a exponer los puntos más compulsivos de su argumento
>Dé gracias pródigamente al recipiente para su tiempo y la atención
>Ofrezca su información del contacto en caso de que el recipiente tenga más preguntas o desee información adicional

Sinceramente,
Firme aquí y proporcione una lista completa de su información del contacto (el número de teléfono, la dirección, y la dirección email)

ULTIMOS PALABRAS

****

MÁS INFORMACION
(divide en temas)

Para más información sobre cualquier tema de esta guía, por favor contacta los recursos que se encuentran en la página de la red www.noharm.org/globalsouthspn. Hay cosas y contactos allí sobre todas de las temas en esta guia. Si hay cosas de las que requiere más información pero no ve recursos aquí, por favor contacta brown.blair@gmail.com seguro obtendrá para mas información.

RECONOCIMIENTOS

La inspiración de esta guía fue de todos los trabajadores de asistencia sanitaria el la provincia Manabi, en el Ecuador. Sus palabras generosas están informadas en cada página aquí. Esta guía no hubiera sido posible sin el regalo de su tiempo y su conocimiento. No hay palabras que expresen mis gracias a su participación en este trabajo. También quiero dar gracias a Nicola Mears por sus contactos, pensamientos, revisiones, sugerencias, apoyo, y confianza brillante en mi idea, y por su comida y casa también. Gracias a Sylvia y Xavier por su confianza en mis habilidades y por darme permiso a explorar esta nueva tierra con mi tema y este proyecto, y a Paquita Veloz, porque sin sus correcciones nadie hubiera podido entender mi español, y a Crissy Haley, sin su presencia no hubiera sobrevivido este proyecto, y a toda la gente de Bahia de Caraquez, su hospitalidad nunca la olvidaré.

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Appendix V.

Instructions for Building a Solar Powered Autoclave; winning entry of HCWH rural healthcare technology competition

Sourced From: http://noharm.org/details.cfm?type=document&id=756

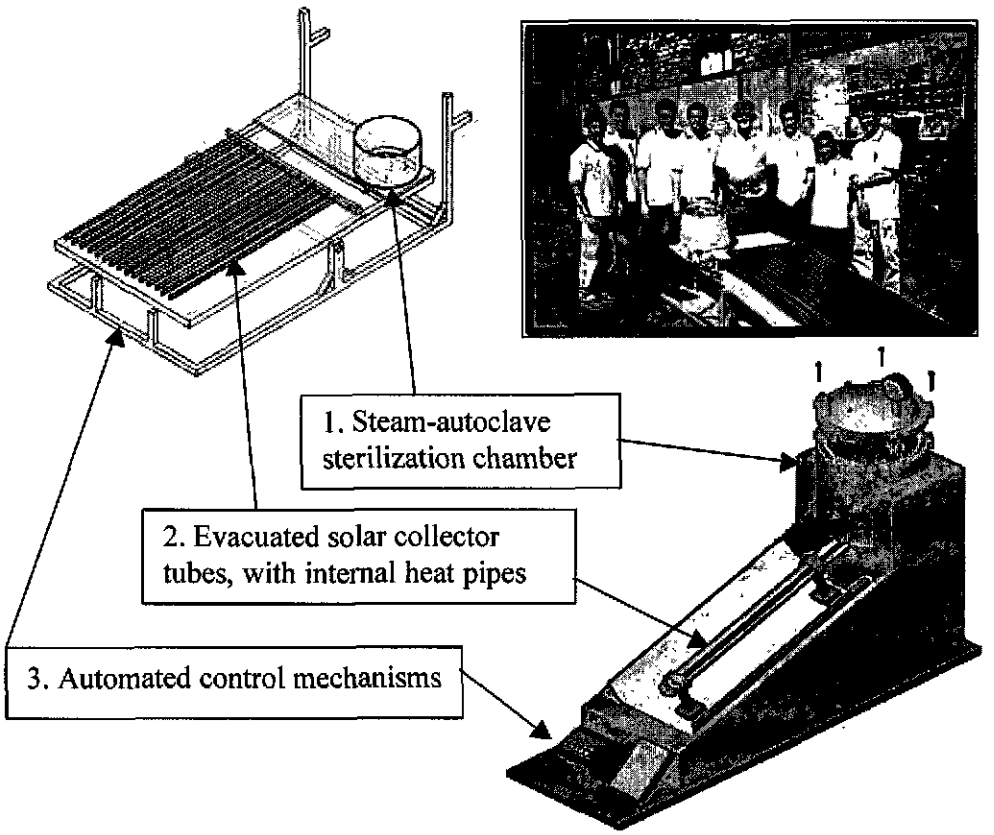
1st Place

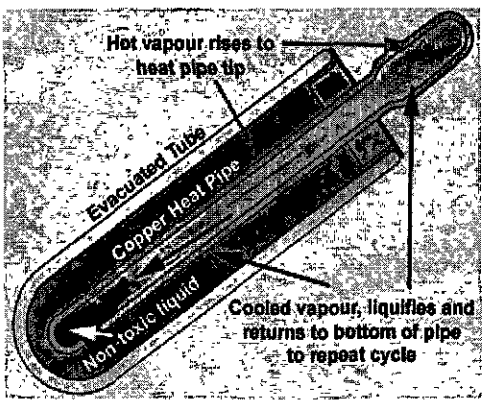
PORTABLE SOLAR-POWERED AUTOCLAVE

Adapted from the entry by: Rhys Hardwick Jones, Iain Brown, Joshua Przybylko, Sandra Fisher, James Tracey, and Nicholas Russell – Sydney University, Australia

DESIGN CONCEPT

Our design concept is a completely solar-powered autoclave-style sterilizer, which provides cheap, non-burn, portable sterilization to rural areas, and operates in both sunny *and* cloudy conditions. Prototypes using this design have been successfully built and tested by research teams at Sydney University. One prototype is much larger, with a capacity of 14 liters per batch. The other version is more portable, and has a capacity of just 1.5 liters per batch. Both prototypes utilize the same technology, and are shown in the "Technical Illustrations" section.



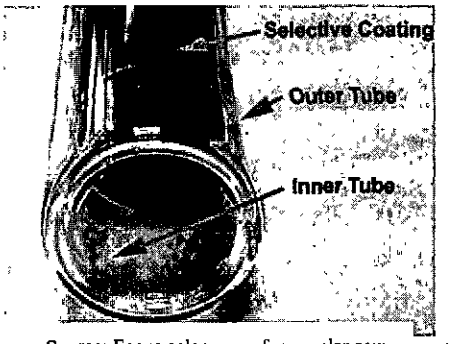


Source: Focus-Solar www.focus-solar.com

The device, nicknamed Prometheus, consists of a sterilization chamber which is directly connected to a set of long copper U-tubes, which in turn are encased in evacuated solar collector tubes. These evacuated tubes are highly efficient collectors of solar thermal energy. The sun's rays strike these tubes, and the energy which is gathered is used to heat water which has been poured into the copper

U-tubes inside. A thermosiphon effect is established, which is illustrated opposite. The water continues to be heated until it evaporates, then the steam is superheated until the whole system reaches equilibrium at temperatures between 121°C-134°C, at which steam sterilization can be achieved.[1] The waste load sits in a basket inside the chamber, where the steam can permeate throughout the load and kill any harmful bacteria.

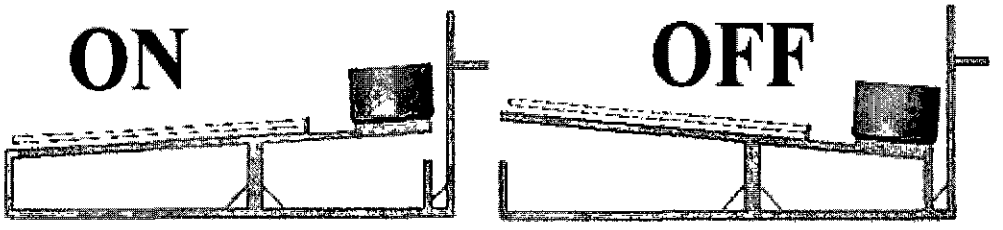
The evacuated solar collector tubes are cheap and readily available from a number of suppliers. The optically sensitive surface of the evacuated tubes allows visible light and UV radiation to pass into but not out of the tubes. The radiation is absorbed as heat. The vacuum between the glass layers acts as an extremely effective thermal insulator, such that at least 92% of energy absorbed is transferred to the copper U-tubes. The glass in the tubes is strong enough to withstand impact from hailstones up to 25mm in diameter.[2] However, the most remarkable property of these tubes is their ability to operate in cold, cloudy and even in rainy conditions, although sunny conditions are clearly optimal. This is because the vacuum does not allow heat loss



Source: Focus solar www.focus-solar.com

due to conduction or convection. The effectiveness of the tube depends mainly on the insolation level of the location, which is a measure of the amount of solar radiation striking an area.[3] This means that even in areas with cold, cloudy, windy winters, it is possible to use the technology all year round.

The heat supply to the pressure chamber can be automatically controlled by the use of a small micro-controller and actuator. An electronic thermocouple wire runs from the chamber of the device to the controller, delivering information about the operating temperatures. As soon as the temperature reaches the required level, the heat supply is cut off to avoid overheating. For a large device with 10 or more evacuated tubes, this can be accomplished by using the motor to tilt the evacuated tubes in the opposite direction, so that the thermosiphon effect is halted.



[1] Cole E., Pierson T. et al. *Guidance for Evaluating Medical Waste Treatment Technologies.* Report for the United States Environmental Protection Agency, 1993. pp25
Available at http://www.epa.gov/epaoswer/other/medical/download.htm
[2] For a chart of worldwide insolation levels, see http://www.focus-solar.com/insolation_levels.htm
[3] Cole, Pierson et al, 1993, pp3

When the chamber is above the collector tubes, a thermosiphon is created, and superheated steam is generated in the pressure vessel. If the tilt is reversed, the thermosiphon effect ceases, and no more heat is supplied.

In the smaller device, the heat supply can be cut off by programming the motor to pull a retractable cover over the evacuated tube and parabolic mirror. In keeping with the environmentally friendly nature of the technology, the micro-controller and actuator are powered by a 12V battery, which is constantly recharged by a small solar electrical panel. For further heat control mechanisms and safety features, please the section "Safety Procedures and Maintenance."

TECHNICAL ILLUSTRATIONS

A) Large capacity device

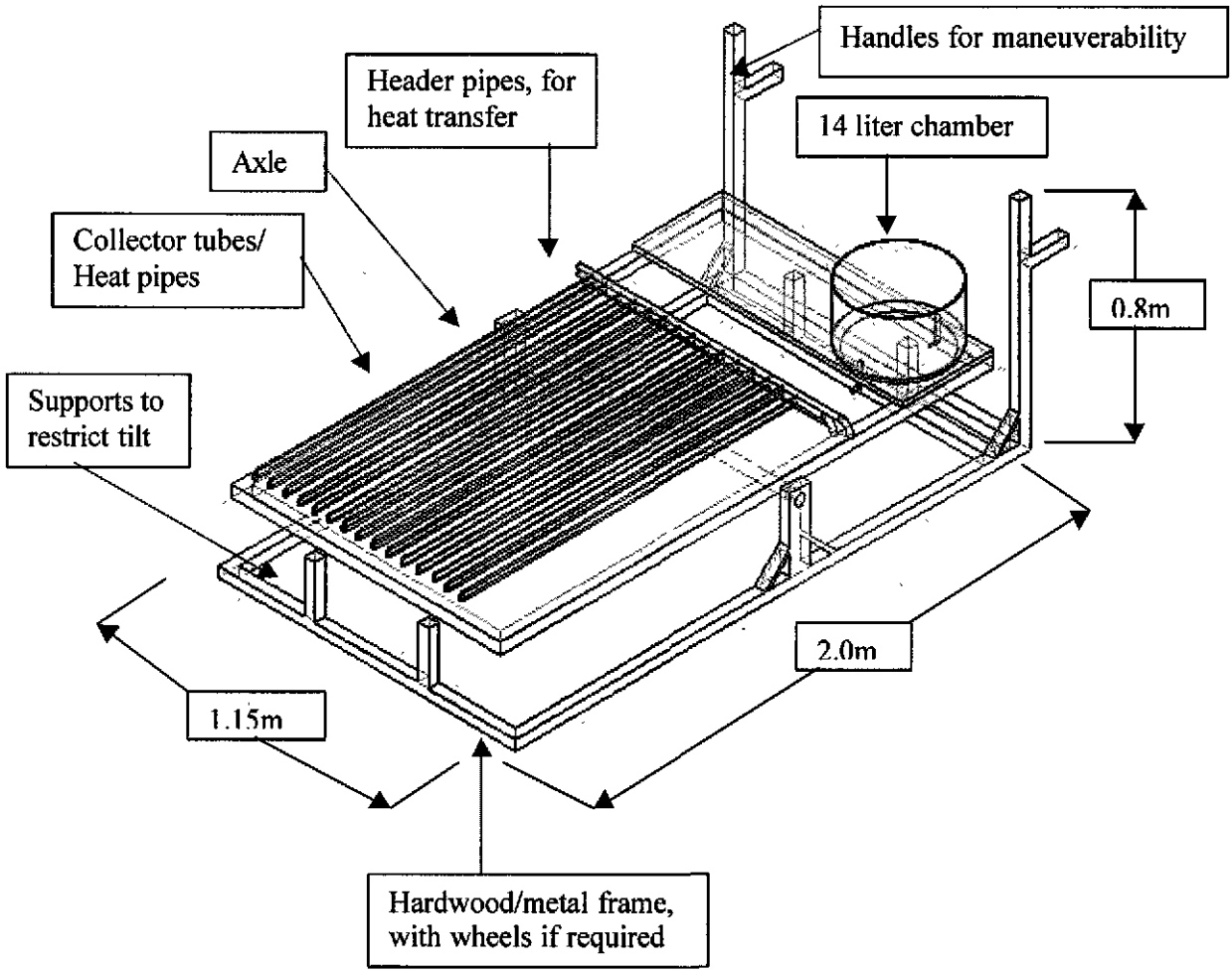


Table 2.1: Vital statistics for large capacity device

Processing capacity	14 liters per batch
Number of evacuated collector tubes	15-20

Average power output from collectors	300-400W
Operating conditions inside chamber during sterilization	Temperature: 121°C – 134°C
	Pressure: 98kPa – 212kPa (gauge)
Time period for one sterilization cycle	55-80 minutes
Cost of construction per unit	US$1694

B) A small, portable device

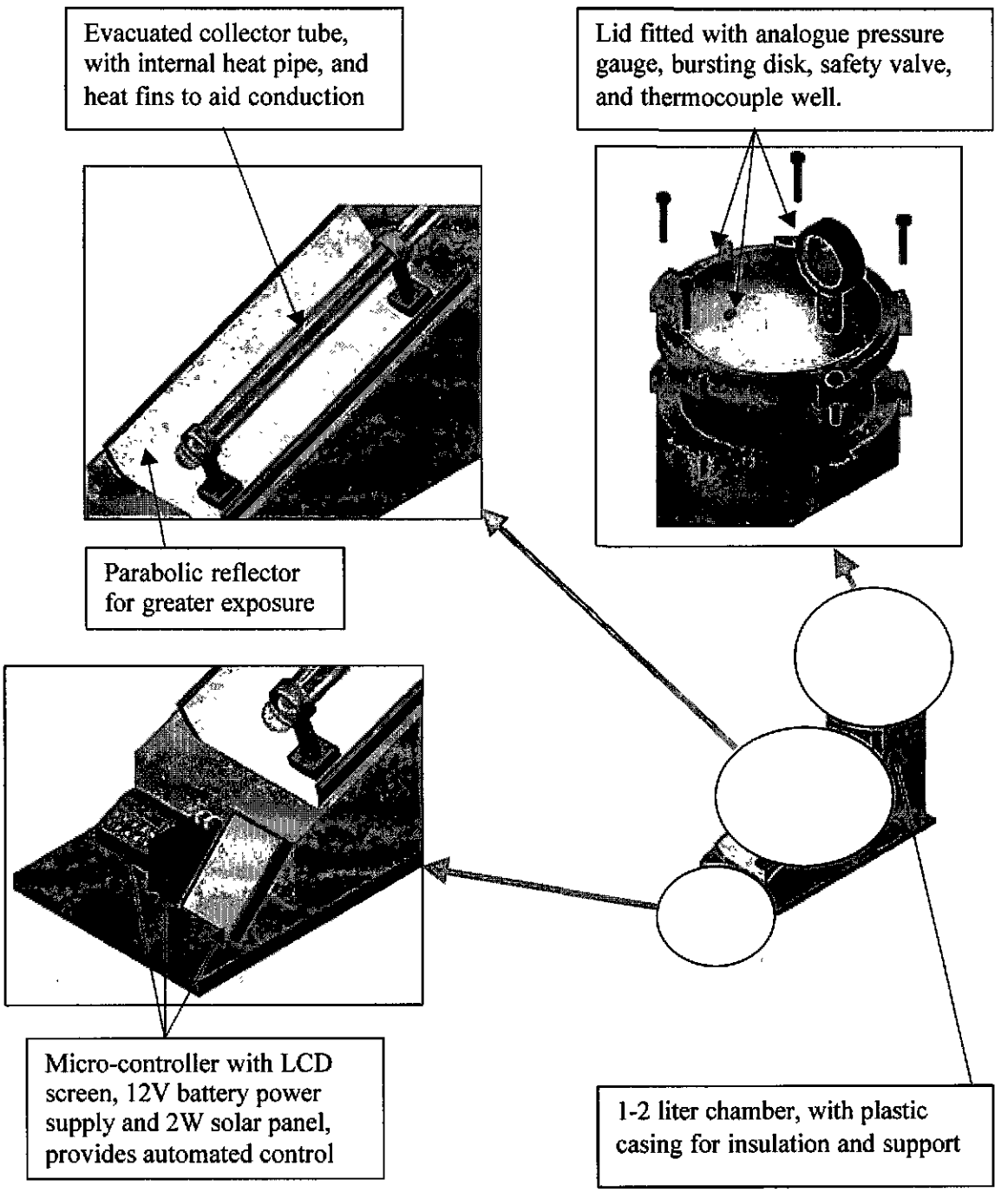


Table 2.2: Vital statistics for portable device

Processing capacity	1.5 liter
Number of collector tubes	1
Average power output from collectors	80-120W
Operating conditions inside chamber during sterilization	Temperature: 121°C – 134°C
	Pressure: 98kPa – 212kPa (gauge)

Time period for one sterilization cycle	40-65 minutes
Cost of construction per unit	US$650

DISINFECTION

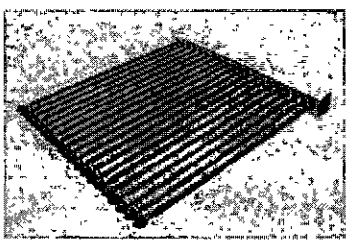
Steam sterilization has very effective microbial inactivation levels. It satisfies both of the widely accepted high-level benchmarks: the death of 10^4 Bacillus subtilis spores and the death of 10^6 Bacillus stearothermophilus spores. Bacillus stearothermophilus is regarded as the most resistant bacterium to moist heat, and as such represents the highest level of microbial inactivation efficacy for steam autoclaving.

The speed at which these results are achieved is dependant on steam temperature. At the minimum steam temperature of 121°C, acceptable levels of inactivation can be assured after 30 minutes of continuous operation. As the temperature rises, inactivation becomes more efficient. At steam temperatures greater than 134°C, complete sterilization occurs in just 5 minutes of continuous exposure.

If the device is fitted with an electronic thermocouple and automated control, the temperature can be monitored so that the process can be terminated at the most efficient time.

MATERIALS FOR CONSTRUCTION

All materials required for this technology are readily available, but greater cost minimization could be achieved by taking responsibility for the manufacturing of certain components, such as the sterilization chamber for small capacity models of the device in particular. An itemized list of required components, and the source from which they can be obtained, is provided in the table below.

PART	SUPPLIER
Pressure vessel (the chamber in which sterilization takes place)	All American Autoclaves (Wisconsin Aluminum) www.wafco.com/wafopening.html There are three sizes available: 1915X model – 14 liters (15 Qt). 1925X model – 23.6 liters (25 Qt). 1941X model – 33.8 liters (41 Qt).
Solar evacuated tubes and heat-pipes. 	Pre-manufactured collector arrays: Focus-solar www.focus-solar.com Powertech solar www.powertech-solar.co.uk/index.htm Solar design www.solar-design.demon.co.uk This is a very competitive industry, and there are many more suppliers of these arrays. Individual collector tubes: Himin solar energy www.himin.com/english/index.htm

	Contact Sydney University Applied Physics Department for information: d.mills@physic.usyd.edu.au
Pressure fittings used to connect the array to the pressure vessel.	Any valve or fitting company.
Wooden frame: • 2 large sheets of 19mm plywood. • 40x60x1000mm piece of hardwood. • 2 trolley wheels • 4 metal braces • Metal axel and fittings • Screws	All components available at a local hardware store or timber yard
Pressure verification tape	Any health care supplies company
Optional components required for complete automation of device	
Electronic thermocouple	Local electronics store.
Micro-controller	Intel
Printer	We used a DP1000, available from DedLines: www.ded.co.uk
Actuator	Local electronics/hobby store
12V battery	Local electronics/hobby store
30W solar cell	Local electronics/hobby store
Circuit components	Local electronics/hobby store

The All American autoclaves appear to be the cheapest and most versatile pressure chamber available. They are designed to be used with an auxiliary heat source, and come fitted with a pressure gauge, safety release valve, and emergency blow-off disc, which prevents catastrophic failure. Alternatively, it would be possible to order custom made pressure chambers either from Wisconsin Aluminum or any other metal casting company.

CONSTRUCTION OPTIONS

The most skill-intensive process involved in the construction of this technology is construction and/or modification of the sterilization chamber itself. There are two options:

1. Use pre-manufactured stove-top sterilizers, such as the All American *1915X*, as we did for our large 14 liter prototype. The only modification required is the drilling of two holes in the base, so that the vessel can be connected, through the use of pressure fittings, to the solar collector array. It is important that this procedure is performed by a skilled workshop machinist, to ensure that the structural integrity of the pressure vessel is not compromised. This modification can be made in less than an hour.
2. Manufacture custom-designed, as we did for our small 1 liter prototype. This procedure must be performed by a certified boilermaker, since the vessel will be pressurized. As suggested above, the best solution would be to contract the services of a metal casting/forging company. However, in terms of financial and temporal cost, this strategy would probably only be viable for mass-production of units.

Based on our experience, it seems that the best strategy would be to use the pre-manufactured vessels for large capacity devices, and to produce custom made chambers for smaller devices.

There is a similar choice to be made with regards to the solar collector array. It can either be bought pre-fabricated, or constructed from individual tubes, which would require more skilled labor. Again, we would recommend that for the larger (10-20 liter) devices, a complete array of 15-30 tubes be purchased. For small devices with a capacity less than 3 liters, it would be more economical to use a single evacuated tube with a parabolic mirror constructed from sheet aluminum.

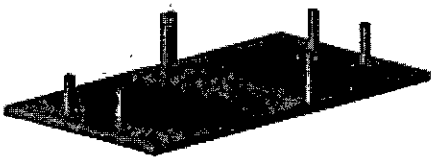
The wooden frame used for the larger prototype was constructed by a student with rudimentary high-school knowledge of woodworking, and hand tools, in approximately 7 hours. In a workshop with power tools, construction time could be as little as 2-3 hours. The pressure fittings can be attached within one hour by a single person. The only tool required is an adjustable wrench.

The total time for construction will depend on the choices made with regard to components, and on shipping times. With all components pre-manufactured, each unit could be constructed within 1-2 days. However, even if the pressure vessel and collector array are constructed to a custom design, the device should be able to be completely fabricated within 1-2 weeks.

BASIC STEPS FOR CONSTRUCTION

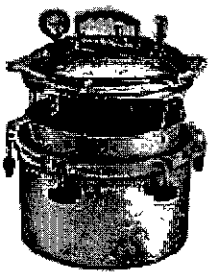
The following guide details the procedure required to build a solar powered medical sterilizer, with automated control and a 14 liter processing capacity per batch. It assumes that all the components listed have been obtained.

Step 1: Build the frame:



Construct the frame (as illustrated) from wooden materials using the dimensions specified on page 3 as a guide. The axle, upon which collector array is placed, should be located approximately half-way along the length of the device. When all the other components are added, the device should lean towards the off position, as shown on page 2. Only a small force should be required to tilt the collector array into the on position.

Step 2: Modify the pressure vessel:



Drill two holes through the bottom of the vessel. The holes should be of appropriate size to accommodate two stainless steel bulkhead fittings. These fittings will provide the connection between the header pipes of the collector array and the pressure chamber.

The top of the pressure vessel also needs to be slightly modified. Remove the analogue pressure gauge from the lid, and insert a stainless steel T-connector into the thread which it previously occupied. Now re-attach the analogue gauge to one port of the T-connector. In the other port, attach a thermocouple well, which can be obtained from most pipe and fitting companies along with the other pressure fittings.

Step 3: Attach the collector array and pressure vessel to the frame:

This step is self-explanatory. The collector array should have holes in it that can be used with screws or nuts and bolts. If it doesn't, it can be modified. Connect the header pipes of the collector array to the bulkhead fittings which are now protruding out of the bottom of the pressure vessel.

Step 4: Program the automatic control:

The micro-controller will require programming, but nothing more complicated than can be achieved by a first year university student. Add the printer, battery, solar panel, and electric motor to the circuit. The motor should be as close to the end of the device as possible, so as to increase the lever arm and reduce the torque required from the motor to reverse the tilt on the collector.

The device is now complete. For operation, the header pipes of the collector array should be filled with water to a level such that water just begins to overflow out of the bulkhead fittings inside the pressure chamber.

CYCLE TIME

These calculations provide an estimate of the time taken per cycle in poor condition (insolation level less than 3), for a large and small capacity device. The time of each cycle ranges from about 40 minutes through to 2 hours, and depends heavily on the total weight of water in the system. An increase in water means an increase in thermal mass, and a longer cycle time. Therefore the process will be most efficient if the amount of water used in a cycle is strictly controlled.

Volume of water (mL)	x quality	Total input energy (kJ)	Time to temperature	Time of cycle (minutes)
100	0.0170779	51.717	**10.77**	**40.77**
200	0.0076145	99.692	**20.8**	**50.8**
300	0.0044597	147.666	**30.8**	**60.8**

Values applicable to small scale sterilizer, 1.1 liter volume, assuming net input 80W

Volume of water (mL)	x quality	Total input energy (kJ)	Time to temperature	Time of cycle (minutes)
1000	0.0248225	532.491	**29.6**	**59.6**
2000	0.0114863	1012.233	**56.2**	**86.2**
3000	0.0070494	1492.025	**82.9**	**112.9**

Values applicable to large scale sterilizer, 15.5 liter volume, assuming net input 300W

SAFETY PROCEDURES AND MAINTENANCE

a) Personnel Protection Equipment

When loading or unloading the device, it is important that the operator takes care to wear proper protective equipment. The operator should wear the following protective equipment:

- A coat that resists liquids, for protection from steam that may rush out when the release valve is opened.
- Gloves that are heat and liquid resistive, to protect the hands against hot surfaces and steam.
- Protective goggles and/or face shield, again mainly to protect from the brief burst of steam then the vessel is opened.

Caution should be taken when opening the chamber and the contents should be left to cool slightly before they are handled.

b) Hazardous surfaces or materials

Due to the high absorption and low radiation of the solar collector tubes, and the vacuum between the glass layers, the collector array remains cool to the touch even at the highest operating temperatures. The pipes and fittings between the collector tubes and the pressure chamber can be covered with basic rubber insulation tube to protect the user. However the metal pressure vessel will become very hot during operation. Care should be taken not to touch any metal surfaces and only to remove the lid by its rubber handle, while wearing protective gloves. Warning signs and stickers on the vessel will serve as a reminder not to touch these metal surfaces during operation. Standard medical waste procedure should be followed in order to protect the operator from hazardous materials which are part of the load, such as sharps.

c) Over-heating

Since the technology involves the build up of steam to reasonably high temperatures and pressures, it is important to take measures to prevent over-heating, which might cause pressure build-up and catastrophic failure, resulting in injury and damage. The Prometheus device is fitted with three separate heat control and safety devices:

1. The heat in the device can be controlled by adjusting the angle of tilt of the thermal collector array. Once the steam in the device reaches the required temperature, the evacuated tubes are tilted in the opposite direction, and the thermosiphon effect in the heat tubes is halted, thereby cutting off the heat supply to the sterilization chamber. If the temperature begins to drop down towards the 121°C threshold, the tubes can be tilted back into the "on" position, to ensure that the temperature remains high enough to achieve sterilization. Thus the heat can be controlled without jeopardizing the operating effectiveness of the device. The array is balanced on a pivot, so that the gravitational forces acting upon it cause it to revert to the "off" position. If the small electronic actuator, which controls the angle of tilt and moves

the array into the "on" position, should happen to fail, then the heat supply will be cut off from the device.

2. If this first control system should fail for any reason, and the pressure in the device begins to rise above acceptable operating levels, the device is fitted with a safety check release valve. This valve is calibrated to open as soon as the internal pressure reaches a predetermined limit, which is approximately 30psi gauge pressure. There will be an audible release of steam. If steam begins to escape through this valve, the device should be manually shut down and checked for the source of failure of the control system.
3. As a final safety measure, the vessel is fitted with a rubber bursting disk. This disk is the weakest point in the structure of the pressure chamber. If the safety check valve fails, and the pressure builds to even higher levels, the bursting disk will pop out before there is sufficient pressure to crack or damage the chamber. All steam will immediately be released from the machine. If this occurs, the device should not be used until it has been thoroughly examined and repaired if necessary.

d) Maintenance

Some regular maintenance will be required to keep the machine running effectively. Once a week, the sterilization chamber, fittings, and header pipes of the solar array should be flushed with water and mild cleaning solution, in order to prevent blockage due to build up of dirt or other contaminants. The check valve, which releases excess steam build up from the pressure chamber, will require scheduled maintenance and testing, as specified by the manufacturer. However, these valves are very reliable and this will not be necessary more than once a year.

e) Verification and Quality Assurance

This technology uses the standard verification and quality assurance procedures for steam-autoclave sterilizers, which have been well documented and defined.[4] There are two procedures in widespread use, which are required to ensure that the sterilizer is working effectively.

The first and most regular test involves placing a simple heat and pressure sensitive strip inside the autoclave along with a load of medical waste. The strip is sensitive to the conditions inside the chamber, and will change color when exposed to sufficiently high temperatures and pressures for a certain period of time. When the load is removed, the operator simply checks to see whether the color change of the strip has been satisfactory. The strip should be placed deep in the center of the load, so as to verify that the steam is permeating throughout the entire load, and complete sterilization is being achieved. This procedure is carried out on a weekly basis.

The second test is conducted bi-annually. It requires that separate spore strips with an average certified population of 10,000 B. stearothermophilis and 1,000,000 B. subtilis spores be placed in the autoclave for the duration of one sterilization cycle. These spores

[4] For a full definition of steam autoclave quality control requirements, consult European Standards EN285 and EN554.

must be placed inside special glass containers, which are provided with the strips. After the cycle is complete, the strips must be tested to guarantee that all the spores have been killed. They should be incubated for a certain period (follow the instructions supplied with the strips), and then checked for any growth. As long as there is no spore growth after incubation, the device is working satisfactorily. The examination of the strips can be carried out on site if the necessary equipment is available, or the specimens can be sent away to a laboratory for testing. There are a large number of commercial organizations which regularly perform this service for autoclave operators. A full guide for this procedure is available from the Regulatory Compliance Office at Colorado State University, or by visiting the website at http://www.research.colostate.edu/rcoweb/ib/ib_hb_autoclave.htm